DEEPWATER HORIZON OIL SPILL
LOUISIANA AND OPEN OCEAN TRUSTEE IMPLEMENTATION GROUPS

DRAFT
JOINT RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT #1:

Restoring Wetlands, Coastal, and Nearshore Habitats, Federally Managed Lands, Fish and Water Column Invertebrates, Sea Turtles, Submerged Aquatic Vegetation, and Birds of the Chandeleur Islands

June 2025

APPENDICES

Appendix A:

Chandeleur Island Restoration Project (PO-0199)

Restoration Alternatives Analysis

CHANDELEUR ISLAND RESTORATION PROJECT (PO-0199) RESTORATION ALTERNATIVES ANALYSIS

ST BERNARD PARISH, LOUISIANA

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December 09, 2024

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CHANDELEUR ISLAND RESTORATION PROJECT (PO-0199)
RESTORATION ALTERNATIVES ANALYSIS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

ACRONYMS

CEC	Coastal Engineering Consultants, Inc.
CPRA	Coastal Protection and Restoration Authority of Louisiana
EBB	Emergency Barrier Berm
ft	feet
GOM	Gulf of Mexico
HPBA	Hewes Point Borrow Area
LDWF	Louisiana Department of Wildlife and Fisheries
MCY	million cubic yards
MHW	mean high water
mm	millimeter
NAVD88	North American Vertical Datum of 1988
NDVI	Normalized Difference Vegetation Index
OSI	Ocean Surveys, Inc.
mSAV	marine submerged aquatic vegetation
SEG	SEG Environmental, Inc.
STA	baseline station
SWCA	SWCA Environmental Consultants
TY	target year
USGS	United States Geological Survey

CHANDELEUR ISLAND RESTORATION PROJECT
RESTORATION ALTERNATIVES ANALYSIS

1.0 INTRODUCTION

1.1 PROJECT PURPOSE AND NEED

The purpose of the Project is to restore the North Chandeleur and New Harbor Islands to provide habitat for several species that inhabit these islands as defined in the Restoration Plan and Environmental Assessment Plan #1 of the Region-wide Trustee Implementation Group (2021). Phase 1 of the Project focuses on plan formulation for the restoration of the main Chandeleur Island and New Harbor Island.

1.2 PROJECT LOCATION

The Chandeleur Island Restoration (PO-0199) Project (from here on will be referred to as Project) is located on the Chandeleur Islands in St. Bernard Parish, Louisiana within the Breton National Wildlife Refuge (Figure 1). The Chandeleur Islands include those lands between Breton Sound and the Gulf of Mexico to include Chandeleur Island (North and South), Gosier Islands, Grand Gosier Islands, Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands (Figure 2). Potential sand resources available for this Project are Hewes Point and St. Bernard Shoals (Figure 2). This Project Area includes North Chandeleur Island, New Harbor Island, and the seagrass beds and water bottoms (Figure 3).

1.3 AUTHORITY

The Coastal Protection Restoration Authority of Louisiana (CPRA) is the designated State agency for the Project. Funding for Engineering, Design, and Permitting comes from the Region-wide Trustee Implementation Group.

The Design Team consists of the following professional firms.

- Coastal Engineering Consultants (CEC) – Planning, Engineering, Permitting, and Prime Consultant
  - EMC – Island topographic and bathymetric surveys
  - Ocean Survey (OSI) – Borrow Area and Offshore Conveyance Corridor geophysical and geotechnical surveys
  - GeoEngineers (GEO) – Island geotechnical investigations and sediment characterizations, onshore/offshore
  - Goodwin & Associates (Goodwin) – Cultural Resource Assessments
  - SWCA Environmental (SWCA) – Seagrass and marine mammal investigations

- SEG Environmental (SEG) – Bird Surveys and habitat assessments
- Sustainable Design Solutions (SDS) – Engineering Peer Review, Oil/Gas Research and Identification
- SCAPE Landscape Architecture (SLA) – Stakeholder Engagement

CEC is pleased to present this Alternatives Analysis report that outlines the development of various Project restoration features, their combinations into potential Alternatives, comparative analysis, and the Recommended Alternative.

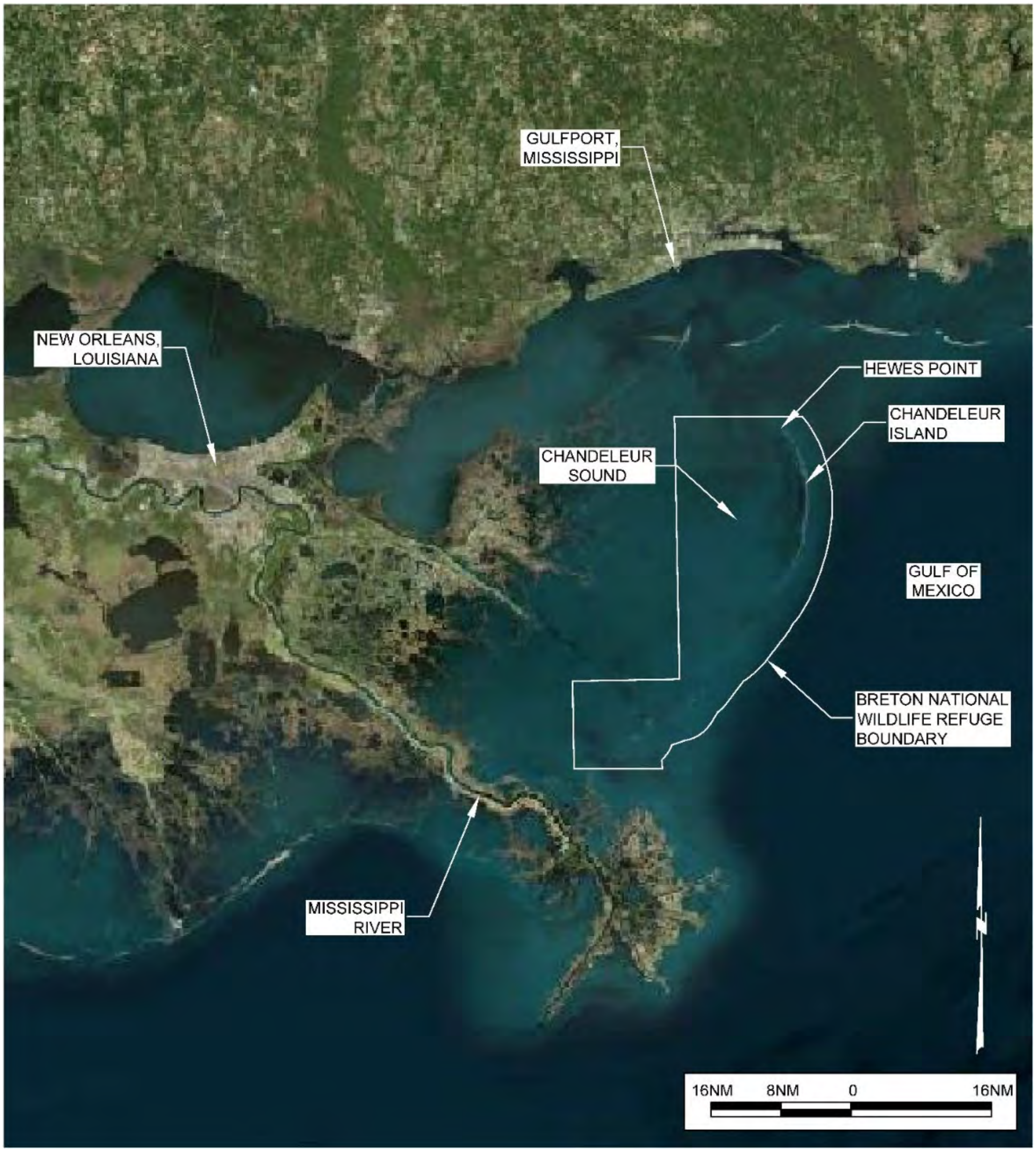

Figure 1. Project Location Map

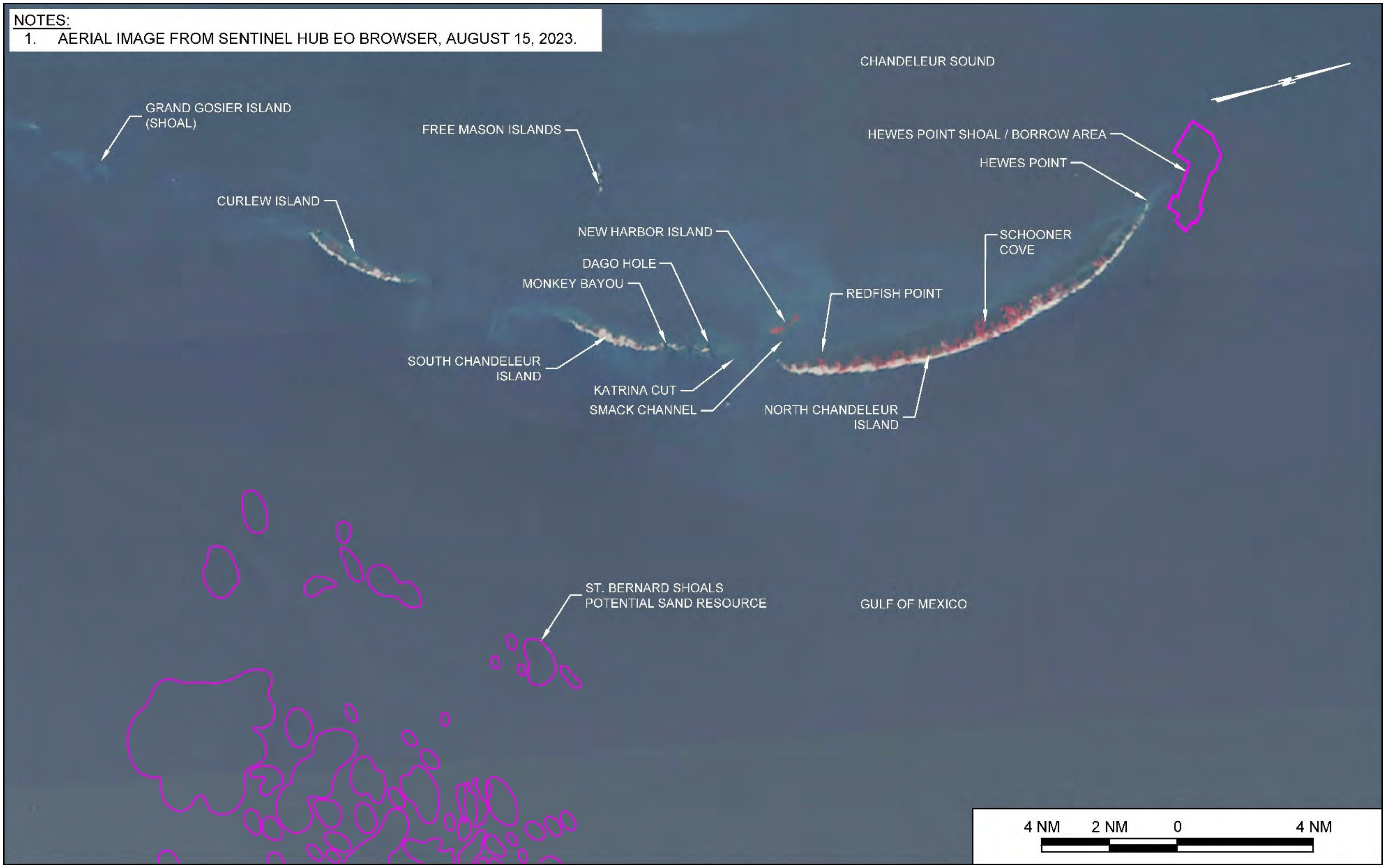

Figure 2. Chandeleur Island and Potential Sand Resources

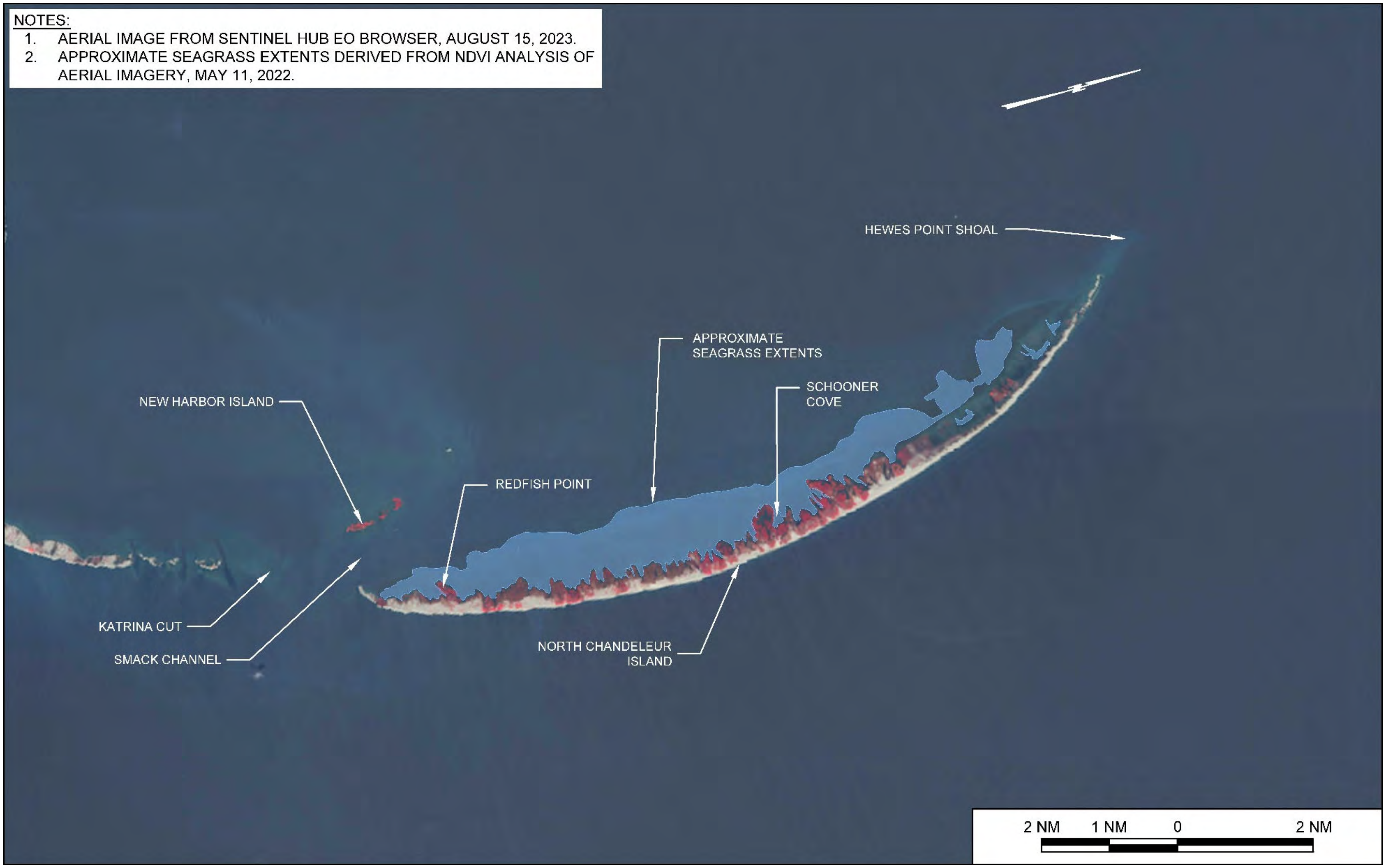

Figure 3. Project Area and Approximate Seagrass Extents

2.0 DATA COLLECTION SUMMARY

2.1 ISLAND TOPOGRAPHIC / BATHYMETRIC SURVEYS

The Island survey consisting of survey control monument installation along with topographic, bathymetric, and magnetometer surveys for North Chandeleur and New Harbor Islands was conducted by EMC from May 06 – September 17, 2023, October 29 – November 09, 2023, and February 01, 2024. The total survey transect length was approximately 252 nautical miles. The data was processed and reviewed for quality control resulting in the Island survey profiles utilized to formulate the Alternative design templates and the Alternative evaluation described herein. Details of this survey effort can be found in the *Chandeleur Island Restoration Project (PO-0199) Island Design and Borrow Area Reconnaissance Survey Report* (CEC and EMC, 2024a).

2.2 ISLAND GEOTECHNICAL INVESTIGATIONS

Geotechnical field exploration for the Project was conducted between July 23 and August 3, 2023. The exploration consisted of drilling 26 soil borings at the locations along the existing beach on the east side of the Island and on the west side of the island in Chandeleur Sound. Upon extrusion in the laboratory, each sample was examined to confirm or modify field classifications. Representative soil samples were selected for laboratory testing. Details of this investigation effort can be found in the *Chandeleur Island Restoration Project (PO-0199) Geotechnical Services – Geotechnical Investigation Data Report* (GEO, 2024).

2.3 BORROW AREA, PUMP-OUT AREA, AND CONVEYANCE CORRIDOR SURVEYS

During the period of June 5 through June 24, 2023, OSI performed a high-resolution geophysical/cultural resource survey of the Emergency Barrier Berm (EBB) borrow area at Hewes Point and the proposed expansion area to the west. The combined borrow areas will be referred to as the Hewes Point Borrow Area (HPBA). Surveys were also conducted along two proposed conveyance corridors and one additional pump-out area. Details of this survey effort can be found in the *Geophysical/Cultural Resource Surveys of Sediment Borrow Area, Pump-Out Areas, & Conveyance Corridors to Support Chandeleur Island Restoration Project (PO-0199)* (OSI, 2024).

2.4 BORROW AREA GEOTECHNICAL INVESTIGATIONS

Although a vibracore investigation was previously conducted on the Hewes Point Shoal by the U.S. Geological Service in 2007 (Flocks et al., 2009), the last complete investigation covering the extents of the sand shoal was for borrow area delineation and cultural clearance in 2010 for the EBB project. The geotechnical investigation for the EBB program collected 23 vibracores in the Hewes Point vicinity. For this project twelve (12) vibracores were permitted in the 2,117-acre

HPBA. Seven (7) of the twelve (12) vibracores were collected in the expansion area of the HPBA to supplement the four (4) cores collected as part of the EBB investigation in 2010. These seven (7) cores provided additional information in the proposed expansion area since the four (4) prior 2010 cores were located around the perimeter of the expansion area. Five (5) additional cores were collected in the prior EBB borrow area to provide more uniform coverage of the area. Details of this investigation effort can be found in the *Chandeleur Island Restoration Project (PO-0199) Hewes Point Borrow Area Geotechnical Investigation Data Report* (CEC et al., 2024b).

2.5 Seagrass Survey

The field study was conducted by SWCA from September 15 through September 25, 2022, known to be within the peak seagrass growing season at the Chandeleur Islands. The primary objective of the survey was to collect data metrics that would characterize the seagrass community, including species composition, percent cover, seagrass bed configuration (patchiness), and preliminary water quality information to establish a baseline condition at the peak of the 2022 growing season. A field survey plan was developed utilizing a grid of tessellated hexagons (500 meters per side) to identify sampling locations for all levels of seagrass monitoring. This hexagonal grid was overlaid onto the survey area to establish a sampling grid. One fixed sample location was randomly selected within each hexagon, for a total of 143 sample locations. Details of the survey and the data collected can be found in *Coastal Protection and Restoration Authority Chandeleur Island Restoration Project (PO-0199) – Seagrass Survey Report* (SWCA, 2024).

2.6 Bird Surveys

Surveys were conducted by SEG for solitary breeding birds and wintering (non-breeding) birds. Surveys for solitary breeding birds were conducted on May 9, June 6, 2023, and June 26, 2024. The wintering bird surveys completed to date were conducted on September 26, October 30, and November 28 for 2023 and on January 30, February 26, March 12, and April 23 for 2024. Analysis of the data by SEG revealed more than 27,000 colonial waterbird nests and nearly 49,000 individual migratory birds including nearly 1,400 Red Knots and Piping Plover. Of the species that are known to frequent the Chandeleur Islands, several of these are endangered and/or threatened including the Red Knot (*Caladris canatus rufa*) and the Piping Plover *(Charadrius melodus*). Additionally, the area is home to the Chandeleur Gull, a hybrid species known to have developed there (Dittman and Cardiff, 2005). Altogether, a total of 76 Species of Greatest Conservation Need (SGCN) inhabit the Island, including 35 bird species; this list continues to grow. Details of the survey and the data collected can be found in *Chandeleur Island Restoration Project (PO-0199) Avian Surveys Report* (SEG, 2024).

2.7 SEA TURTLE NESTING HABITAT SURVEYS

On November 7 and 8, 2023, a survey team visited 12 of the 2022-2023 nesting sites selected by the biologist from CPRA, Louisiana Department of Wildlife and Fisheries, and the Sea Turtle Habitat Team to obtain survey elevation transect data from gulfward of mean high water (MHW) to bayside of dune, visual soil characteristics, nearby vegetation types and percent coverage, and photos of the surrounding area. The information gathered was used to inform the Design Team of the acceptable slopes and elevations for the restoration features that were considered for incorporation in the Restoration Alternatives.

3.0 PROJECT ELEMENTS

3.1 North Chandeleur Island

North Chandeleur Island is approximately 14 miles in length with an average width of 0.5 miles (Figure 3). Its topography varies from north to south with the northern expanses being bare sandy beaches at or near intertidal elevations. As the island progresses to the south, the beaches become narrower with broken vegetated dunes, *Spartina* sp. marshes, and black mangrove (*Avicennia germinans*) stands expanding to the west side. Prior studies (Georgiou et al., 2009, Byrnes et al., 2018, and Miner et al., 2021) as well as analysis of collected data for this Project have identified a nodal zone near the geographic center of the Gulf of Mexico (GOM) facing shoreline. North Chandeleur Island is the primary restoration element for shorebirds and sea turtle nesting habitats and protection of the seagrass beds.

3.2 New Harbor Island

New Harbor Island is a small, intertidal island located on the southwest side of North Chandeleur Island. It is exposed to Katrina Cut, a breach in Chandeleur Island formed as a result of Hurricane Katrina in 2005 creating North and South Chandeleur Islands (Figure 3). Mangroves are the dominant species on the Island with few salt marsh grasses intermixed. New Harbor Island is also a primary restoration element for Brown Pelican and Egret nesting Habitat.

3.3 Hewes Point Borrow Area

The HPBA is a submerged shoal that is located within one mile of the north end of North Chandeleur Island. The HPBA is located within the waters of the State of Louisiana (Figure 2). The sand deposits within the HPBA are sediment collected from longshore transport from North Chandeleur Island and are suitable for restoration purposes. Based on the prior and recently conducted investigations, the Design Team was able to determine that the volume of restoration-compatible sediments within the expanded HPBA is over 44 million cubic yards (MCY) that can be efficiently and cost-effectively excavated (OSI 2024). The sand in the HPBA has a median grain size of 0.13 millimeters (mm) as 93.5% of the sediment was retained on the No. 200 sieve (GEO, 2024).

3.4 St. Bernard Shoals Borrow Area

The St. Bernard Shoals are a group of 61 individual subaqueous sand bodies 11 nautical miles southeast of South Chandeleur Island (Figure 2). The shoals are estimated to contain 260 MCY of fine-grained, well-sorted, moderate yellowish-brown sandy sediment. Individual shoals consist of as much as 97% quartz sand. The St. Bernard Shoals have a sedimentary texture that is similar to that of Chandeleur Island, making them an ideal borrow site for renourishment of the Chandeleur Island system (Lavoie, 2009). However, due to the distance from the Project Area as compared to HPBA, the St. Bernard Shoals were not further considered for use in the Project.

3.5 Nearshore Conveyance Corridor

The Project includes a Nearshore Conveyance Corridor from the HPBA along the GOM shoreline for the full length of North Chandeleur Island which was previously surveyed and cleared for cultural resources during the construction of the EBB project (TAR, 2011). An extension at the southern end of North Chandeleur Island through Katrina Cut toward New Harbor Island (Figure 4) was surveyed for this Project (OSI, 2024).

3.6 Offshore Pump-Out Areas and Conveyance Corridors

Three (3) Offshore Pump-Out Areas and associated Offshore Conveyance Corridors have been identified for use during the Project (Figure 4). The purpose of the Offshore Pump-Out Areas is to provide locations for direct pump-out of sediments from a hopper dredge or scow barges via sediment pipeline corridors for sediment transport to North Chandeleur Island and New Harbor Island. Two (2) of the three Offshore Pump-Out Areas were previously surveyed for cultural resources and permitted for the EBB project (TAR, 2011). Rehandling Area 1 from the EBB project is located approximately 11 miles south-southeast of HPBA. This area and its associated corridor have been redesignated as Central Offshore Pump-Out Area and Central Offshore Conveyance Corridor. Rehandling Area 2 from the EBB project is located approximately 16 miles south-southeast of HPBA. This area and its associated corridor have been redesignated for this Project as South Offshore Pump-Out Area and South Offshore Conveyance Corridor.

The North Offshore Pump-Out Area and the North Offshore Conveyance Corridor were surveyed for cultural resources as part of this Project (OSI, 2024). Its location was selected to be approximately midway between the HPBA and the Central Offshore Pump-Out Area and is approximately 7 miles southeast of the HPBA.

3.7 Access Channels

Temporary Access Channels may be dredged to provide construction access to North Chandeleur Island for equipment and personnel. The temporary Access Channels will be utilized for the Project duration and will be backfilled upon Project completion. Three (3) locations were identified that minimized impacts to marine submerged aquatic vegetation (mSAV), specifically turtle grass (*Thalassia testudinum*). The Access Channels are positioned on the north end, central area, and south end of North Chandeleur Island and are presented in the figures in Section 6 of this Report.

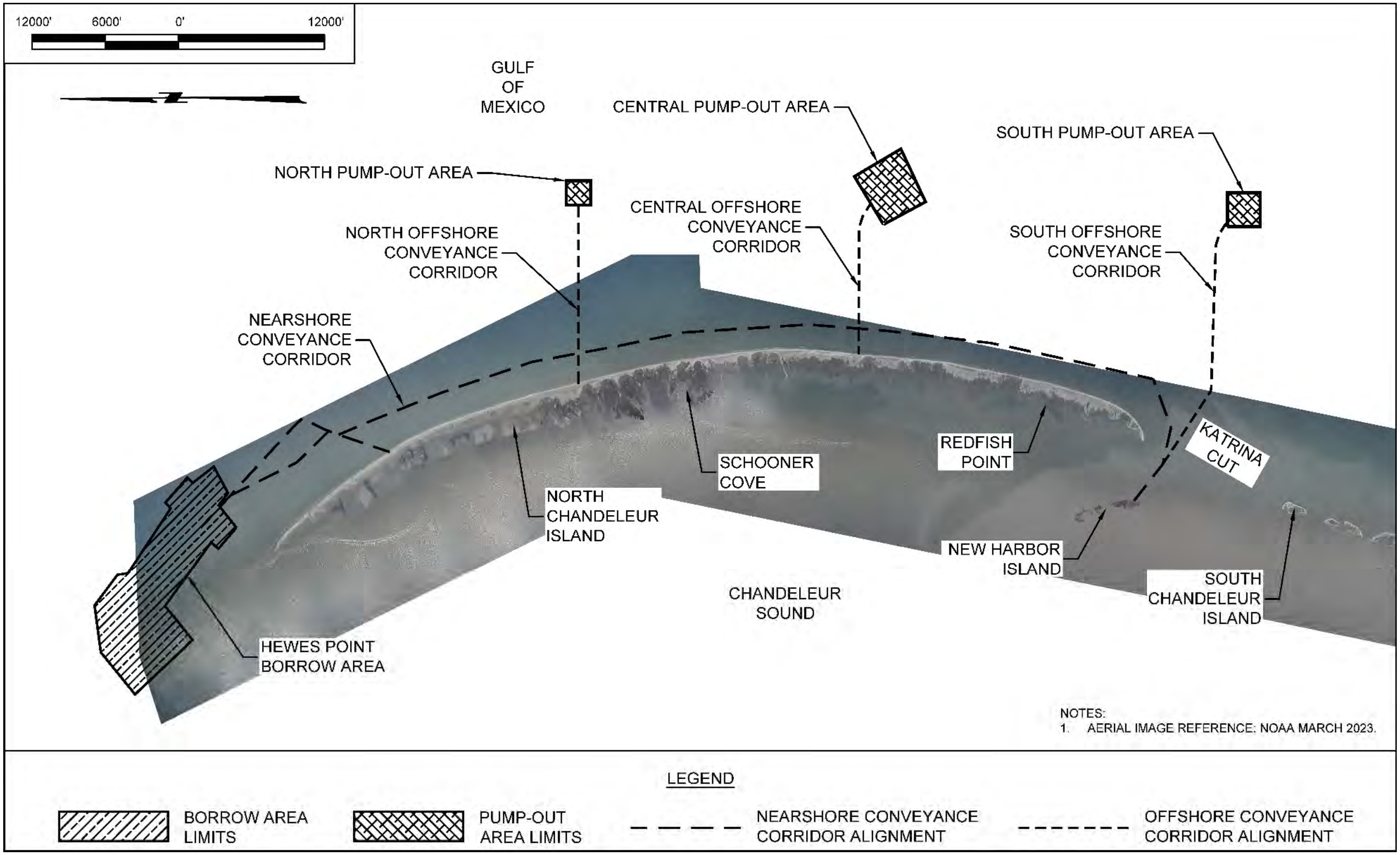

Figure 4. Conveyance Corridors and Pump-Out Areas

4.0 HABITATS

4.1 SHOREBIRD AND WINTERING BIRD HABITAT

The Chandeleur Islands have long been known for their diverse assemblages of both colonial nesting birds and migratory shorebirds. Recent bird surveys of North Chandeleur Island have shown that multiple species and thousands of individuals either migrate to or permanently live on the island. Bird surveys were conducted by SEG in 2023 and 2024 for the Project.

CEC and EMC performed an investigation of pre-identified bird nest sites to determine surrounding area elevations, soil characteristics, and vegetation type and percent cover. Based on the results of the investigation, the various species of birds inhabiting North Chandeleur Island utilize elevations from +1.4 to +4.7 feet (ft) North American Vertical Datum of 1988 (NAVD88) as presented in Table 1.

Table 1. Avian Nest Surrounding Elevation Ranges

Species	Nest Surrounding Elevation Range (NAVD88)
Common Tern	+2.0 ft to 3.3 ft
Sooty Tern	+2.9 ft to 4.7 ft
Black Skimmer	+2.7 ft to 3.2 ft
Am. Oyster Catcher	+2.3 ft to +4.7 ft
Wilson Plover	+1.4 ft to +4.7 ft *
Chandeleur Gull	+2.1 ft to +4.7 ft
Reddish Egret	+2.0 ft (ground elevation)

* The nest at an elevation of +1.4 ft is considered an isolated outlier.

4.2 SEA TURTLE HABITAT

The beaches of the Chandeleur Islands have historically been utilized by various species of sea turtles as nesting habitat for egg laying while the expansive mSAV beds on the west side are valuable sea turtle foraging grounds. The three (3) main species of sea turtle that have been observed on and around North Chandeleur Island (Fuller et al., 1987) include the Loggerhead sea turtle (*Caretta caretta*), the Green sea turtle (*Chelonia mydas*), and the Kemp's Ridley sea turtle (*Lepidochelys kempii*).

Most recently, 2023 aerial sea turtle surveys were conducted by CPRA and Louisiana Department of Wildlife and Fisheries (LDWF) throughout the nesting season. This survey revealed a total of 54 crawls and at least 13 nests. The same number of crawls was observed in the 2022 sea turtle surveys. Subsequent site visits by CEC and EMC to catalog the nesting sites gathered data including site morphology, elevation, distance from water, and surrounding habitat. Nesting elevations observed for Loggerhead and Kemp's Ridley sea turtles within the Project Area ranged from +3.4 to +5.5 ft NAVD88 (Table 2). Nesting sites were situated only in GOM-side habitats ranging from nearly bare sand to vegetated habitat in the foredune.

Table 2. Sea Turtle Nest Surrounding Elevation Ranges

Species	Nest Surrounding Elevation Range (NAVD88)
Loggerhead	+4.0 ft to 5.0 ft
Kemp's Ridley	+3.4 ft to +5.5 ft

4.3 MARINE SAV HABITAT

The area on the west side of North Chandeleur Island contains expansive mSAV beds of varying density. Based on analysis of data collected by SWCA (SWCA, 2024), the mSAV coverage on the northern extreme of the island is very sparse, having only patchy SAV coverage. Marine SAV density increases to the south. Predominant species include shoal grass (*Halodule wrightii)*, star grass (*Halophila engelmannii)*, widgeon grass (*Ruppia maritima)*, and turtle grass (*Thalassia testudinum)*. Areas where mSAV coverage is denser are areas that are better protected from the high-energy environment of the GOM. Conversely, areas of less dense mSAV coverage occur where there is considerable washover or previous breaching of the Island.

5.0 RESTORATION FEATURES

5.1 North Chandeleur Island

Restoration of North Chandeleur Island will consist of several Project features. Beach and dune renourishment will provide and enhance existing sea turtle habitat. Bird habitat will also be enhanced as restored dunes will protect from storms and waves. Widening the Island footprint will provide increased island longevity. Marsh Fill and Pocket Marshes will create future marsh habitat by placing sediment on the west side of the island. Similarly, Sand Reservoirs will increase sediment input to the system as the Island transgresses to the west. Lastly, the Feeder Beach feature will nourish the adjacent shoreline by utilizing the natural longshore drift to the north and south.

5.1.1 Beach and Dune Fill

Beach and Dune Fill will be accomplished utilizing compatible sediments from HPBA. Fill material will be placed at varying elevations and widths along the existing shoreline. Typical beach sections will be constructed to an elevation of +4.5 ft NAVD88 from the toe of the Dune with a slope of 1V:200H extending seaward to an elevation of +3.2 ft NAVD88. Here the slope will increase to 1V:50H down to mean high water (MHW) at an elevation of +1.2 ft NAVD88 where the slope will increase again to 1V:30H down to existing grade. Typical Dune features will be constructed to an elevation of +8.0 ft NAVD88 with side slopes of 1V:25H and a crest width of 100 ft. These elevations, slopes, and distances were selected because they have been shown to lend themselves best to habitat creation and sustainability. Specifically, the Beach slopes were adopted from designs utilized for sea turtle nesting beaches in Florida (CEC 2024c). The Beach and Dune profiles are comparable to those used on the North Breton Island Early Restoration (OBG, 2019).

5.1.2 Marsh Fill

Marsh Fill will be initially constructed to an elevation of +3.0 ft NAVD88 with slopes of 1V:30H down to the existing grade. The Marsh Fill will be constructed on the north end of North Chandeleur Island behind the constructed Beach and Dune Fill where a narrow bare sandy beach and an expansive low-lying, nearly unvegetated, sandy intertidal platform currently exists. Marsh Fill elevations were selected to provide foraging habitats as well as a stable platform to accept washover sediments enhancing the longevity of the Project. The marsh elevation may be refined once the settlement analysis is completed during the preliminary design phase of the Project.

5.1.3 Sand Reservoirs

Several areas along the west side of North Chandeleur Island were identified as potential locations for Sand Reservoir construction. The Sand Reservoirs would function as future sediment supplies, dispersing sand into the system, as the Island migrates westward. These sites were selected because of their degraded existing vegetation. Fill placement in these areas will provide twofold benefits: additional sediment input into the existing system over time and increased intertidal and supratidal habitat acres. The typical Sand Reservoir feature will be initially constructed to an elevation of +4.0 ft NAVD88 with slopes of 1V:30H down to existing grade. The northernmost Sand Reservoir has a crown elevation of +4.5 ft NAVD88 with a slope of 1V:200H out to an elevation of +3.2 ft NAVD88. From +3.2 the slope will steepen to 1V:30H extending to the existing grade to mimic the proposed Beach Fill feature to which it is connected.

5.1.4 Pocket Marshes

Similar to the Sand Reservoirs, several areas along the west side of the island were identified as potential locations for Pocket Marsh construction because of their degraded existing vegetation. Typical Pocket Marsh features will be initially constructed to an elevation of +2.0 ft NAVD88 with a bay slope of 1V:30H down to existing grade with the expectation that they will settle to an intertidal elevation sooner than Marsh Fill providing more immediate foraging habitat. The marsh elevation may be refined once the settlement analysis is completed during the preliminary design phase of the Project.

5.1.5 Feeder Beach

The previously mentioned nodal zone that was identified near the center of the Gulf shoreline of North Chandeleur Island (near STA 400+00) presents an opportunity to provide a sustainable source of sediment to the system through the longshore transport processes. Placement of this feature near the nodal zone would take advantage of longshore transport to the north and south of this point, thereby allowing natural processes to nourish the beach over time. This Feeder Beach feature widens the beach platform up to 800 ft at its widest point at an elevation of +3.2 ft NAVD88.

5.2 NEW HARBOR ISLAND

New Harbor Island is currently a mangrove stand of approximately 35 acres that is situated to the west of Katrina Cut. New Harbor Island serves as an important nesting habitat for the Brown Pelican and foraging habitat for other species. In an effort to protect the existing mangrove habitat and restore the eroded avian habitat, the western side of New Harbor Island will receive sediment placement to form at least 100 acres of colonial and migratory shorebird habitat. Additionally, the construction of shoreline protection features will help abate land loss due to currents and wave action.

5.2.1 Fill Placement

To protect existing mangrove habitat and restore eroded avian habitat, the western side of New Harbor Island will be filled to an elevation of +2.0 ft NAVD88 with side slopes of 1V:30H to intersect with existing grade. The elevation may be refined once the settlement analysis is completed during the preliminary design phase of the Project.

5.2.2 Shoreline Rock Breakwater

On the west side of New Harbor Island, a Shoreline Rock Breakwater will be constructed along the fill area boundary as a shoreline protection feature and fill containment. This feature will be constructed to an elevation of +4.6 ft NAVD88 with side slopes of 1V:3H. During the Preliminary Design phase of the Project engineered living shoreline components will be investigated.

5.2.3 Detached Rock Breakwater

Because of its exposure to winds and wave action through Chandeleur Sound, the existing mangrove habitats of New Harbor Island will be protected by a Detached Rock Breakwater that will effectively surround the entire northern shoreline. This feature will be constructed to an elevation of +4.6 ft NAVD88 with side slopes of 1V:3H. It will also include a minimum of two (2) 25-ft wide sheltered gaps built to allow sufficient water exchange and fish passage.

6.0 ALTERNATIVES

Restoration Alternatives were developed by combining Restoration Features to increase bird and sea turtle nesting and foraging habitats, protect the mSAV beds, and provide longevity and sustainability to North Chandeleur Island. Due to the importance of New Harbor Island as a brown pelican colony, it is included in all of the Alternatives. Five (5) Alternatives have been developed with one (1) of them being a No-Action scenario (Alternative 1). Several meetings were conducted with the Stakeholders and Habitat Teams of the Project where the proposed Alternatives were presented, and input and comments were sought. Based on the input, minor alterations were applied, and a consensus was achieved for the Alternatives presented herein. Detailed drawings for Alternatives 2 through 5 can be found in Appendix A.

6.1 ALTERNATIVE 1 – NO-ACTION

Under the No-Action Alternative, none of the Restoration Features would be constructed. Without importing sediment through restoration and nourishment, the Project Area would not be protected from future storm events. Ongoing erosion, land loss, and landward transgression would continue along the islands. Threatened and endangered species, mSAV beds, and recreational value would be impacted.

6.2 ALTERNATIVE 2

Alternative 2 combines the following restoration features:

- Beach, Dune, and Marsh Fill from STA 100+00 to STA 310+00
- Beach and Dune Fill from STA 310+00 to STA 790+00
- New Harbor Island Fill with shoreline protection features
- Four (4) Sand Reservoirs

The first two (2) of the above listed Restoration Features will create a total of 1,237 acres of beach and dune habitat along with 468 acres of marsh habitat. The New Harbor Island Fill will create 109 acres of bird nesting habitat. Constructed acres on this island will be built to an elevation to nourish the existing mangroves and support woody vegetation for shrub/scrub colonial nesting birds such as Brown Pelicans and egrets for 20+ years into the future. The combined Sand Reservoirs will create a total of 273 acres of beach habitat. In total 2,087 acres would be created/restored with this Alternative. A plan view depiction of Alternative 2 is presented in Figure 5.

6.3 ALTERNATIVE 3

Alternative 3 combines the following restoration features:

- Beach, Dune, and Marsh Fill from STA 40+00 to STA 310+00
- Beach and Dune Fill from STA 310+00 to STA 790+00
- New Harbor Island Fill with shoreline protection features
- Four (4) Pocket Marshes

The first two (2) of the above-listed Restoration Features will create a total of 1,341 acres of Beach and Dune habitat along with 592 acres of Marsh habitat. The New Harbor Island Fill will create 109 acres of Marsh habitat. The combined Pocket Marshes will create a total of 106 acres of Marsh habitat. In total 2,148 acres would be created/restored with this Alternative. A plan view depiction of Alternative 3 is presented in Figure 6.

6.4 ALTERNATIVE 4

Alternative 4 combines the following restoration features:

- Beach, Dune, and Marsh Fill from STA 90+00 to STA 310+00
- Beach and Dune Fill from STA 310+00 to STA 790+00
- New Harbor Island Fill with shoreline protection features
- Feeder Beach from STA 350+00 to STA 460+00 (maximum 800 ft in width)

The first two (2) and the last of the above listed Restoration Features will create a total of 1,397 acres of Beach and Dune habitat along with 468 acres of Marsh habitat. The New Harbor Island Fill will create 109 acres of Marsh habitat. In total 1,974 acres would be created/restored with this Alternative. A plan view depiction of Alternative 4 is presented in Figure 7.

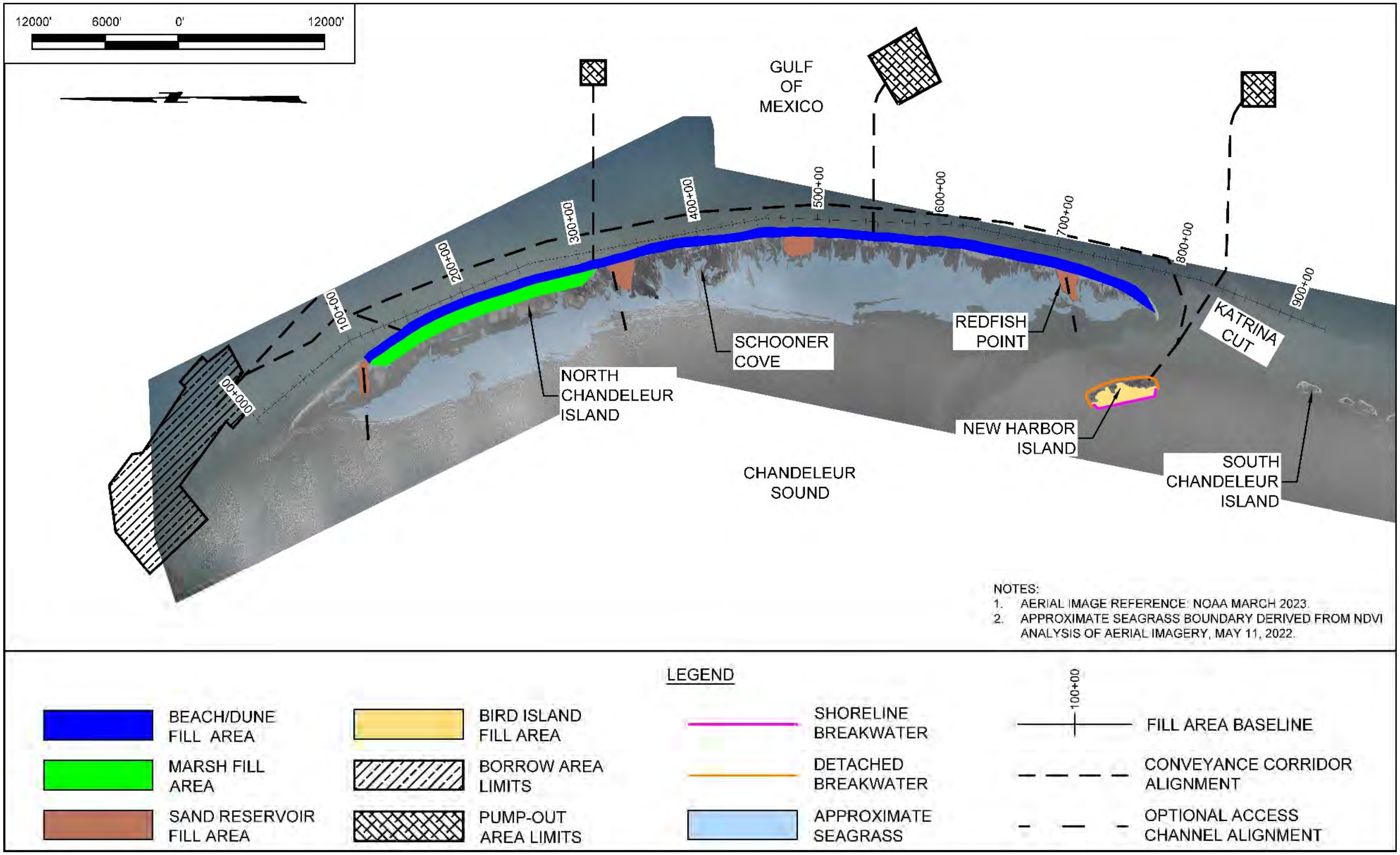

Figure 5. Alternative 2 Plan View

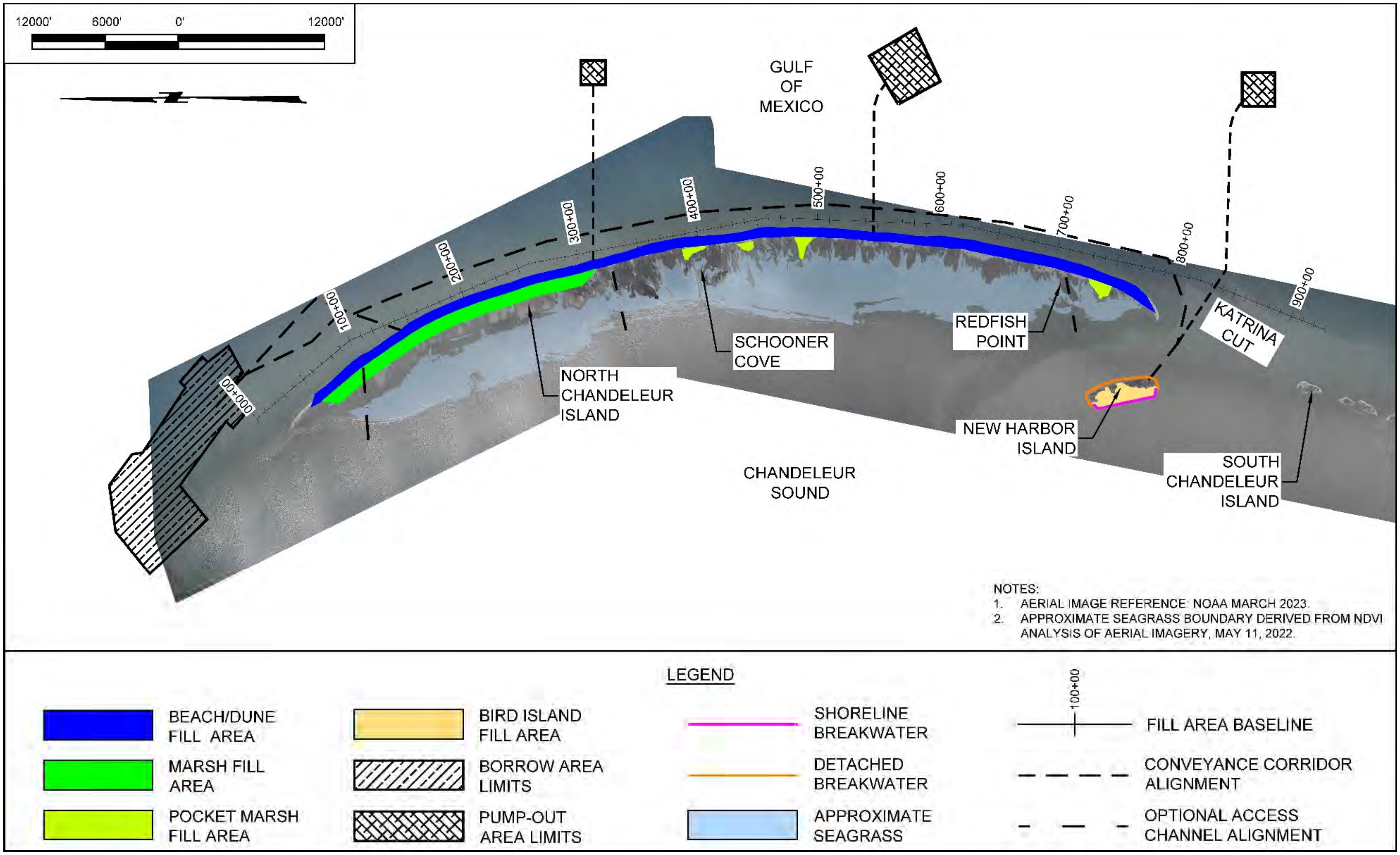

Figure 6. Alternative 3 Plan View

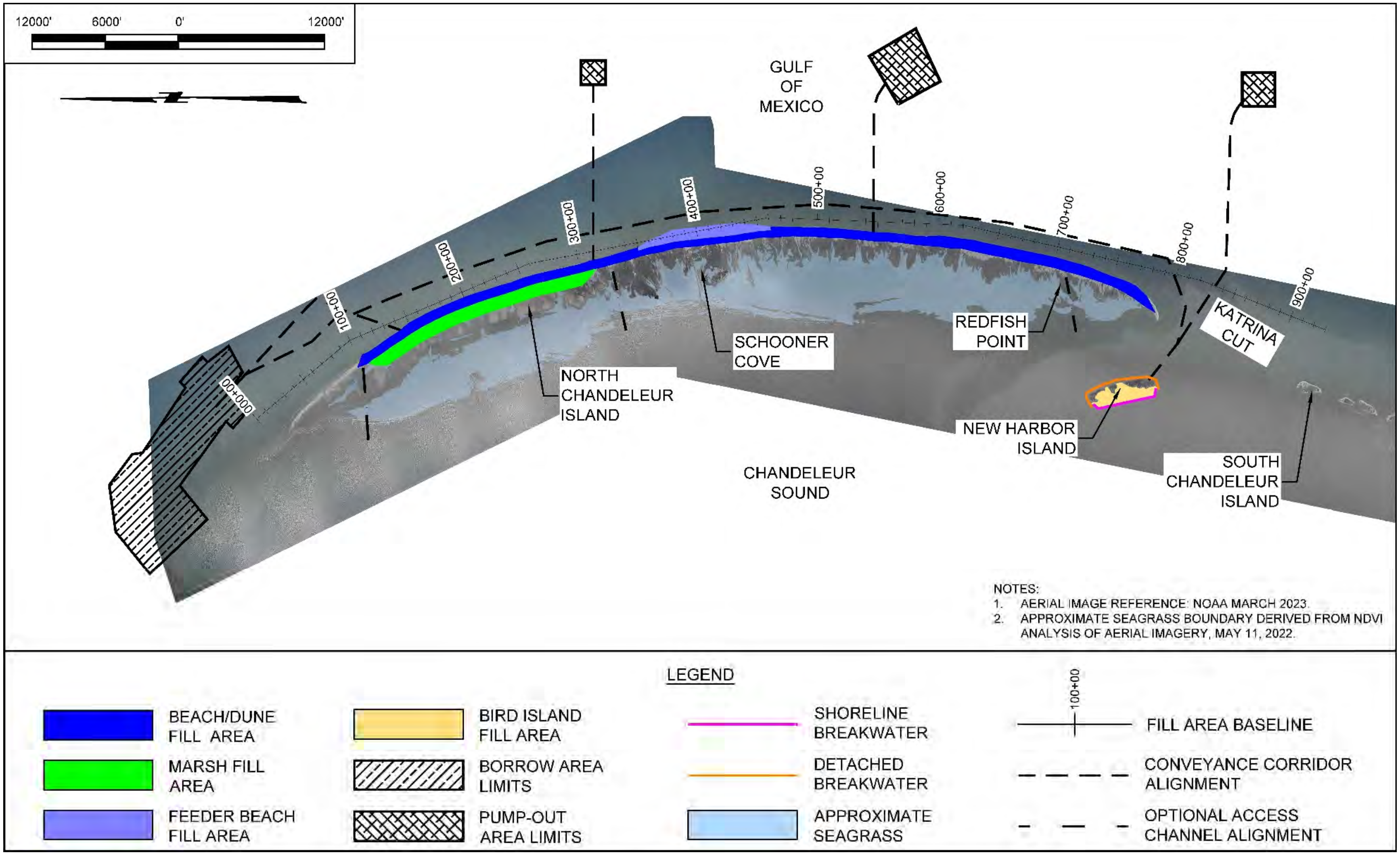

Figure 7. Alternative 4 Plan View

7.0 EVOLUTION ANALYSIS

7.1 INTRODUCTION

An evolution analysis was performed to quantify habitat acreages over a period of 20 years for each of the Alternatives. The empirical analysis utilized historical rates of shoreline change, sea-level rise, subsidence, wave action, and post-storm recovery. These coastal processes and forcing functions affecting the Project Area were applied over a 20-year period of analysis based upon the experience and professional judgement of the Design Team. The Alternatives were modeled by manually eroding the design templates over the time segments at Target Year (TY)-0, TY-5, TY-10, TY-15, and TY-20.

7.2 COASTAL PROCESSES AND FORCING FUNCTIONS

7.2.1 Relative Sea-Level Rise

Relative sea-level rise (RSLR) includes both subsidence and eustatic sea-level rise (ESLR).

Little has been developed for subsidence rates for Chandeleur Island. However, it has been shown that subsidence rates correlate well with thickness of Holocene deltaic deposits (Penland and Ramsey, 1990; Tornqvist et al 2008) and the current delta complex age. The Water Institute conducted an analysis and extrapolation of subsidence rates developed for the St Bernard Delta Complex's more inland areas presented in the *2023 Louisiana Comprehensive Master Plan for a Sustainable Coast – Attachment B3* (Fitzpatrick et al., 2021) shown in Figure 8 and *Determining Recent Subsidence Rates for Breton Sound and Eastern Ponchartrain Basins, Louisiana: Implications for Engineering and Design of Coastal Restoration Projects* (ACRE, 2019). The analysis concluded a subsidence rate of 3.00 mm/yr for Chandeleur Island (Miner, *personal communication*, 2024).

The *2012 Louisiana Comprehensive Master Plan for a Sustainable Coast – Appendix C* (CPRA, 2012) determined the ESLR specific to the Chandeleur Island area to be 3.35 mm/yr (Figure 9). Combining the ESLR and the subsidence values derived the resultant RSLR is 0.02 ft/year (6.35 mm/year).

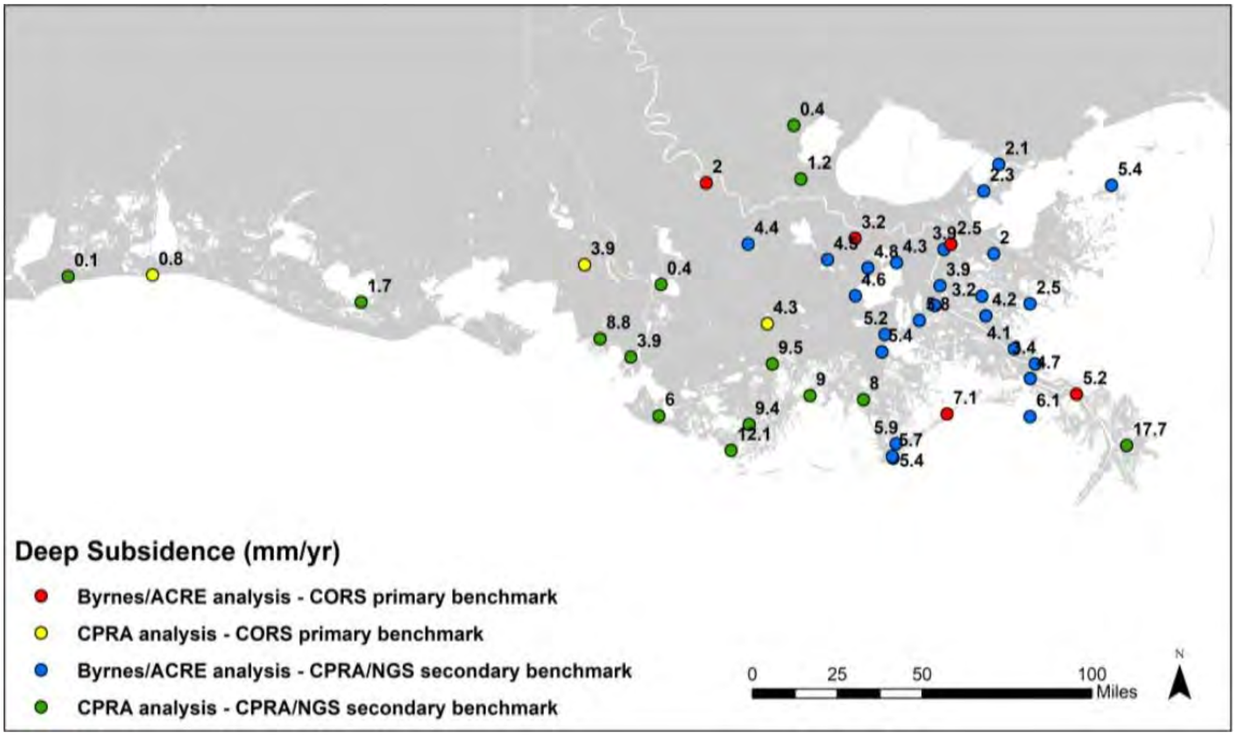

Figure 8. Coastwide Map of Deep Subsidence Rates (Fitzpatrick et al., 2021)

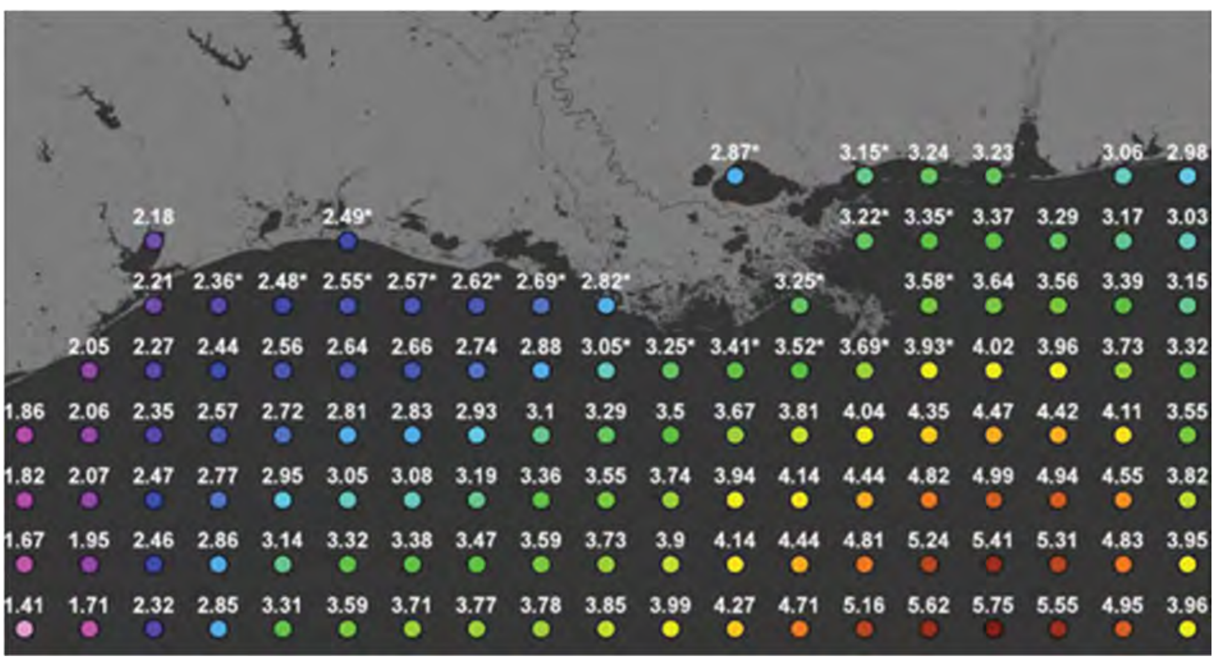

Figure 9. Spatial Variability in Sea-Level Rise Trends Across Coastal Louisiana (CPRA, 2012)

7.2.2 Shoreline Change and Longshore Transport

Through analysis of the gulf shoreline position data from the Louisiana Barrier Island Comprehensive Monitoring Program (Byrnes, 2018), the Design Team computed the average near-term (1998 – 2015) Gulf shoreline change rate for North Chandeleur Island to be -100 ft/year. This period was representative of more volatile conditions on the island where shoreline retreat was greater due to the declining land mass of the Island and would be consistent with the No Action Alternative. Using the same gulf shoreline positional dataset, the Design Team computed the long-term gulf shoreline change rate (1950 - 1998) for North Chandeleur Island to be -34 ft/year. This period was representative of more stable conditions on the Island where shoreline retreat was less due to a greater land mass. This rate would be consistent across all Future With Project Alternatives. The bayside shoreline change was determined to be negligible, and no erosion rates were applied to any of the Alternatives.

For Alternative 1 No-Action, a Gulf shoreline change rate of -100 ft/year was applied since no new sediments would be introduced to the system. For Alternatives 2 through 4, a Gulf shoreline change rate of -34 ft/year was applied to account for the importing of sediment to construct the Beach and Dune Fill. For Alternative 4, a one-line diffusion model was performed to determine the diffusion rate and longshore transport distances of the Feeder Beach over time. Analysis of the results allowed for a segmentation of the Beach Fill feature with varying Gulf shoreline change rates to approximate the effects of Feeder Beach diffusion along the shoreline. As a result of the diffusion of the Feeder Beach laterally north and south of the nodal zone, represented by the lower shoreline change rates along the restoration template, the Feeder Beach sediment placed in front of the typical beach/dune fill template would be dispersed by TY-5. Table 3 below presents the gulf shoreline change rates applied to each Alternative for each Target Year.

Table 3. Applied Gulf Shoreline Change Rates for each 5-Year Period

Alternative	Baseline Station	Feet per 5-Year Period				
		TY-0	TY-5	TY-10	TY-15	TY-20
Alternative 1	All	0	500	500	500	500
Alternative 2	All	0	170	170	170	170
Alternative 3	All	0	170	170	170	170
Alternative 4	20+00 to 150+00	0	170	170	170	170
	160+00 to 240+00	0	148	116	110	108
	250+00 to 330+00	0	39	53	56	57
	340+00 to 440+00	0	Remove Feeder	40	47	54
	450+00 to 540+00	0	18	27	38	50
	550+00 to 610+00	0	147	110	95	90
	620+00 to 780+00	0	170	170	170	170

7.2.3 Washover

Washover was accounted for through conservation of volume within the first ten (10) years as described in Section 7.3. Washover events are associated with high water and surge events that accompany hurricanes and tropical storms. Sediment from the beach and dune shoreface is transported backward and deposited in the back barrier marsh.

7.2.4 The Bruun Rule of Erosion

The influence of wave action and RSLR on the beach profile over time was also considered in the analysis. In a 2-dimensional shoreline analysis where the longshore transport of sediment is neutral, beach, dune, and offshore profiles will equilibrate as a function of wave action and sea levels (Bruun 1988). When erosion is experienced on the beach face side of the profile, deposition is likely on the offshore side of the profile as well as landward of the beach via washover and dune recovery from windblown sand as the system equilibrates. The beach profile and dune elevation will also be a function sea level. An increase in the sea level results in an increase in the beach profile and dune elevations. As RSLR increases over time, a resultant increase in the beach profile height would be expected (Figure 10) as observed over the historical period at the Chandeleur Islands in the ability to maintain subaerial exposure as the shoreline, beach, and dune systems migrate landward, contingent on the available sediment in the subaerial beach (D'Anna, 2021).

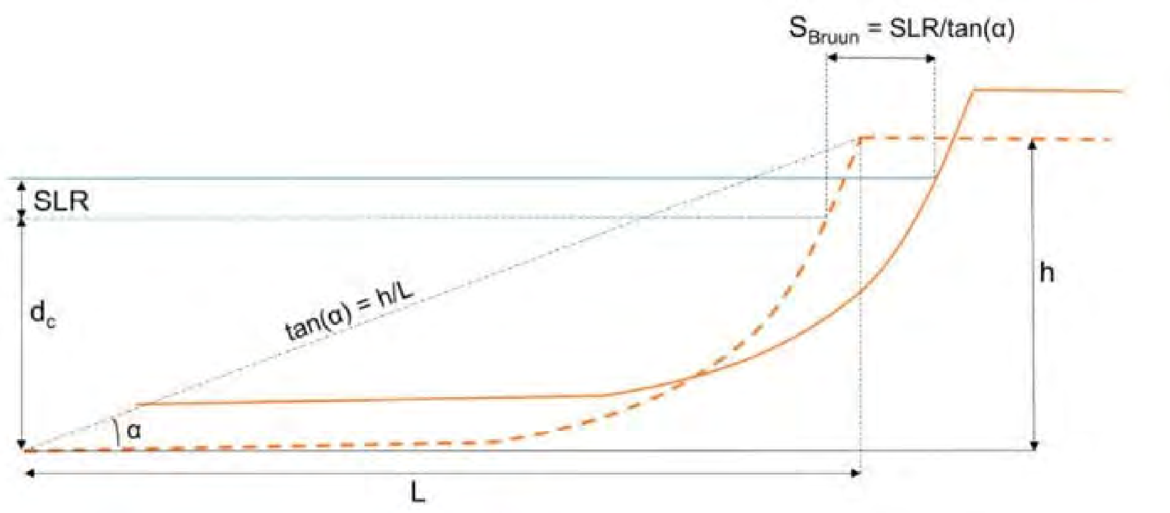

Figure 10: Modified Bruun Rule
(From D'Anna et al. 2021, redrawn from Bruun 1962 and subsequent modifications based on field and laboratory observations and numerical modeling)

7.2.5 Post-Storm Recovery

Hurricanes, tropical storms, and other high-energy events often cause significant erosion along the Island's gulf and bay shorelines. Extreme events can cause island breaching and segmentation. Hurricane Katrina (2005) segmented the Chandeleur Islands arc into numerous small marsh islets exposing back-barrier marshes to Gulf wave attacks. (Sallenger Jr. et al. 2009). In the years following Katrina, the islets served as nucleation sites for sand accumulation and shoreline rebuilding. Vegetation was reestablished on the newly built shoreline and dune growth began through aeolian processes (Miner et al. 2021). To capture a post-storm elevation recovery factor, time-series LiDar data (OCM Partners, 2024a, b) were analyzed for an area on the northern end of the Chandeleur Island chain to calculate dune accretion between 2007 to 2011 yielding an accretion factor of 0.043 ft^3/ft^2 for post-Hurricane Katrina dune recovery.

7.3 ISLAND PROFILE MORPHOLOGY

Post-construction profiles (TY-0) were developed by inserting the fill templates for each Alternative into the 2023 survey profiles. RSLR was offset by the wave action and coastal processes associated with the Bruun Rule. The profile was broken at the beach crest then the offshore segment of the profile was migrated bayward (Figure 11) to account for the shoreline change by the values shown in Table 3 above. The profiles were then recombined. The annual shoreline change rate accounts for all storms during the analysis period. In TY-10 a major storm consistent with a category 2 hurricane (i.e. Hurricane Gustav in 2008) was assumed to occur causing washover and the dune was moved behind the previous dune position atop the constructed Marsh Fill, Sand Reservoir, Pocket Marsh, or existing grade platforms (Figure 12). Following the TY-10 storm event, a dune recovery factor of 0.043 ft^3/ft^2 was applied along the dune footprint from TY10 to TY15 (Figure 13). Offshore profile segment migration was applied and continued for TY-15 and TY-20. Typical profiles for each time period are presented in Figure 14. Following profile modifications, the intersections of the profile at elevations of -1.5, 0.0, 2.0, and 5.0 ft NAVD88 for each time period were mapped to determine the resultant habitat acres at each elevation. This data was used in the analysis of island longevity described in Section 8.6.

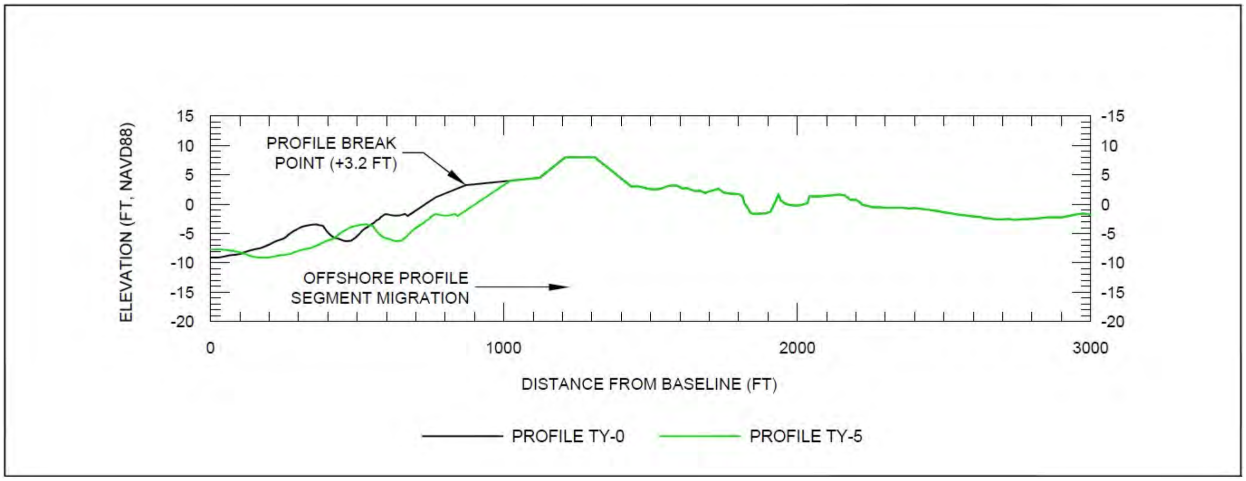

Figure 11. Profile Modification for Shoreline Change.

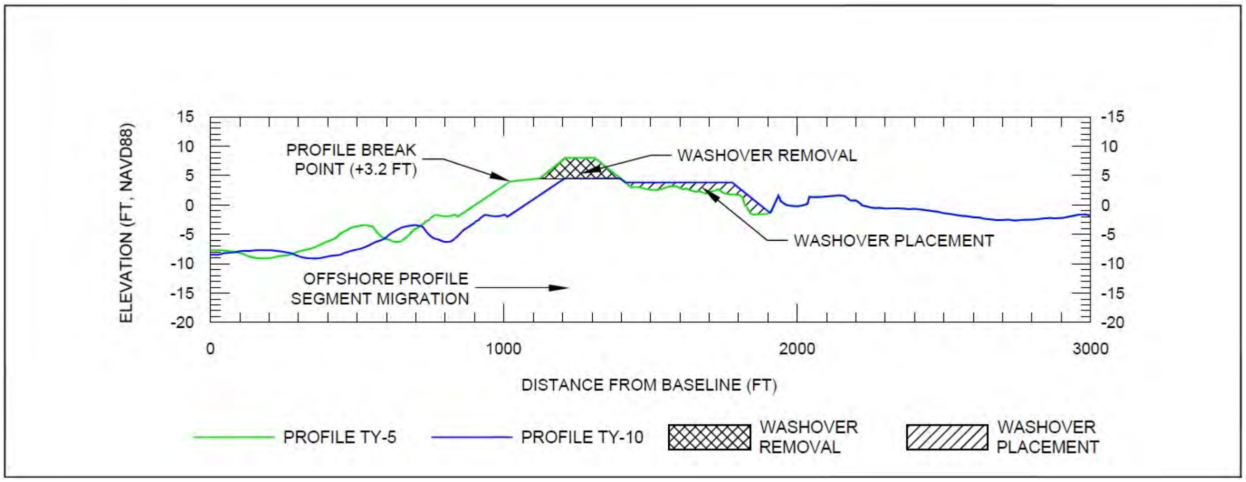

Figure 12. Profile Modification due to Washover at TY-10.

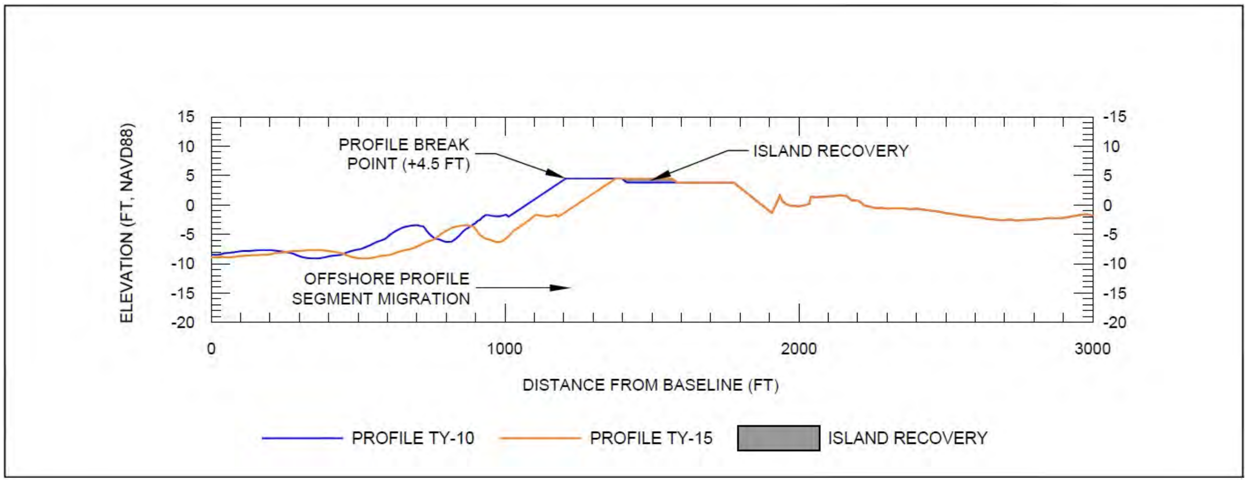

Figure 13. Profile Modification for Island Recovery.

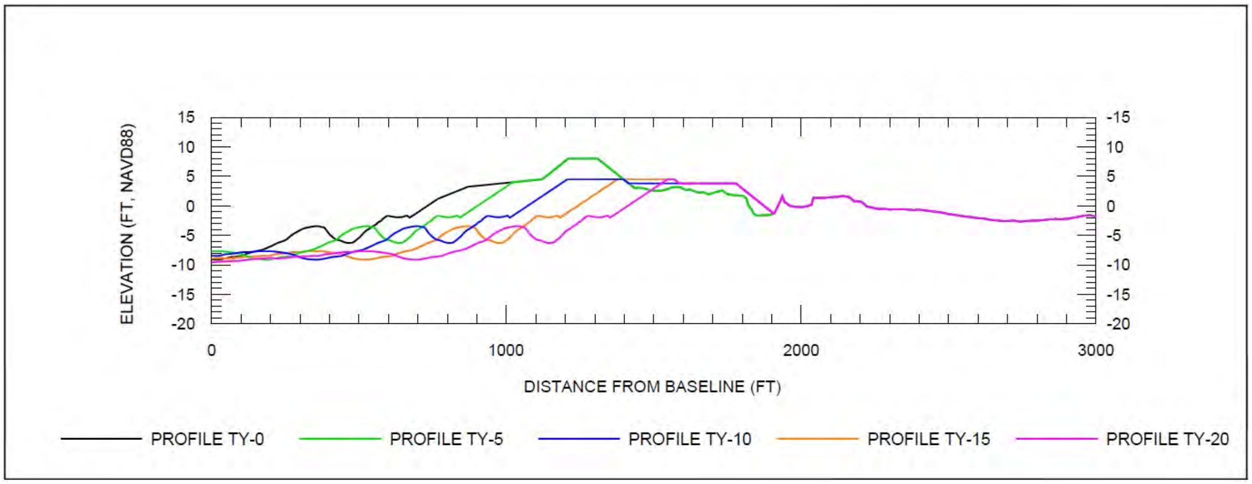

Figure 14. Typical Profile Modeling over Time.

8.0 ALTERNATIVE EVALUATION

Alternative evaluation criteria were selected to assess the performance and impacts of each Alternative while avoiding redundancy in the assessment. The evaluation criteria include:

- Constructed nesting habitat for birds and sea turtles,
- Sediment volumes required to construct the restoration fill templates,
- Order of Magnitude Construction Cost to construct the restoration fill templates,
- Construction duration,
- Existing vegetation impacts due to construction,
- Longevity of the constructed restoration,
- Sustainability of bird nesting habitat,
- Sustainability of sea turtle nesting habitat,
- Placed volume retention,
- Oil and gas pipeline crossings, and
- Marine SAV Benefits

8.1 CONSTRUCTED NESTING HABITAT

Utilizing the information from the nest investigations described in Section 4.0, it was determined that birds nested within an elevation range of +2.0 ft to +4.7 ft NAVD88 without the single outlier of a Wilson Plover nest at +1.4 ft NAVD88. Similarly, the sea turtles nested within an elevation range of +3.4 ft to +5.5 ft NAVD88. For the purposes of this evaluation criteria, the constructed habitat acres that fall within the restoration fill template footprint were computed from those areas of the restoration template (TY-0) above +2.0 ft NAVD88 for birds and from +4.0 ft to +5.5 ft NAVD88 on the GOM side only for sea turtles. Tables 4 and 5 present the results of the constructed nesting bird and sea turtle habitat acres, respectively, and the score of the individual Alternatives. Scores are represented as the constructed nesting habitat acres for each Alternative divided by the most acres, such that higher scores relate to larger number of constructed habitat acres.

Table 4. Constructed Bird Nesting Habitat Acres

Alternative	Constructed Bird Nesting Habitat Acres (> +2.0 ft NAVD88)	Score
Alternative 1	0	**0.000**
Alternative 2	1,784	**0.970**
Alternative 3	1,840	**1.000**
Alternative 4	1,650	**0.897**

Table 5. Constructed Sea Turtle Nesting Habitat Acres

Alternative	Constructed Sea Turtle Nesting Acres (>+4.0 ft and <+5.5 ft NAVD88)	Score
Alternative 1	0	**0.000**
Alternative 2	200	**0.976**
Alternative 3	205	**1.000**
Alternative 4	164 *	**0.771**

* The Feeder Beach area of Alternative 4 was excluded due to long distances from the shoreline to the nesting elevation range along the upper beach and dune.

8.2 REQUIRED FILL VOLUMES

Required restoration fill volumes were calculated utilizing the industry standard planning level cross sectional method for volume computations referred to as Average End Area along the length of each Alternative. Table 6 presents the required volumes to construct the Restoration Features for each Alternative on North Chandeleur Island and does not include New Harbor Island which is a component of all of the Alternatives. Scores are represented as the least volume for each Alternative divided by the Required Volume, such that higher scores relate to lower required volumes.

Table 6. Required Fill Volumes

Alternative	Volume (CY)	Score
Alternative 1	0	**0.000**
Alternative 2	8,892,200	**0.992**
Alternative 3	8,824,800	**1.000**
Alternative 4	8,933,100	**0.998**

8.3 ORDER OF MAGNITUDE CONSTRUCTION COST PER ACRE

Order of Magnitude Construction Costs were assessed using a proprietary cost analysis program that incorporates dredge production rates utilizing a variation of the Cutter Suction Dredge Cost Estimating Program developed by the Center for Dredging Studies, Zachary Department of Civil Engineering, Texas A&M University. The estimating tool is customized for current inflation values, specific dredge parameters relating to fuel consumption, sediment transport, and material handling for dredges. Shore-based construction and survey crews are derived from the daily cost equations.

Separate mobilization/demobilization costs were developed for each major construction element such as cutterhead dredge with associated support equipment; bucket dredge; construction personnel, lodging, and transportation; equipment at fill site; and sediment pipeline delivery, installation, and removal.

The respective fill unit cost was computed by considering the daily rates for the cutterhead dredge, booster pump(s), fuel, per foot sediment pipeline, supporting equipment, and lodging and transportation. The daily cost was then multiplied by the sum of the fill placement duration including weather days. The unit cost per cubic yard of fill was based on the required fill volume, anticipated cut-to-fill ratio losses, pumping distance, dredge pumping capacity, total dredging equipment daily cost, construction crews, and shore equipment. This total was then divided by the required fill volume to derive a unit cost inclusive of sediment dredging, transport, and fill placement.

The cost for survey crews was developed in two (2) phases, shore crew and offshore crew. The different equipment and crews required for the two (2) distinctly different survey types lead to the development of the cost as separate entities. The shore-based survey crew requires a survey chief and rodmen to conduct the upland segments of the survey prior to, during, and following fill placement. The offshore crew requires the inclusion of a survey vessel and operator for the HPBA and nearshore bathymetric profile data collection at the Restoration Areas. The surveying cost included a daily rate for survey crews, survey vessel, and survey equipment, multiplied by the sum of the fill placement duration and weather days. Survey costs were also developed for the pre- and post-construction surveys of both the Restoration Areas and HPBA.

The Access Channel excavation cost was based on the utilization of a barge mounted bucket excavator and associated crews. The daily cost of a barge mounted excavator with crews was used to determine the cost of excavation and temporary sidecast placement of the required volume to be removed to construct the Access Channel.

Following fill placement, sand fencing and vegetative plantings will be installed. The sand fences are porous barriers that reduce wind speed along the coast such that sand being transported by the wind accumulates on the downwind side of the fence. The sand fences will promote deposition of windblown sand, increase dune elevation, and protect vegetative plantings. Following construction, vegetative plantings would commence for the dune and supratidal platform.

The material and installation of the settlement and washover monitoring system cost was developed using analysis of recent construction contract bids.

The cost associated with the construction of the Rock Breakwaters were broken down by armor and core stone, and geotextile. The materials and installation cost of the stone and geotextile were developed using professional judgement and analysis of recent construction contract bids along with the required volumes of armor and core stone, and the computed geotextile required coverage areas.

Temporary warning signs along the temporary sidecast disposal areas and Rock Breakwater alignments are required by the U.S. Coast Guard (USCG) to make the general public aware of the temporary navigational hazard during construction. Similarly, the USCG will likely require permanent warning signs and lights to be installed along the detached Rock Breakwater at New Harbor Island. The materials and installation cost of the warning signs were developed using professional judgement and analysis of recent construction contract bids.

With a restoration of this magnitude, it was assumed the construction duration would include multiple bird nesting seasons. The daily cost associated with bird abatement was derived from consultation with those in the industry. Calculations were made to determine how many abatement days over multiple nesting seasons would be required for each Alternative. Under Alternative 1, No Action, the Project would not be constructed.

Table 7 presents the Order of Magnitude Construction Cost and the individual associated elements for the Alternatives. Scores are represented as the lowest total cost per created/restored acre for each Alternative divided by the cost per acre for each Alternative such that higher scores relate to lower costs per acre.

Table 7. Order of Magnitude Construction Cost

Construction Element	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Mobilization/ Demobilization	$0	$19,848,000	$19,848,000	$19,848,000
Hydraulic Fill	$0	$192,277,000	$189,383,000	$194,999,000
Surveying	$0	$4,861,000	$4,939,000	$4,664,000
Access Channel	$0	$1,972,000	$1,972,000	$1,972,000
Sand Fencing	$0	$1,100,000	$1,195,000	$1,100,000
Vegetative Plantings	$0	$4,609,000	$5,494,000	$3,855,000
Settlement/Washover Monitoring System	$0	$104,000	$116,000	$104,000
Rock Breakwater Armor Stone	$0	$14,615,000	$14,615,000	$14,615,000
Rock Breakwater Core Stone	$0	$9,274,000	$9,274,000	$9,274,000
Geotextile	$0	$2,041,000	$2,041,000	$2,558,000
Temporary Warning Signs	$0	$169,000	$169,000	$169,000
Bird Abatement	$0	$497,000	$422,000	$488,000
Administration and Inspection	$0	$5,823,000	$5,752,000	$5,835,000
Sub -Total	$0	$257,190,000	$255,220,000	$258,964,000
10% Bid Contingency	$0	$25,719,000	$25,522,000	$25,896,000
Total	$0	$282,909,000	$280,742,000	$284,860,000
Total Constructed Acres	$0	2,087	2,148	1,974
Cost per Acre	$0	$135,558	$130,699	$144,306
Alternative Score	**0.000**	**0.964**	**1.000**	**0.906**

8.4 CONSTRUCTION DURATION

Construction durations were estimated as part of the Order of Magnitude Construction Cost development. Table 8 presents the estimated construction duration to construct the Restoration Features for each Alternative. Construction durations are dependent on the volume of sediment required for construction but more importantly the location within the fill template the sediment is placed. Placement locations further from the borrow source reduce the productivity of the dredge and increase the construction duration. Scores are represented as the shortest duration divided by the construction duration for each Alternative such that higher scores relate to lower construction duration.

Table 8. Construction Duration

Alternative	Duration (Days)	Score
Alternative 1	0	**0.000**
Alternative 2	752	**0.996**
Alternative 3	749	**1.000**
Alternative 4	754	**0.993**

8.5 EXISTING VEGETATION IMPACTS

Analysis of existing vegetation on North Chandeleur Island was performed using high-resolution 4-band (0.25-foot pixel) aerial imagery acquired on May 22, 2022. Vegetation types were extracted using an analysis known as Normalized Difference Vegetation Index (NDVI) in ArcGIS Pro 3.2. This analysis utilizes the near-infrared and red bands of multi-spectral imagery to arrive at an index number between zero (0) and one (1) which is subsequently converted into an integer index value. These index numbers can subsequently be classified into statistical groups that represent the most likely vegetation type based on reflectance and transmittance of light. Effectively, NDVI can be considered a measure of greenness. Higher numbers indicate denser or darker vegetation while lower numbers indicate sparse/low-lying vegetation and/or bare ground.

Combining the results of the NDVI analysis on the imagery with visual observations of the same imagery and on-the-ground observations, the statistical bins were classified into four (4) vegetation types. The individual bins were then combined into multi-part polygons using the Pairwise Dissolve method in ArcGIS Pro to arrive at acreage calculations for each vegetation type classification.

With the multi-part vegetation polygons in place, an identity analysis was performed within ArcGIS Pro to determine impacted existing vegetation acreages within each Alternative's constructed footprint.

It should be noted here that the existing vegetation impacts attributed to the New Harbor Island fill are included in all of the calculations, but because the New Harbor Island fill template does not change across the various Alternatives, the impacted existing vegetation acreage is the same.

8.5.1 Intertidal Vegetation

Intertidal vegetation was defined as vegetation within the middle classes of the NDVI classification lying over what could be visibly observed as an intertidal region. These vegetation features typically have a mid-range NDVI value with lower reflectivity and transmission in the target spectra. These vegetation classifications typically have a moderately high density when observed in visible aerial imagery.

8.5.2 Mangrove

Mangrove stands are usually indicated by the highest index values due to their deep green leaf coloration in the NDVI analysis and can be readily identified using these high values over the visible imagery bands. Additionally, mangroves are known to have relatively high canopy densities and are also known to primarily inhabit intertidal elevations.

8.5.3 Upland Vegetation

Upland vegetation classes were derived from the other vegetation classes by determining the overall vegetative cover and subtracting the vegetation classes derived above.

8.5.4 Marine Submerged Aquatic Vegetation

Aquatic portions of the high-resolution aerial imagery were separated from the intertidal, mangrove, and upland portion and analyzed using NDVI. The results of the NDVI analysis were combined with the resultant polygons from the 2022 mSAV survey (SWCA, 2023) to provide the best estimate of mSAV coverage possible.

8.5.5 Existing Vegetation Impacts Scoring

Existing vegetation acres are presented as a reference to what existed on North Chandeleur Island and New Harbor Island at the time of the aerial photography used for analysis. Scores for each vegetation type are represented as the lowest impacted acres of all Alternatives divided by the total impacted acres for each Alternative. Individual vegetation type impact scores were then added together and divided by four (4) resulting in higher scores relating to lower existing vegetation impacts. Table 9 provides a comparison and score of impacted existing vegetation acreages for each Alternative as determined by the geospatial analyses. Figure 15 provides a visual example of mangrove impacts within a proposed Sand Reservoir feature.

Table 9. Alternative Existing Vegetation Impacts

Alt.	Existing Upland Vegetation (Acres)	Upland Vegetation Impacts (Acres)	Upland Vegetation Impacts Score	Existing Intertidal Vegetation (Acres)	Intertidal Vegetation Impacts (Acres)	Intertidal Vegetation Impacts Score	→
Alt. 1	24.82	0.00	0.000	944.17	0.00	0.000	→
Alt. 2		17.03	0.942		253.20	0.669	→
Alt. 3		17.69	0.907		219.33	0.772	→
Alt. 4		16.05	1.000		169.35	1.000	→

Alt.	Existing Mangrove Vegetation (Acres)	Mangrove Vegetation Impacts (Acres)	Mangrove Vegetation Impacts Score	Existing mSAV (Acres)	mSAV Impacts (Acres)	mSAV Impacts Score	Total Score
Alt. 1	197.21	0.00	0.000	5242.54	0.00	0.000	**0.000**
Alt. 2		45.40	0.466		128.27	0.872	**0.737**
Alt. 3		21.67	0.977		147.56	0.758	**0.854**
Alt. 4		21.17	1.000		111.85	1.000	**1.000**

In summarizing the overall impacts to vegetation, Alternative 4 yielded the lowest overall impact score. This is largely due to the Feeder Beach feature which is constructed gulfward of the current shoreline and the lack of back-barrier features such as Sand Reservoirs and Pocket Marshes. Alternative 2 had the highest mangrove impacts due in part to the large size of the Sand Reservoirs in the back-barrier regions as compared to the smaller Pocket Marshes of Alternative 3.

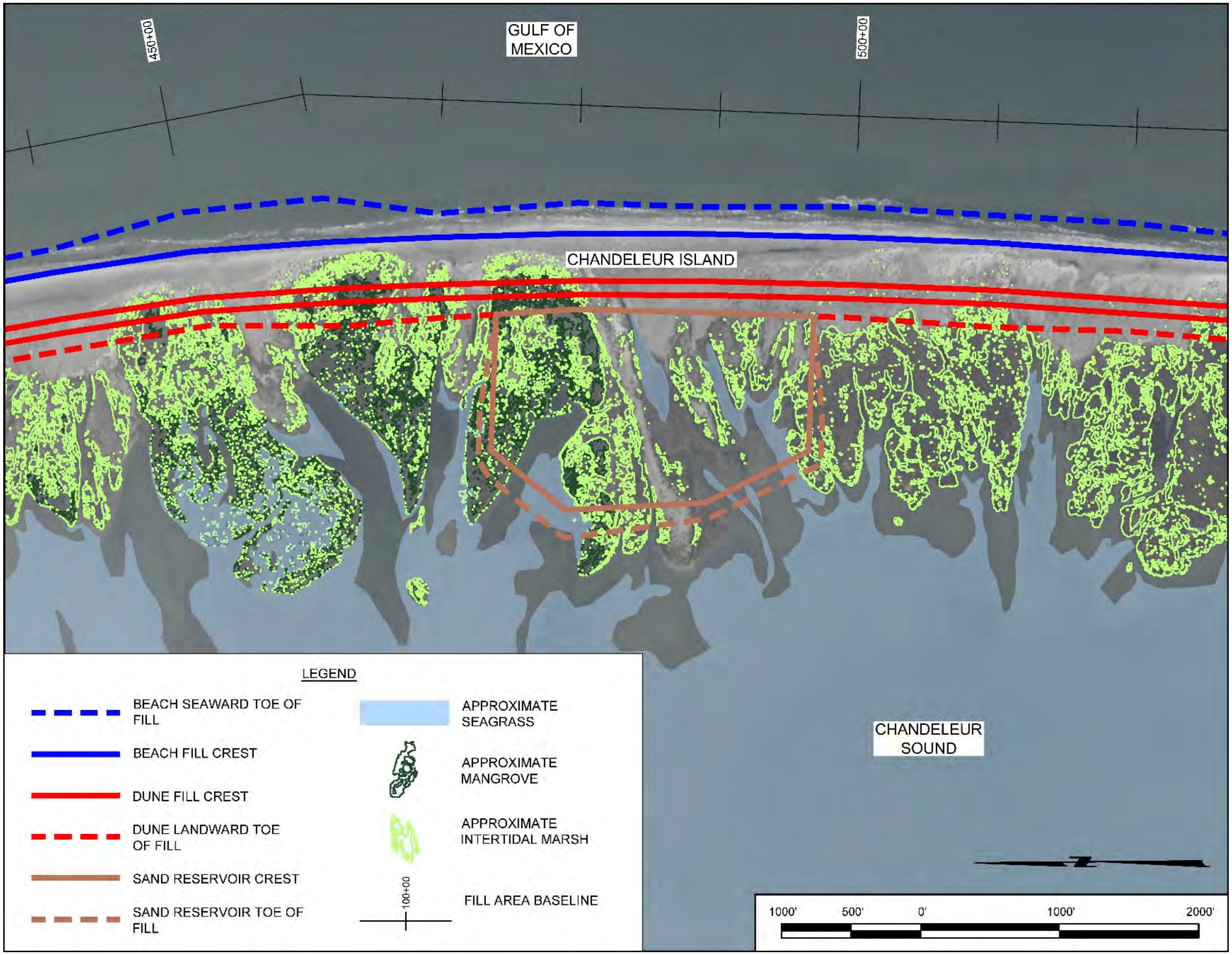

Figure 15. Example Mangrove and Intertidal Vegetation Impacts in Relation to a Sand Reservoir

8.6 NORTH CHANDELEUR ISLAND LONGEVITY

Utilizing the evolution modeling output, the habitat acres for each Alternative were computed for each habitat zone including dune (+5.0 NAVD88 and above), supratidal (between +2.0 and +5.0 NAVD88), intertidal (between 0.0 and +2.0 NAVD88) and subtidal (between -1.5 and 0.0 NAVD88). The acres were calculated at five-year increments over the 20-year period of analysis. The calculations are presented for each individual Alternative in Table 10 and include existing habitat acreage contiguous to the restoration footprints. Because the habitat acres constantly change due to erosion, sea level change, subsidence, and washover, utilizing the equation below, the weighted benefit acres were computed for each Alternative to yield the average benefit acres created and sustained throughout the 20-year period of analysis.

$$
\begin{aligned}
\mathit{Weighted\ Acreage\ Calculation} \\
= \left[\frac{(TY0 + TY5)}{2}\right]\left(\frac{\#\ of\ years\ between\ TY}{\#\ of\ years\ for\ analysis}\right) \\
+ \left[\frac{(TY5 + TY10)}{2}\right]\left(\frac{\#\ of\ years\ between\ TY}{\#\ of\ years\ for\ analysis}\right) \\
+ \left[\frac{TY10 + TY15}{2}\right]\left(\frac{\#\ of\ years\ between\ TY}{\#\ of\ years\ for\ analsis}\right) \\
+ \left[\frac{TY15 + TY20}{2}\right]\left(\frac{\#\ of\ years\ between\ TY}{\#\ of\ years\ between\ TY}\right)
\end{aligned}
$$

Table 10 and Figure 16 present the North Chandeleur Island Longevity analysis results. Scores are represented as the sum of the weighted average acres for each elevation range divided by the highest such that higher scores relate to higher weighted average acres. New Harbor Island is presented solely as reference and is not included in the individual Alternative acre calculations since it is not a component of Alternative 1, thus providing a true analysis of North Chandeleur Island.

Alternative 4 had the highest total weighted average acres remaining above -1.5ft NAVD88 at TY-20 followed by Alternatives 2 and 3 which are nearly identical. In contrast Alternative 1 is only approximately 40% of Alternatives 2 and 3 and approximately 36% of Alternative 4 of the acres remaining at TY-20. All of the remaining acres at TY-20 for Alternative 1 are below +2.0 ft NAVD88. The locations of the Sand Reservoirs of Alternative 2 only begin to be influenced by shoreline erosion at TY-20 and will serve to provide longevity to the Island outside of the 20-year period of analysis as they disperse sediment to the shoreline as they erode albeit on a more localized level versus that of the Feeder Beach in Alternative 4.

Table 10. North Chandeleur Island Longevity

Alternative	Target Year	Acres at Elevation -1.5 ft to 0.0 ft	Acres at Elevation 0.0 ft to 2.0 ft	Acres at Elevation 2.0 ft to 5.0 ft	Acres at Elevation > 5.0 ft	Total Acres
Alternative 1 [1]	TY-0	1,596	2,339	966	39	4,941
	TY-5	1,557	2,193	319	0	4,069
	TY-10	1,591	1,615	0	0	3,206
	TY-15	1,469	913	0	0	2,381
	TY-20	1,205	337	0	0	1,543
	Weighted Average	**1,504**	**1,515**	**201**	**5**	**3,224**
Alternative 2 [1]	TY-0	1,496	1,609	1,523	379	5,007
	TY-5	1,489	1,566	1,283	379	4,717
	TY-10	1,462	1,416	1,550	0	4,428
	TY-15	1,452	1,393	1,283	0	4,128
	TY-20	1,439	1,438	953	0	3,830
	Weighted Average	**1,468**	**1,475**	**1,339**	**142**	**4,423**
Alternative 3 [1]	TY-0	1,449	1,596	1,557	410	5,011
	TY-5	1,439	1,568	1,299	410	4,716
	TY-10	1,416	1,423	1,591	0	4,431
	TY-15	1,404	1,419	1,307	0	4,130
	TY-20	1,390	1,411	1,029	0	3,831
	Weighted Average	**1,419**	**1,478**	**1,373**	**154**	**4,424**
Alternative 4 [1]	TY-0	1,504	1,802	1,424	379	5,110
	TY-5	1,493	1,765	1,167	379	4,804
	TY-10	1,470	1,587	1,569	0	4,627
	TY-15	1,458	1,562	1,402	0	4,422
	TY-20	1,446	1,534	1,248	0	4,228
	Weighted Average	**1,474**	**1,645**	**1,369**	**142**	**4,630**
New Harbor Island	TY-0	6	69	111	0	187
	TY-5	6	180	0	0	186
	TY-10	6	180	0	0	185
	TY-15	5	180	0	0	185
	TY-20	5	179	0	0	184
	Weighted Average	**6**	**166**	**14**	**0**	**185**

[1] Exclusive of New Harbor Island.

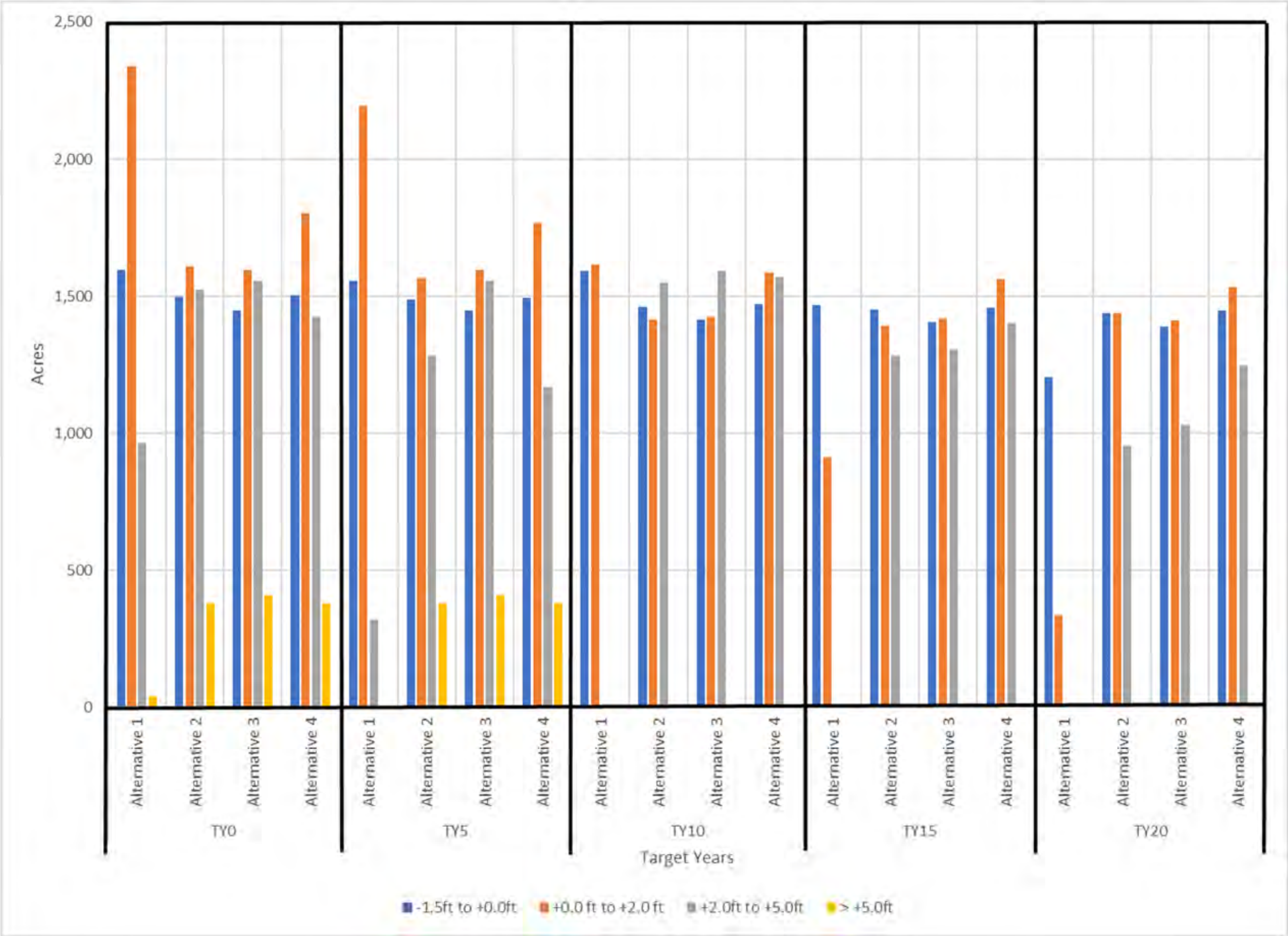

Figure 16. Histogram of Habitat Acres over Time

8.7 Bird Nesting Habitat Sustainability

The assessment of bird nesting habitat sustainability over time was evaluated utilizing the acres computed above +2.0 ft NAVD88 over time derived as part of the Island longevity analysis. Scores are represented as the sum of the acreage for all of North Chandeleur Island above +2.0 ft NAVD88 for each Target Year divided by the highest such that higher scores relate to higher acreage above +2.0 NAVD88 over time (Table 11).

Table 11. Bird Nesting Habitat Sustainability (Acres > +2.0 ft NAVD88)

Alternative	TY-0	TY-5	TY-10	TY-15	TY-20	Total	Score
Alternative 1	1,005	319	0	0	0	1,324	**0.175**
Alternative 2	1,902	1,663	1,550	1,283	953	7,351	**0.967**
Alternative 3	1,967	1,709	1,591	1,307	1,029	7,603	**1.000**
Alternative 4	1,803	1,547	1,569	1,402	1,248	7,569	**0.995**

At TY-20, Alternative 4 retains the largest number of acres available for bird habitat due to the Feeder Beach feature dispersing sediment along the island and thus slowing the shoreline erosion rate. However, Alternative 3 was designed with approximately 5,000 more linear feet of beach and dune on its northern extreme thus providing more sustainable acres of bird habitat throughout the 20-year period of analysis. At TY-20, the 2-D empirical modeling showed that without restoration (Alternative 1), the Island will be almost completely subaqueous with no viable habitat remaining for birds.

8.8 Sea Turtle Nesting Habitat Sustainability

The assessment of sea turtle nesting habitat sustainability over time was evaluated utilizing the acres computed between +4.0 ft NAVD88 and +5.5 NAVD88 over time. Scores are represented as the sum of the acreage for all of North Chandeleur Island within the nesting zone for each Target Year divided by the highest such that higher scores relate to higher nesting acreage retention over time (Table 12).

Table 12. Sea Turtle Nesting Habitat Sustainability (Acres +4.0 to +5.5 ft NAVD88)

Alternative	TY-0	TY-5	TY-10	TY-15	TY-20	Total	Score
Alternative 1	48	0	0	0	0	48	**0.033**
Alternative 2	200	200	310	305	50	1,065	**0.935**
Alternative 3	205	205	336	335	52	1,133	**0.994**
Alternative 4	164	190	347	282	230	1,113	**1.000**

Alternative 3 has the most sea turtle nesting acres of all the alternatives throughout the 20-year period of analysis primarily due to the longer beach and dune at the time of construction. Following the modeled storm impact at TY-10 and subsequent island recovery, habitat acres increased for Alternatives 2 - 4 due primarily to the lack of dune slope restriction. An analysis of the data collected during the sea turtle nesting habitat surveys indicated that the average crawl distance from MHW to sea turtle nests in areas where dunes were not present was 290 feet. This crawl distance was used to determine the maximum distance from MHW for nesting habitat for TY-10 through TY-20 in those areas where the beach platform was wider than this limit above +4.0 ft NAVD88, and no dune was present above +5.5 ft NAVD88, for example where Sand Reservoirs are present (Figure 17). In TY-20 Alternative 4 retained a significantly larger nest habitat due to the slowing shoreline erosion rate attributed to the Feeder Beach which maintains a wider beach platform preserving the nesting zone from erosion over time as compared to the other Alternatives. At TY-20, the 2-D empirical modeling showed that without restoration (Alternative 1), the Island would be almost completely subaqueous with no viable habitat remaining for sea turtle nesting.

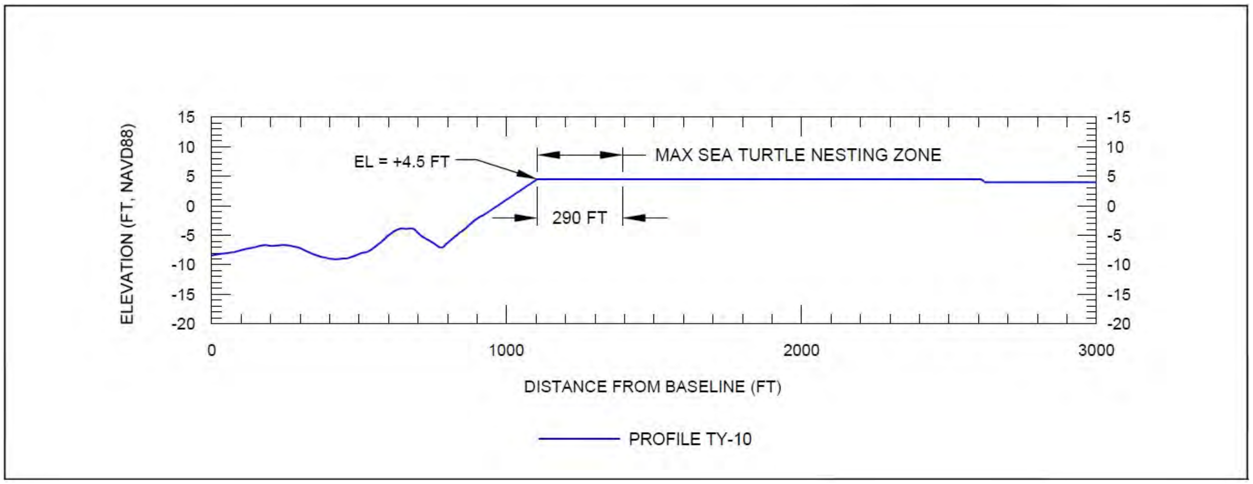

Figure 17. Maximum Sea Turtle Nesting Zone for Calculations Where Dune is Not Present

8.9 PLACED VOLUME RETENTION

An analysis was conducted to determine what portion of the sediment placed on North Chandeleur Island during construction remained on or within the extents of sediment movement at Target Year 20 (Table 13). Alternative 1 was not applicable to this scoring criteria as no sediment is placed for restoration.

Table 13. Placed Volume Retention

Alternative	Volume Placed (CY) at TY-1	Volume Retained (CY) at TY-20	% Volume Retained at TY-20	Score
Alternative 1	N/A	N/A	N/A	**0.000**
Alternative 2	8,892,200	5,927,000	66.7	**1.000**
Alternative 3	8,824,800	4,587,600	52.0	**0.774**
Alternative 4	8,933,100	4,606,600	51.6	**0.777**

Results show that Alternative 2 performed the best due primarily due to the Sand Reservoirs placed behind the constructed dune that do not experience shoreline erosion during the initial 20-year period of analysis but will provide sediment dispersal to the shoreline as the Island further transgresses. It should be noted that retention of sediment does not necessarily equate to retained habitat as the sediment may not be concentrated in areas to result in elevations suitable for bird and sea turtle nesting habitat.

8.10 Oil and Gas Pipeline Crossings

The Strategic Online Natural Resources Information System (https://www.sonris.com), National Pipeline Mapping System (https://pvnpms.phmsa.dot.gov), and the Bureau of Ocean Energy Management (https://www.data.boem.gov) pipeline databases were researched to identify known pipelines in the vicinity of the Chandeleur Islands, New Harbor Island, HPBA, Offshore Pump-Out Areas, Conveyance Corridors, and the St. Bernard Shoals area. Details on each pipeline identified included the owner, status, commodity, and size. There were only two (2) pipelines identified that were in close proximity to Project Area and lay on the GOM side of North Chandeleur Island, pass underneath the historic island footprint through what is now Katrina Cut, and continue south on the Chandeleur Sound side of the Island chain. These two (2) pipelines are active and consist of a 12-inch and a 16-inch natural gas pipeline. Through the geophysical/cultural resources survey of the Nearshore Conveyance Corridor it was determined that the pipelines are positioned approximately 8-foot and 11-foot below the seabed where the Nearshore Conveyance Corridor crosses the pipelines (OSI, 2024). All of the Alternatives require a sediment pipeline to be installed along the seabed over the gas pipelines for fill placement at New Harbor Island therefore scoring of this criterion is not necessary.

8.11 Marine SAV Benefits

Preservation and enhancement of mSAV is crucial to a wide range of fish and wildlife. Enhancement of the mSAV is expected to benefit a wide number of birds, sea turtles, fisheries, and dolphins. Fisheries use the mSAV beds as nursery habitat while dolphins, sea turtles, and additional fisheries species utilize the mSAV beds for foraging habitat.

Each of the Alternatives will initially and over the Project life provide two benefits to the existing mSAV beds. First, the restoration of the beach and dune features will provide protection to the existing mSAV by adding longevity to the existing Island footprint. Alternative 3 provides greater benefits to mSAV on the north side of the Restoration Area by providing an additional 5,000 ft of restored Beach and Dune Fill as compared to Alternatives 2 and 4. Secondly, the restoration of the Island will provide low-energy/low-turbidity conditions that allow the mSAV to thrive. Overall, the restoration of the beach, dune, and marsh is expected to enhance the environment for mSAV resulting in enhanced species abundance and species diversity. Scoring for the Island longevity reflected the protection and sustainability of the mSAV. Therefore, mSAV benefits were not scored separately to avoid redundancy.

8.12 Alternative Scoring Analysis

Scores from each of the Alternative evaluation criteria were summed to identify the optimal Alternative suitable for meeting the Project goals. The results are presented in Table 14.

Without weighting any of the individual criteria, Alternative 3 ranked the highest followed closely by Alternative 2 with a difference of only 0.092. Alternative 4 ranked the lowest with a difference of 0.282. The results of the Alternatives Analysis indicate Alternatives 2 through 4 are very comparable for achieving the Project goals of constructing Island habitat acres, maintaining Island longevity, and sustaining key habitats for nesting birds and sea turtles, while minimizing existing vegetation impacts. The required fill volume and construction duration scores are essentially the same for the Alternatives as they were developed specifically to match cost so the emphasis of the scoring would be on the habitat criteria.

Table 14. Alternative Scoring Analysis

Alternative	**Constructed Shorebird Nesting Habitat**	**Constructed Sea Turtle Nesting Habitat**	**Required Fill Volume**	**Construction Cost / Acre**	→
Alternative 1	0.000	0.000	0.000	0.000	→
Alternative 2	0.969	0.976	0.992	0.964	→
Alternative 3	1.000	1.000	1.000	1.000	→
Alternative 4	0.921	0.799	0.988	0.906	→
Alternative	**Construction Duration**	**Impacts to Existing Vegetative Habitat**	**North Chandeleur Island Longevity**	**Shorebird Nesting Habitat Sustainability**	→
Alternative 1	0.000	0.000	0.696	0.175	→
Alternative 2	0.996	0.737	0.955	0.967	→
Alternative 3	1.000	0.854	0.956	1.000	→
Alternative 4	0.993	1.000	1.000	0.995	→
Alternative	**Sea Turtle Nesting Habitat Sustainability**	**Placed Volume Retention**	**Final Score**		
Alternative 1	0.033	0.000	**0.904**		
Alternative 2	0.941	1.000	**9.498**		
Alternative 3	1.00	0.774	**9.583**		
Alternative 4	0.983	0.777	**9.363**		

8.13 SUMMARY

The goals of the Project are to restore and conserve bird nesting and foraging habitat; restore and enhance submerged aquatic vegetation; enhance sea turtle hatchling productivity and restore and conserve nesting beach habitat; and create, restore, and enhance barrier islands and headlands.

Alternative 3 requires the least amount of volume to construct and had the lowest construction cost due largely to the location of the fill placement relatively close to the borrow area compared to the other Alternatives. Alternative 3 creates the largest amount of bird nesting and foraging habitat, largest enhancement to sea turtle nesting habitat, and provides the greatest level of mSAV protection due to the additional 5,000 feet of constructed beach and dune along North Chandeleur Island at the time of construction followed closely by Alternative 2 then Alternative 4.

With the No-Action Alternative 1, only 13% of the current total island acreage will remain at TY-20; sea turtle and bird habitat (>+2.0 ft NAVD88) are reduced to effectively zero acreage at TY-10. At TY-20, Alternatives 2 through 4 all provide greater than 953 acres of viable habitat above +2.0 ft NAVD88. In terms of land mass above 0.0 ft NAVD88 at TY-20, Alternative 1 had 337 acres whereas Alternatives 2 had 2,391, Alternative 3 had 2,441, and Alternative 4 had 2,782 acres.

9.0 RECOMMENDED ALTERNATIVE

Based on the analysis, Alternative 3 scored the highest for constructed bird and sea turtle nesting habitat acres, construction cost per acre, and shorebird nesting habitat sustainability. Alternative 3 scored between Alternatives 2 and 4 for impacts to existing vegetation. Examining the individual vegetation zones in this analysis, it had the highest impact to mSAV among the three Alternatives primarily due to the longer marsh platform on the north end of the island. Noting that Alternative 4 scored the highest for North Chandeleur Island longevity, it is recommended that the Feeder Beach feature in addition to the Sand Reservoir feature from Alternative 2 be combined with the features of Alternative 3 to formulate Alternative 5 (Figure 18) as the recommended plan.

Values for the Alternative Analysis criteria for Alternative 5 consistent with those done for Alternatives 2, 3, and 4 were calculated. Criteria included constructed habitat acres for both shorebird and sea turtle nesting; required fill volumes; construction duration, order of magnitude construction cost; impacts to existing habitats; island longevity; bird habitat sustainability; and volume retained at TY-20. Below are tables of the findings.

Table 15. Alternative 5 Constructed Habitat Acres

Habitat Classification	Acres
Constructed Bird Nesting Habitat (acres above +2.0 ft NAVD88)	2,326
Constructed Sea Turtle Habitat (acres from +4.0 ft to +5.5ft NAVD88)	179

Table 16. Alternative 5 Required Fill Quantities

Required Fill Quantities (cubic yards)	11,502,000

Table 17. Alternative 5 Construction Duration

Construction Duration in Days	868

Table 18. Alternative 5 Order of Magnitude Construction Cost

Order of Magnitude Construction Cost ($US)	$350,348,000

Table 19. Alternative 5 Impacts to Existing Habitat

Acreage Classification	Acres
Upland Vegetation Impacts	18.64
Intertidal Marsh Vegetation Impacts	314.85
Mangrove Vegetation Impacts	46.99
Seagrass Impacts	158.93

Table 20. Alternative 5 North Chandeleur Island Longevity

Target Year	-1.5ft to 0.0 ft	0.0 ft to 2.0 ft	2.0 ft to 5.0 ft	> 5.0ft	Total
TY-0 (Acres)	1,430	1,475	1,805	410	5,120
TY-5 (Acres)	1,420	1,447	1,539	410	4,816
TY-10 (Acres)	1,397	1,311	1,929	0	4,637
TY-15 (Acres)	1,381	1,307	1,739	0	4,427
TY-20 (Acres)	1,371	1,300	1,565	0	4,235
Weighted Average (Acres)	1,399	1,363	1,723	154	4,639

Table 21. Alternative 5 Bird Habitat Sustainability

Habitat	TY-0	TY-5	TY-10	TY-15	TY-20
Bird Habitat (Acres)	2,215	1,948	1,929	1,929	1,565

Table 22. Alternative 5 Sea Turtle Habitat Sustainability

Habitat	TY-0	TY-5	TY-10	TY-15	TY-20
Sea Turtle Habitat (Acres)	179	205	273	307	234

Table 23. Alternative 5 Volume Retained

Volume Placed at TY-0 (cubic yards)	11,502,000
Volume Retained at TY-20 (cubic yards)	6,620,800
% Retained at TY-20	57.6%

In comparing the results of Alternative 5 to the results from Alternatives 2 through 4, Alternative 5 provided more habitat acreage for a more sustainable period. This is primarily due to the additional material volumes provided by the Feeder Beach and Sand Reservoir features added to Alternative 3 to assemble the cumulative Alternative 5 features (Figure 18).

Combining the longevity features of Alternatives 2 and 4, Sand Reservoirs and Feeder Beach, respectively, to Alternative 3 provides the best combination of habitat creation and resiliency. While this is the most expensive Alternative due to the increased volume of sand, it provides the greatest amount of flexibility for construction depending on the final funding obtained to construct the Project.

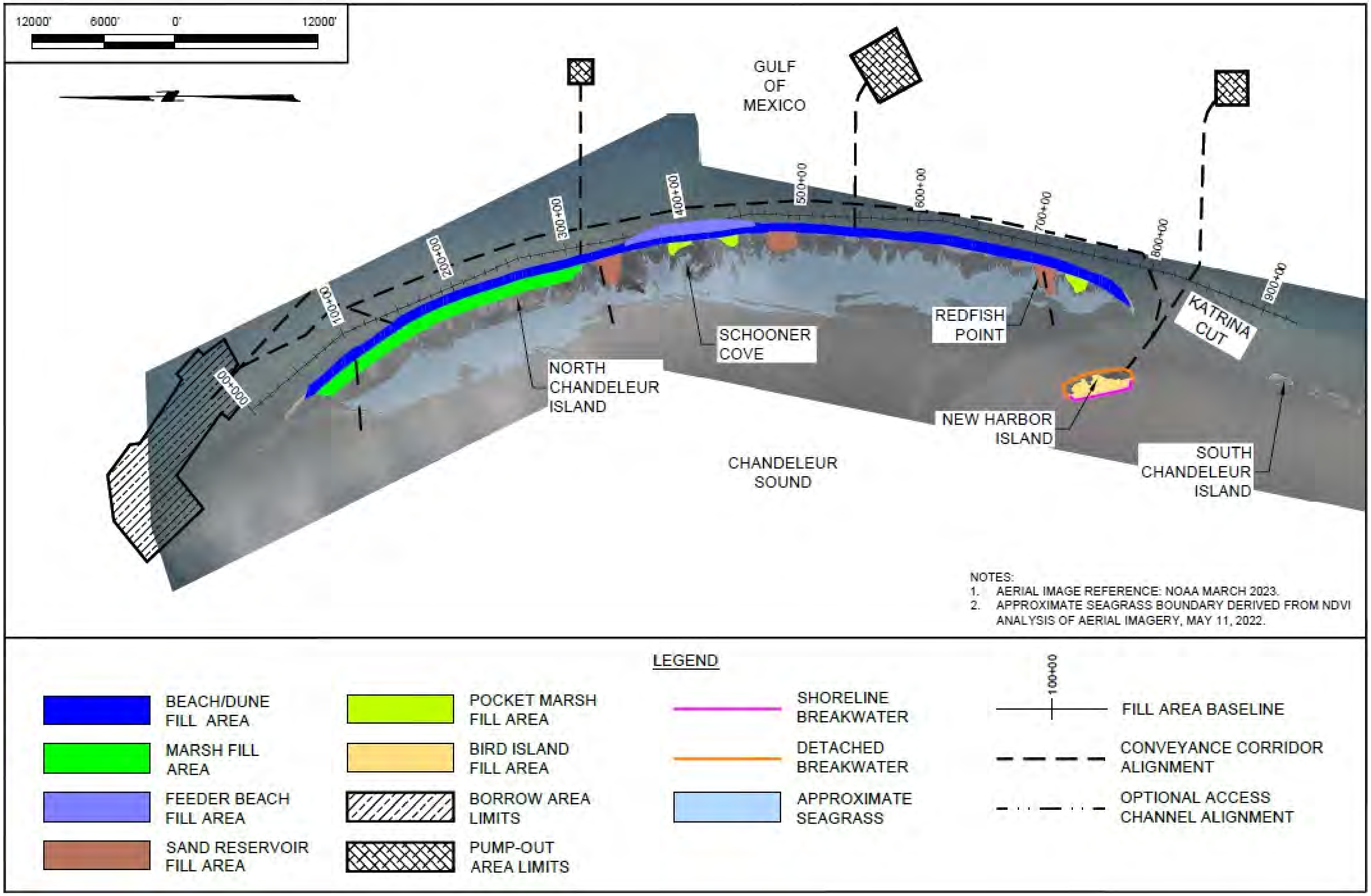

Figure 18. Recommended Alternative Plan View (Alternative 5)

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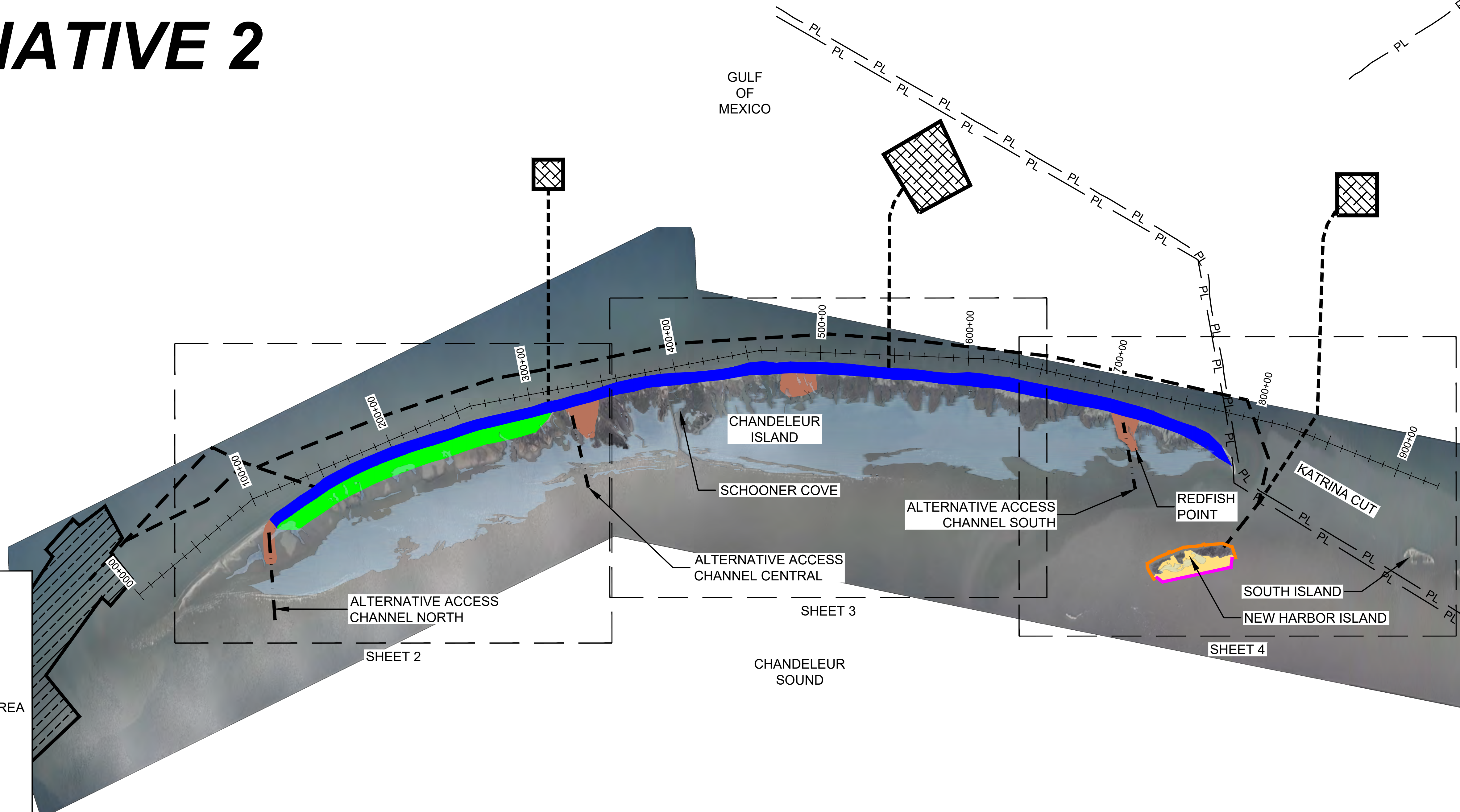
Appendix A: Alternative Design Drawings

ALTERNATIVE 2



LEGEND

- BEACH/DUNE FILL AREA
- MARSH FILL AREA
- SAND RESERVOIR FILL AREA
- BIRD ISLAND FILL AREA
- BORROW AREA LIMITS
- PUMP-OUT AREA LIMITS
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- APPROXIMATE SEAGRASS
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT
- OPTIONAL ACCESS CHANNEL ALIGNMENT
- PL — PROBABLE PIPELINE
- 100+00 FILL AREA BASELINE

ALTERNATIVE	DESIGN FEATURES	ACRES BEACH/DUNE	ACRES MARSH	VOLUME (CY)	EST. COST
ALTERNATIVE 2	NORTHEND BEACH, DUNE, & MARSH FROM 100+00 TO 310+00	1,237	468	3,460,000	$282,697,000
	BEACH & DUNE FROM 310+00 TO 750+00			2,552,500	
	SOUTHEND BEACH & DUNE FROM 750+00 TO 790+00			304,500	
	SAND RESERVOIRS (4)	273	0	1,635,500	
	NEW HARBOR ISLAND WITH SHORELINE PROTECTION	0	109	970,000	
	TOTALS	***1,510***	***577***	***8,922,500***	

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. PIPELINE INFORMATION OBTAINED FROM THE STRATEGIC ONLINE NATURAL RESOURCES INFORMATION SYSTEM (SONRIS), NATIONAL PIPELINE MAPPING SYSTEM (NPMS), AND THE BUREAU OF OCEAN ENERGY MANAGEMENT (BOEM) PIPELINE DATABASES.
3. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

8000' 4000' 0' 8000' 16000'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD
01	01/15/2024	REMOVED PACKET MARSHES, ADDED SAND RESERVOIRS, UPDATED TABLE	SD

COASTAL ENGINEERING CONSULTANTS, INC.
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SUITE E
DENHAM SPRINGS, LA
70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

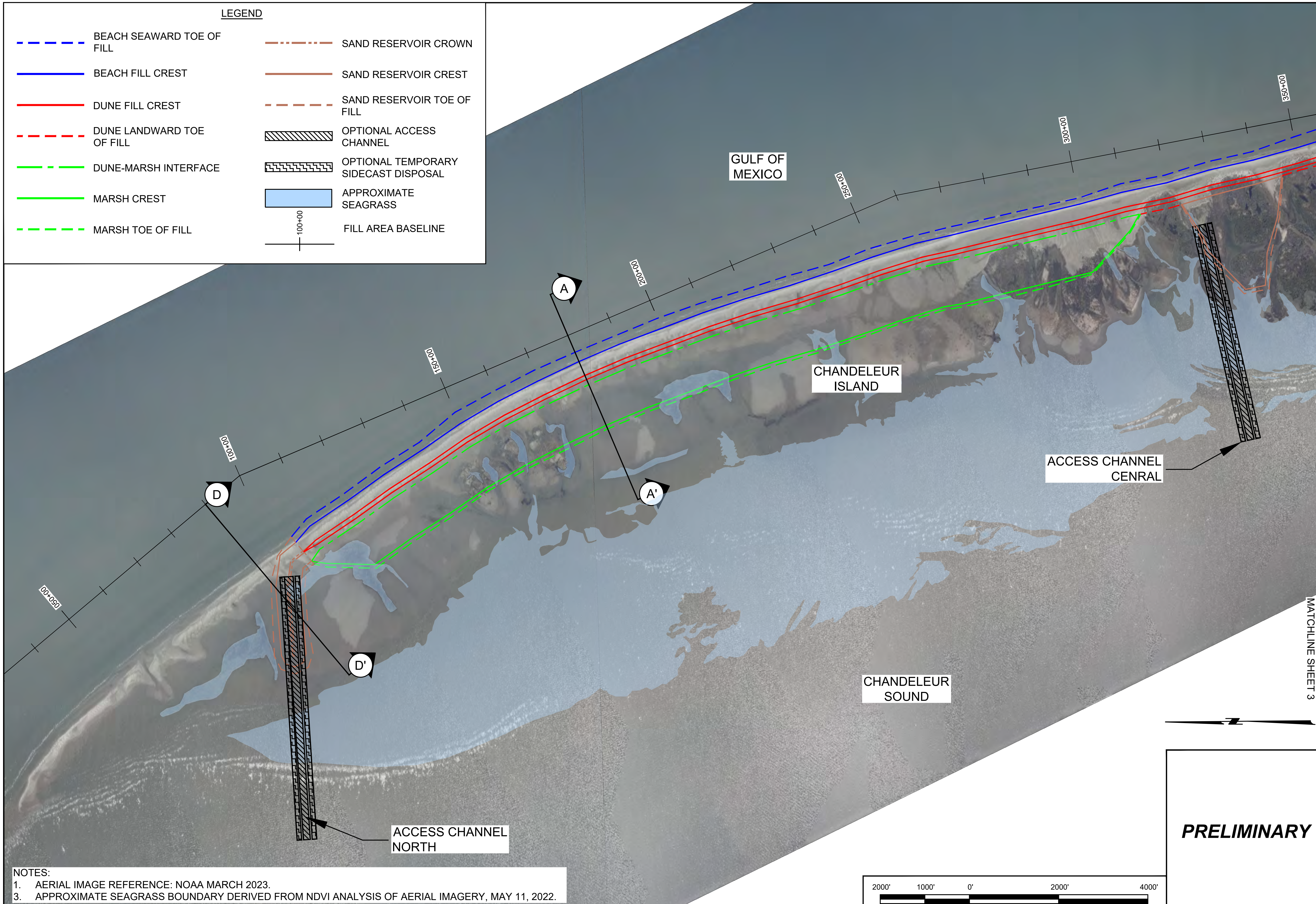
CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 2 OVERVIEW

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
3. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

2000' 1000' 0' 2000' 4000'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS, RELOCATION OF SAND RESERVOIR	SD
01	01/15/2024	REMOVED PACKET MARSHES, ADDED SAND RESERVOIRS	SD

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COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

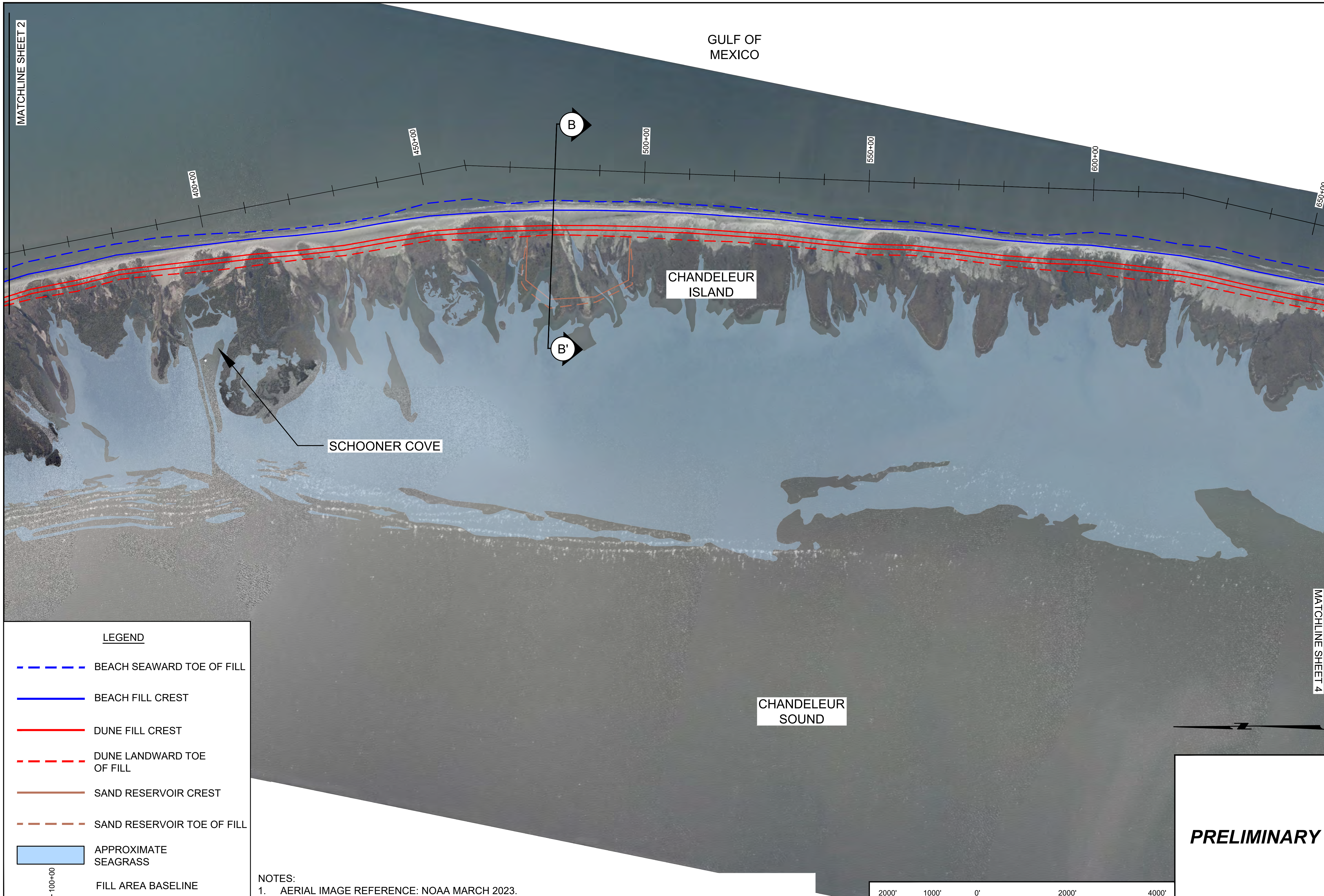
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 2 PLAN VIEW

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 2 OF 5



LEGEND

- BEACH SEAWARD TOE OF FILL
- BEACH FILL CREST
- DUNE FILL CREST
- DUNE LANDWARD TOE OF FILL
- SAND RESERVOIR CREST
- SAND RESERVOIR TOE OF FILL
- APPROXIMATE SEAGRASS
- 100+00 FILL AREA BASELINE

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
3. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD
01	01/15/2024	REMOVED PACKET MARSHES, ADDED SAND RESERVOIRS	SD

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BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.

APPROVED BY: MICHAEL POFF, P.E.

PRELIMINARY

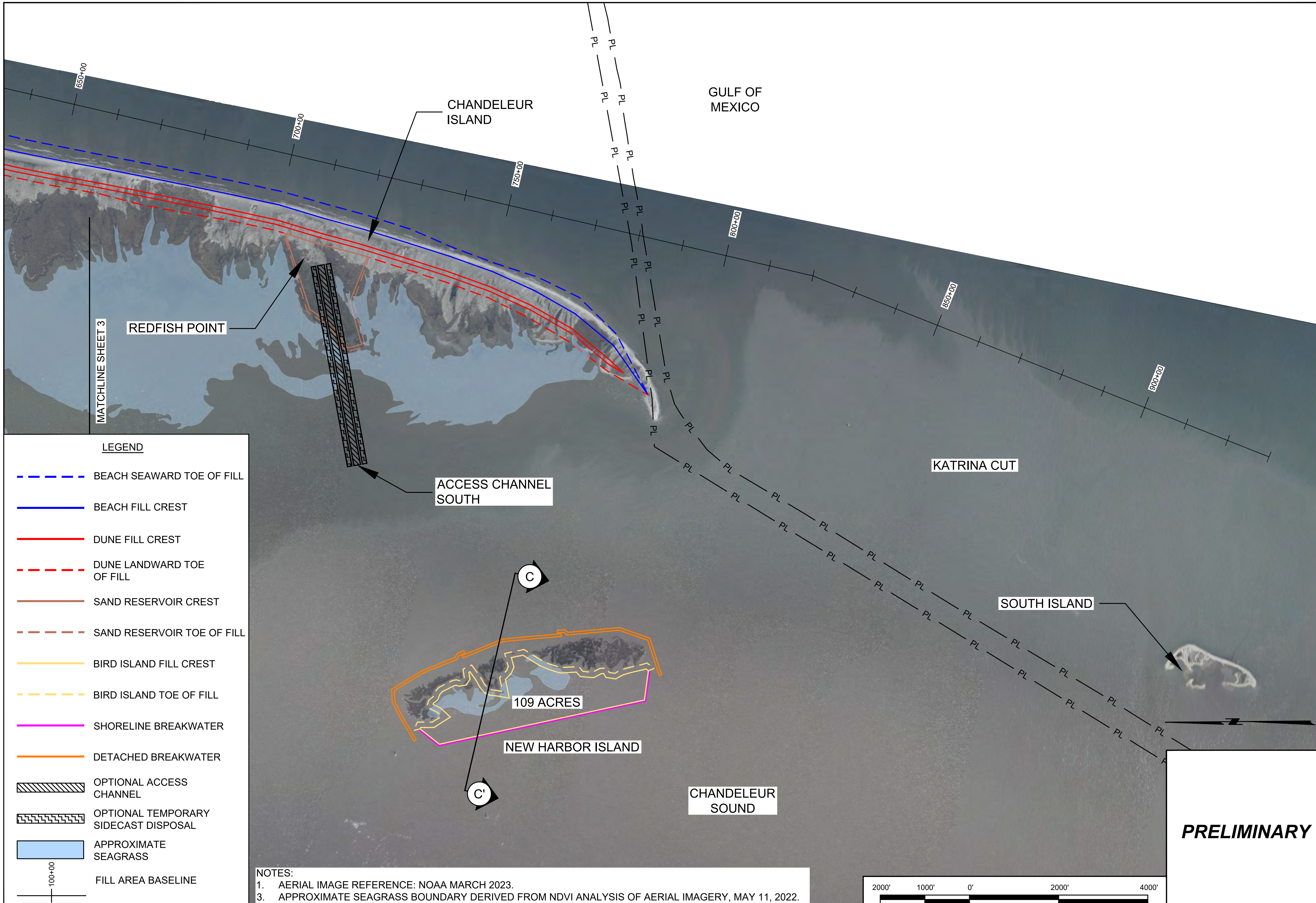
RESTORATION ALTERNATIVE 2 PLAN VIEW

STATE PROJECT NUMBER: PO-0199

DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 3 OF 5



LEGEND

- BEACH SEAWARD TOE OF FILL
- BEACH FILL CREST
- DUNE FILL CREST
- DUNE LANDWARD TOE OF FILL
- SAND RESERVOIR CREST
- SAND RESERVOIR TOE OF FILL
- BIRD ISLAND FILL CREST
- BIRD ISLAND TOE OF FILL
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- OPTIONAL ACCESS CHANNEL
- OPTIONAL TEMPORARY SIDECAST DISPOSAL
- APPROXIMATE SEAGRASS
- 100+00 FILL AREA BASELINE

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
3. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD
01	01/15/2024	REMOVED PACKET MARSHES, ADDED SAND RESERVOIRS	SD

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE
SUITE E
DENHAM SPRINGS, LA
70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

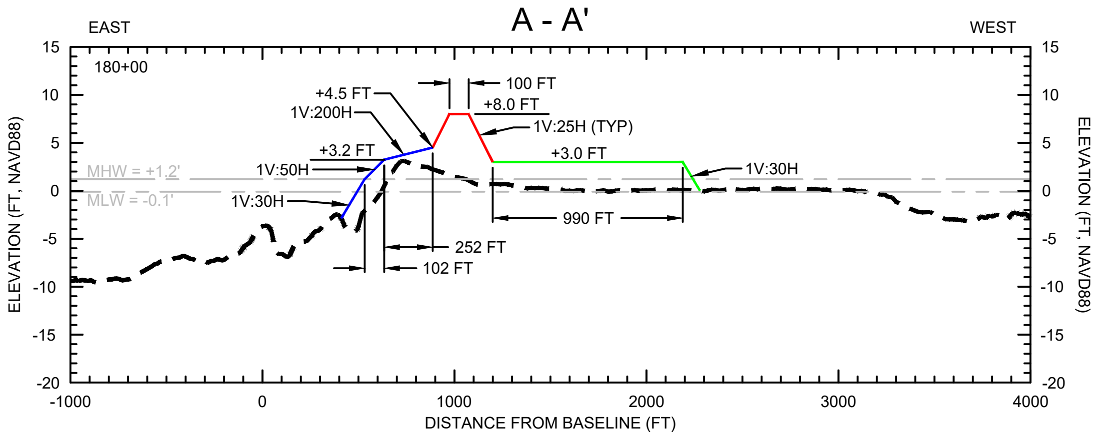
RESTORATION ALTERNATIVE 2 PLAN VIEW

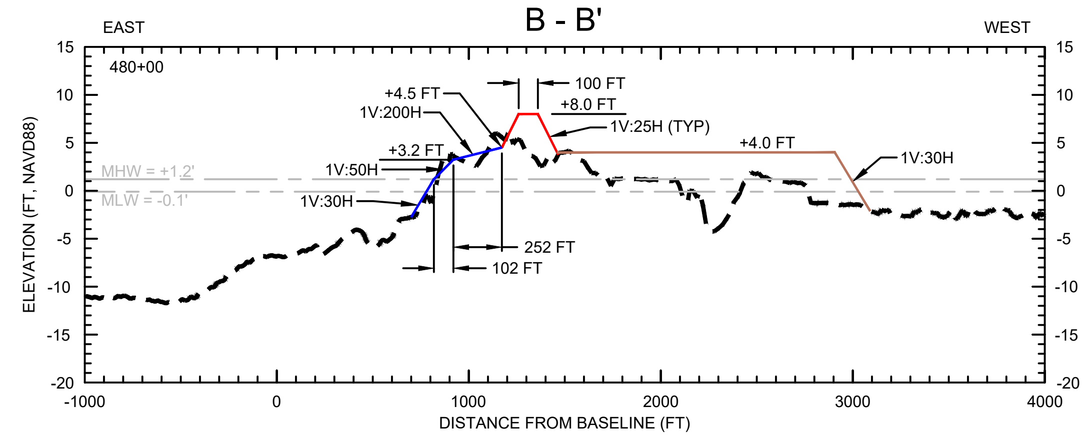
STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

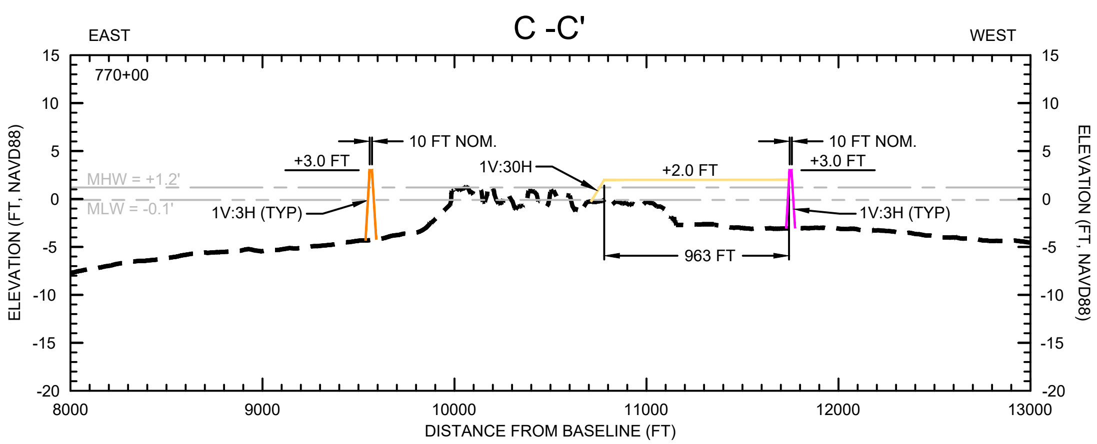
PRELIMINARY

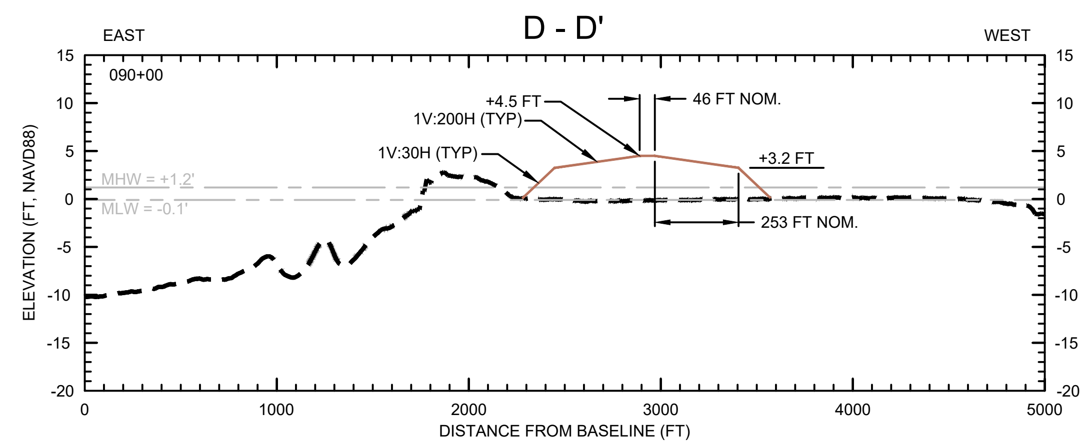
DATE: FEBRUARY 2024

SHEET 4 OF 5









LEGEND

- BEACH FILL
- DUNE FILL
- MARSH FILL
- SAND RESERVOIR FILL
- DETACHED BREAKWATER
- SHORELINE BREAKWATER
- BIRD ISLAND FILL
- EXISTING GRADE (2023)

NOTES:
1. SECTIONS ARE VIEWED LOOKING SOUTH.
2. DESIGN SURVEY CONDUCTED BY EMC, INC ON JUNE - NOVEMBER, 2023.
3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.

SCALE:
H: 1" = 1000'
V: 1" = 20'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
01	01/15/2024	REMOVED PACKET MARSHES, ADDED SAND RESERVOIRS	SD

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE
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DENHAM SPRINGS, LA
70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

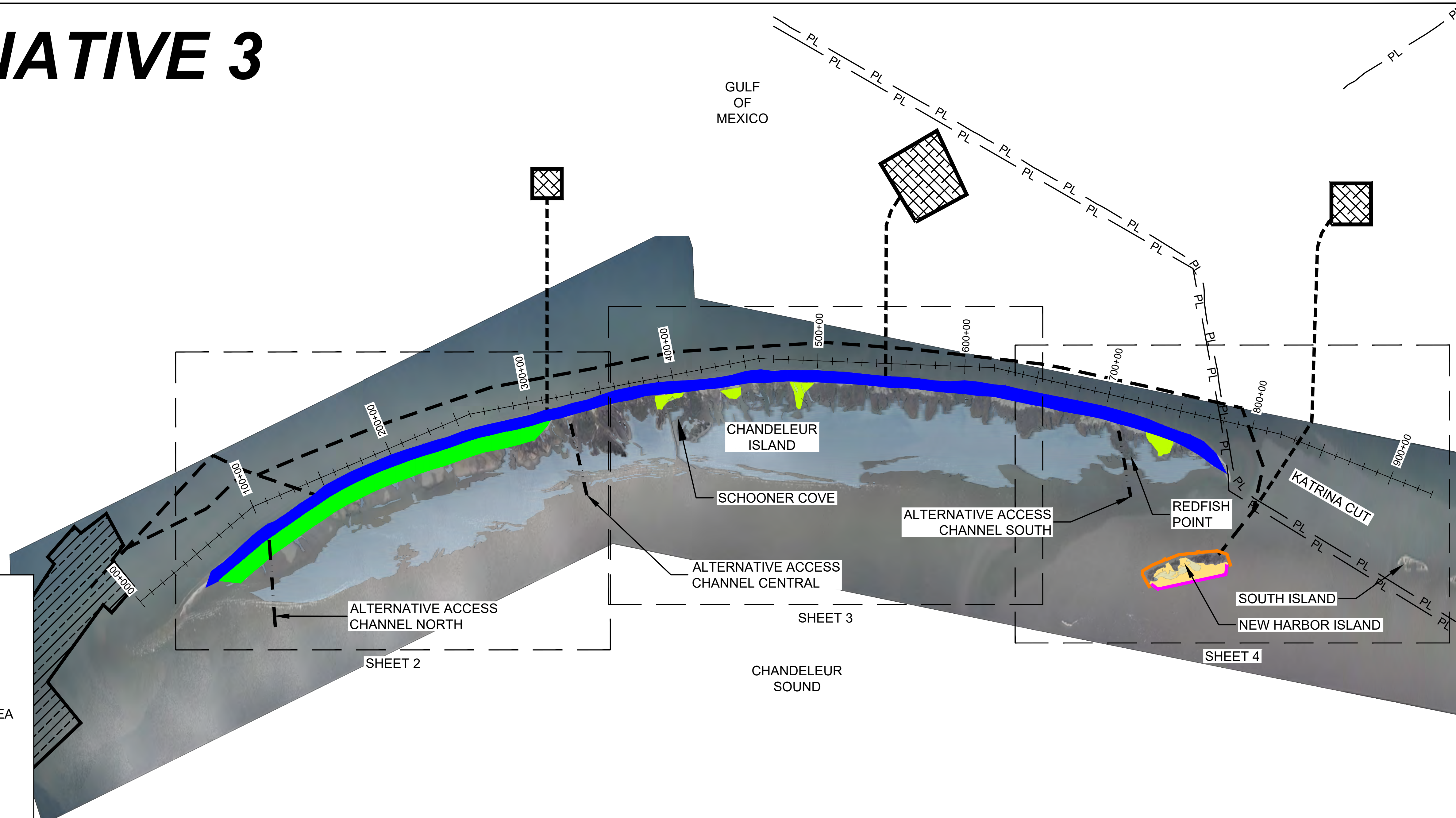
RESTORATION ALTERNATIVE 2 TYPICAL SECTIONS

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 5 OF 5

ALTERNATIVE 3



LEGEND

- BEACH/DUNE FILL AREA
- MARSH FILL AREA
- POCKET MARSH FILL AREA
- BIRD ISLAND FILL AREA
- PUMP-OUT AREA LIMITS
- BORROW AREA LIMITS
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- APPROXIMATE SEAGRASS
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT
- OPTIONAL ACCESS CHANNEL ALIGNMENT
- PL — PROBABLE PIPELINE
- 100+00 FILL AREA BASELINE

ALTERNATIVE	DESIGN FEATURES	ACRES BEACH/DUNE	ACRES MARSH	VOLUME (CY)	EST. COST
ALTERNATIVE 3	NORTHEND BEACH, DUNE, & MARSH FROM 40+00 TO 310+00	1,341	592	4,675,000	$280,170,000
	BEACH & DUNE FROM 310+00 TO 750+00			2,552,500	
	SOUTHEND BEACH & DUNE FROM 750+00 TO 790+00			304,500	
	POCKET MARSHES (4)	0	106	475,000	
	NEW HARBOR ISLAND WITH SHORELINE PROTECTION	0	109	970,000	
	TOTALS	***1,341***	***807***	***8,947,000***	

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. PIPELINE INFORMATION OBTAINED FROM THE STRATEGIC ONLINE NATURAL RESOURCES INFORMATION SYSTEM (SONRIS), NATIONAL PIPELINE MAPPING SYSTEM (NPMS), AND THE BUREAU OF OCEAN ENERGY MANAGEMENT (BOEM) PIPELINE DATABASES.
3. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

8000' 4000' 0' 8000' 16000'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD
01	01/15/2024	UPDATED TABLE	SD

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
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70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

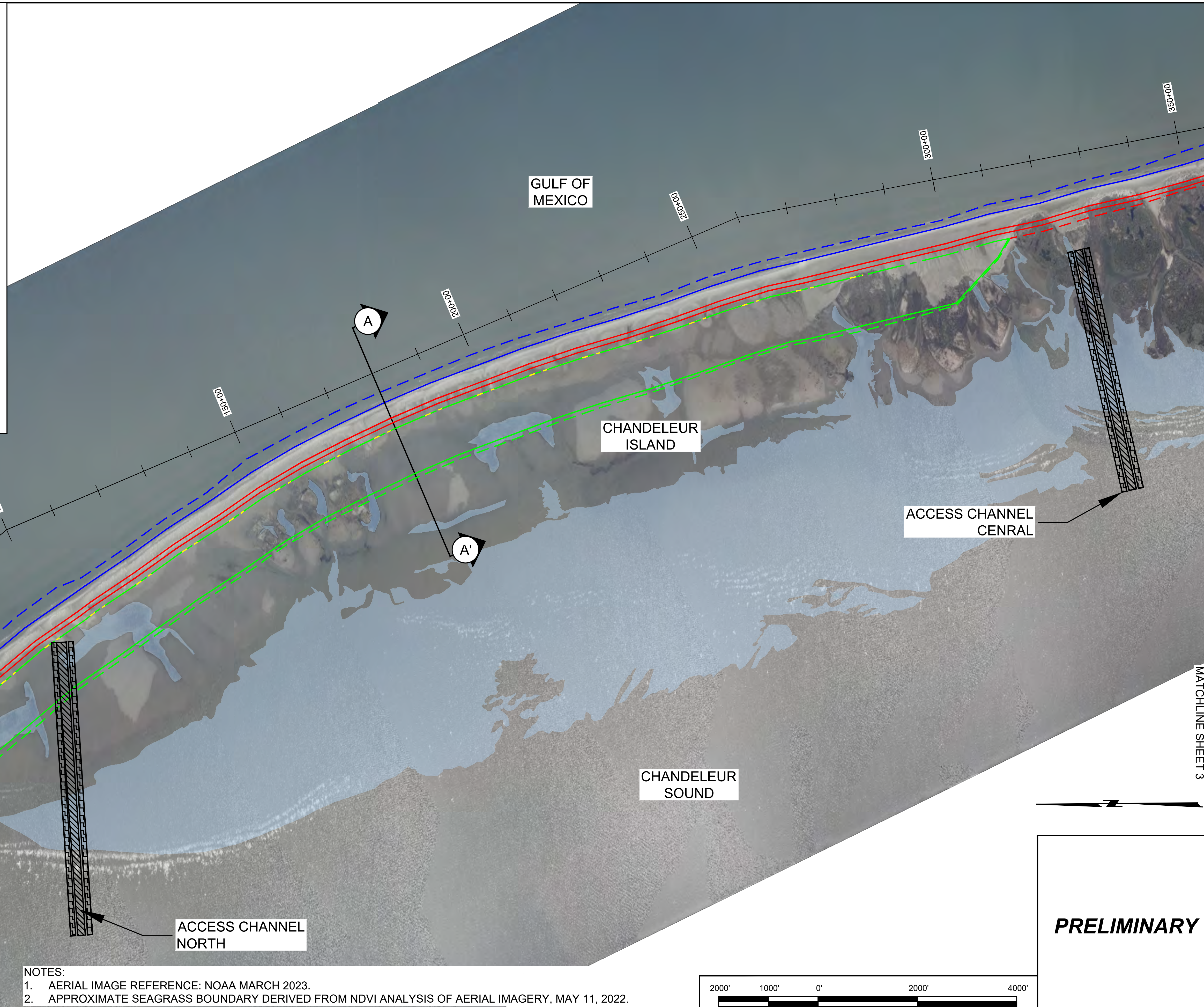
CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 3 OVERVIEW

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024



LEGEND

- BEACH SEAWARD TOE OF FILL
- BEACH FILL CREST
- DUNE FILL CREST
- DUNE LANDWARD TOE OF FILL
- DUNE-MARSH INTERFACE
- MARSH CREST
- MARSH TOE OF FILL
- OPTIONAL ACCESS CHANNEL
- OPTIONAL TEMPORARY SIDECAST DISPOSAL
- APPROXIMATE SEAGRASS
- 100+00 FILL AREA BASELINE

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD

COASTAL ENGINEERING CONSULTANTS, INC.
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150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.

APPROVED BY: MICHAEL POFF, P.E.

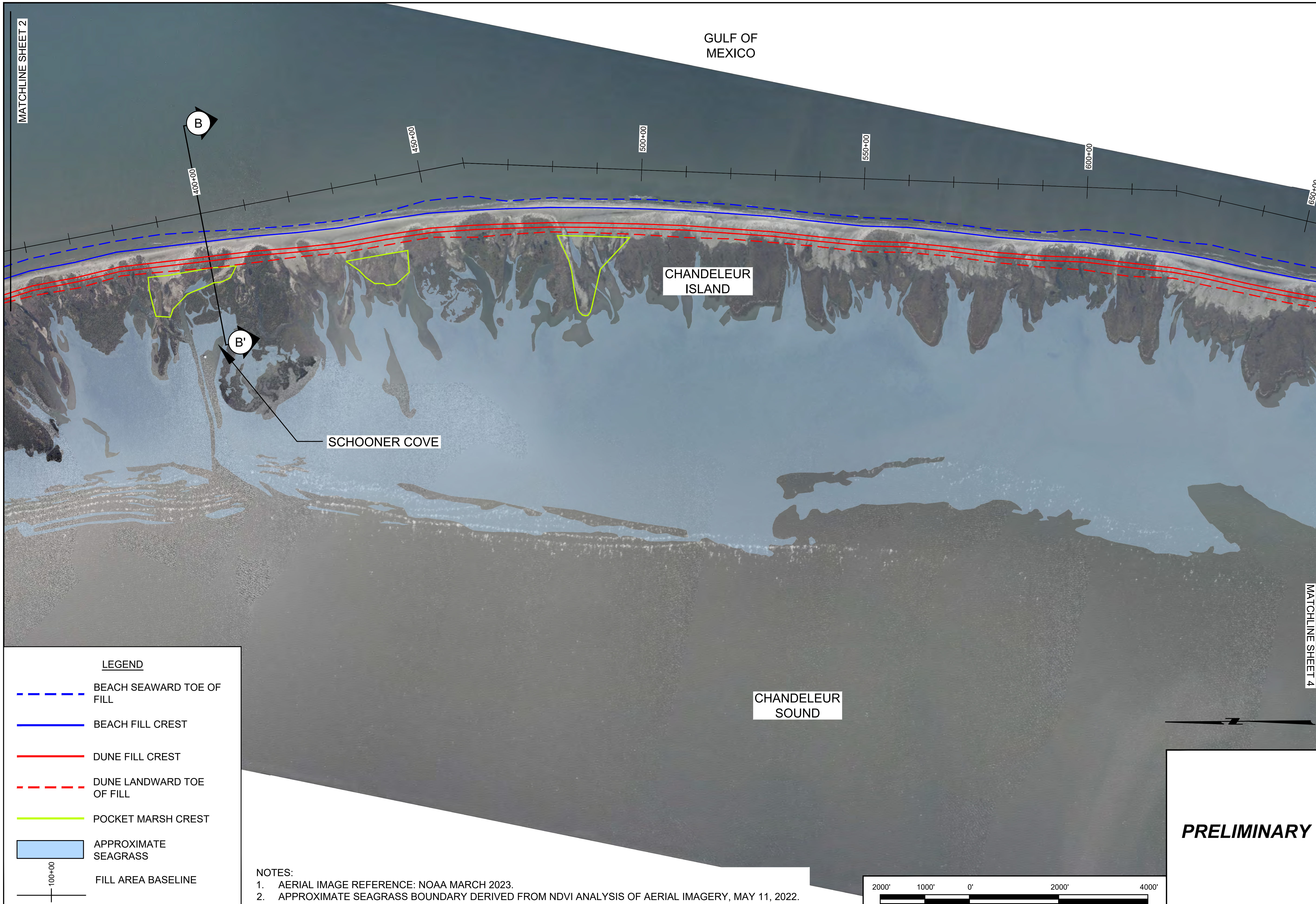
RESTORATION ALTERNATIVE 3 PLAN VIEW

STATE PROJECT NUMBER: PO-0199

DRAWN BY: STEVE DARTEZ

PRELIMINARY

DATE: FEBRUARY 2024



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD

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150 TERRACE AVENUE
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CHANDELEUR ISLAND RESTORATION

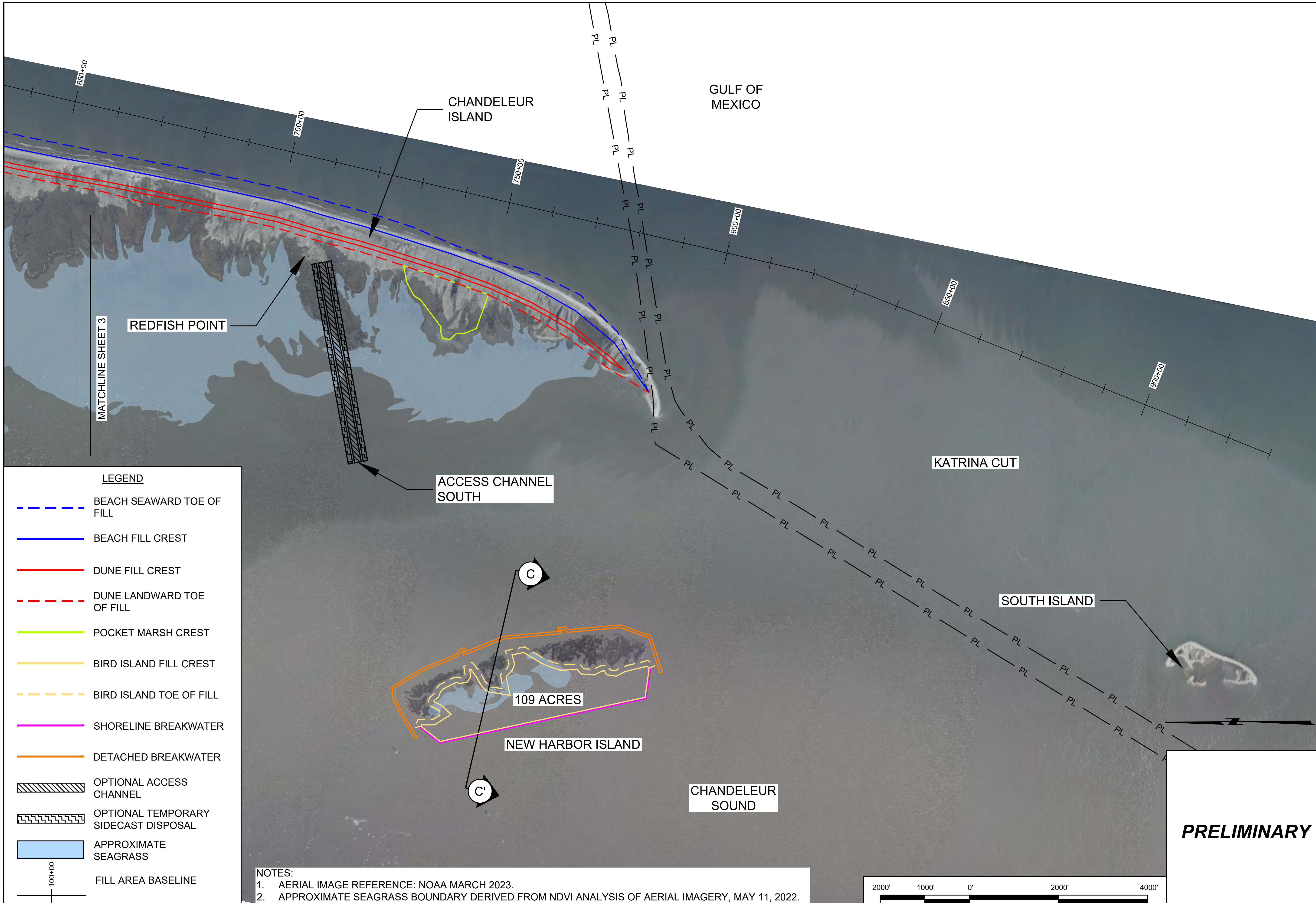
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 3 PLAN VIEW

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 3 OF 5



LEGEND

- BEACH SEAWARD TOE OF FILL
- BEACH FILL CREST
- DUNE FILL CREST
- DUNE LANDWARD TOE OF FILL
- POCKET MARSH CREST
- BIRD ISLAND FILL CREST
- BIRD ISLAND TOE OF FILL
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- OPTIONAL ACCESS CHANNEL
- OPTIONAL TEMPORARY SIDECAST DISPOSAL
- APPROXIMATE SEAGRASS
- 100+00 FILL AREA BASELINE

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD

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DENHAM SPRINGS, LA 70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

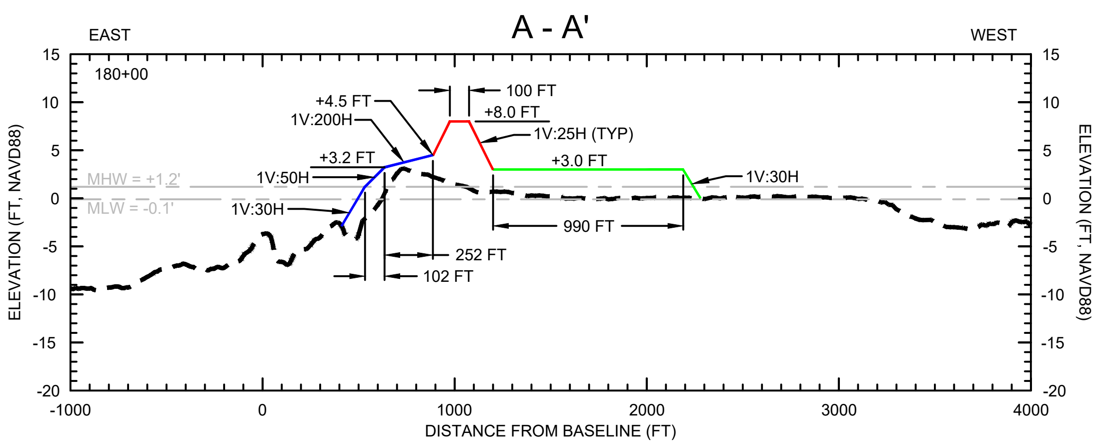
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

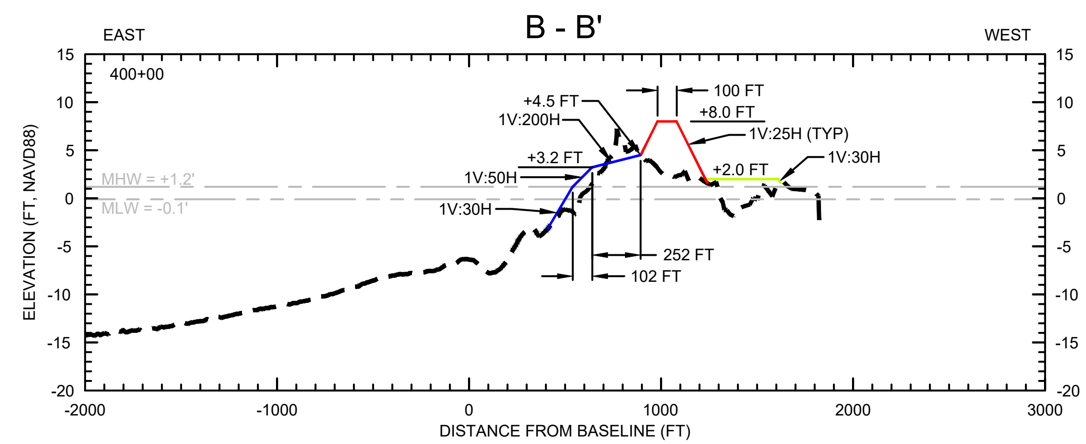
RESTORATION ALTERNATIVE 3 PLAN VIEW

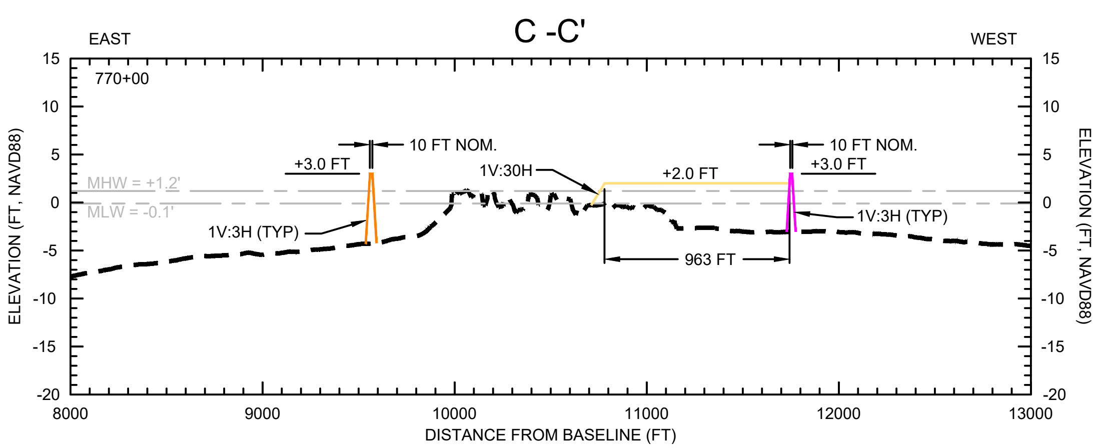
STATE PROJECT NUMBER: PO-0199

DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024







LEGEND

- BEACH FILL
- DUNE FILL
- MARSH FILL
- POCKET MARSH FILL
- BIRD ISLAND FILL
- DETACHED BREAKWATER
- SHORELINE BREAKWATER
- EXISTING GRADE (2023)

NOTES:
1. SECTIONS ARE VIEWED LOOKING SOUTH.
2. DESIGN SURVEY CONDUCTED BY EMC, INC ON JUNE - NOVEMBER, 2023.
3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.

SCALE:
H: 1" = 1000'
V: 1" = 20'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY

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DENHAM SPRINGS, LA
70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

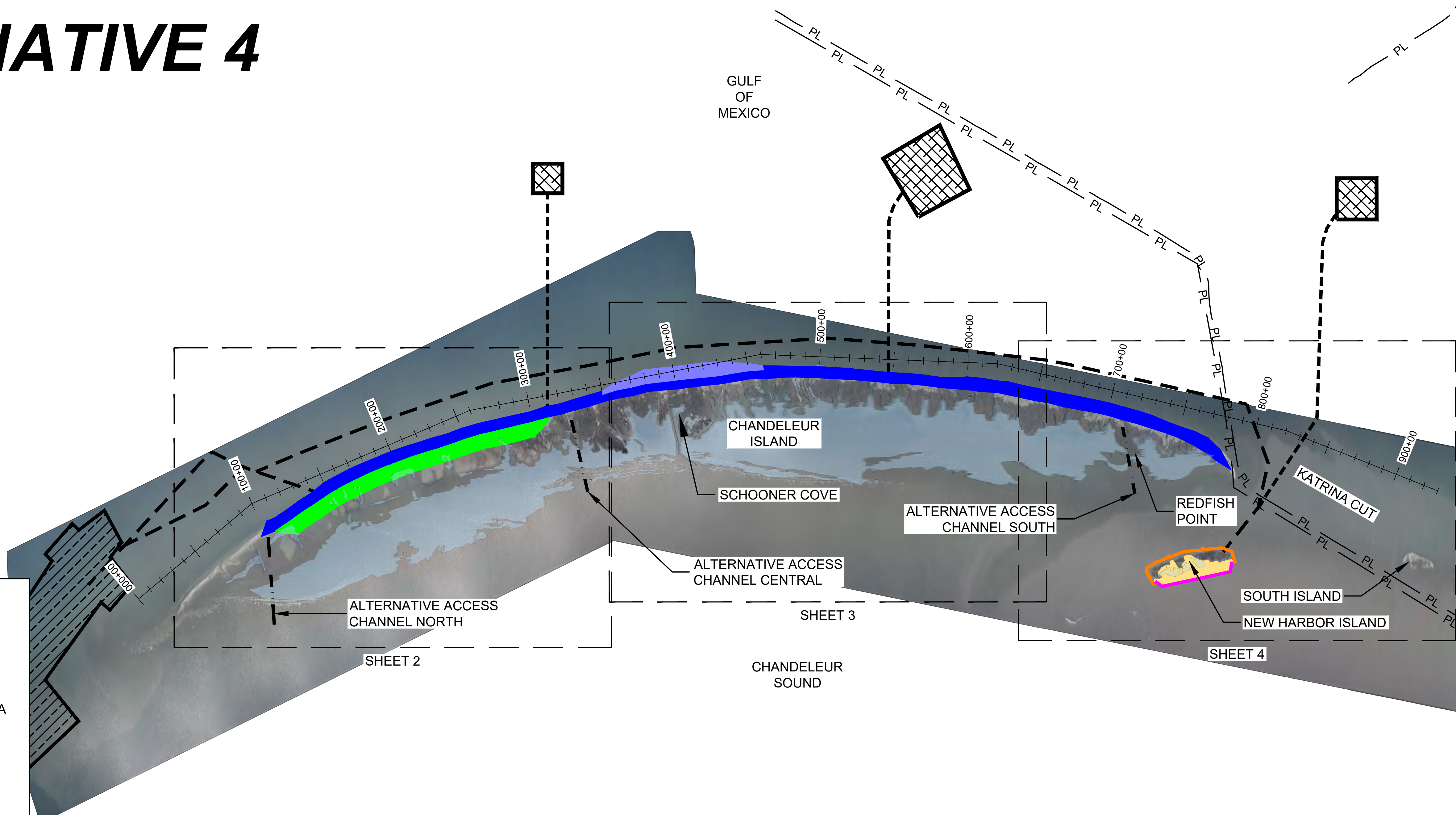
RESTORATION ALTERNATIVE 3 TYPICAL SECTIONS

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 5 OF 5

ALTERNATIVE 4



LEGEND

- BEACH/DUNE FILL AREA
- MARSH FILL AREA
- FEEDER BEACH FILL AREA
- BIRD ISLAND FILL AREA
- BORROW AREA LIMITS
- PUMP-OUT AREA LIMITS
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT
- OPTIONAL ACCESS CHANNEL ALIGNMENT
- APPROXIMATE SEAGRASS
- PL — PROBABLE PIPELINE
- 100+00 FILL AREA BASELINE

ALTERNATIVE	DESIGN FEATURES	ACRES BEACH/DUNE	ACRES MARSH	VOLUME (CY)	EST. COST
ALTERNATIVE 4	NORTHEND BEACH, DUNE, & MARSH FROM 90+00 TO 310+00	1,397	468	3,450,800	$284,460,000
	BEACH & DUNE FROM 310+00 TO 750+00 PLUS FEEDER BEACH			4,220,000	
	SOUTHEND BEACH & DUNE FROM 750+00 TO 790+00			304,500	
	NEW HARBOR ISLAND WITH SHORELINE PROTECTION	0	109	970,000	
	TOTALS	***1,397***	***577***	***8,945,300***	

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. PIPELINE INFORMATION OBTAINED FROM THE STRATEGIC ONLINE NATURAL RESOURCES INFORMATION SYSTEM(SONRIS), NATIONAL PIPELINE MAPPING SYSTEM(NPMS), AND THE BUREAU OF OCEAN ENERGY MANAGEMENT (BOEM) PIPELINE DATABASES.
3. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

8000' 4000' 0' 8000' 16000'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD
01	01/15/2024	REDUCED SIZE OF FEEDER BEACH, UPDATED TABLE	SD

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE
SUITE E
DENHAM SPRINGS, LA 70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

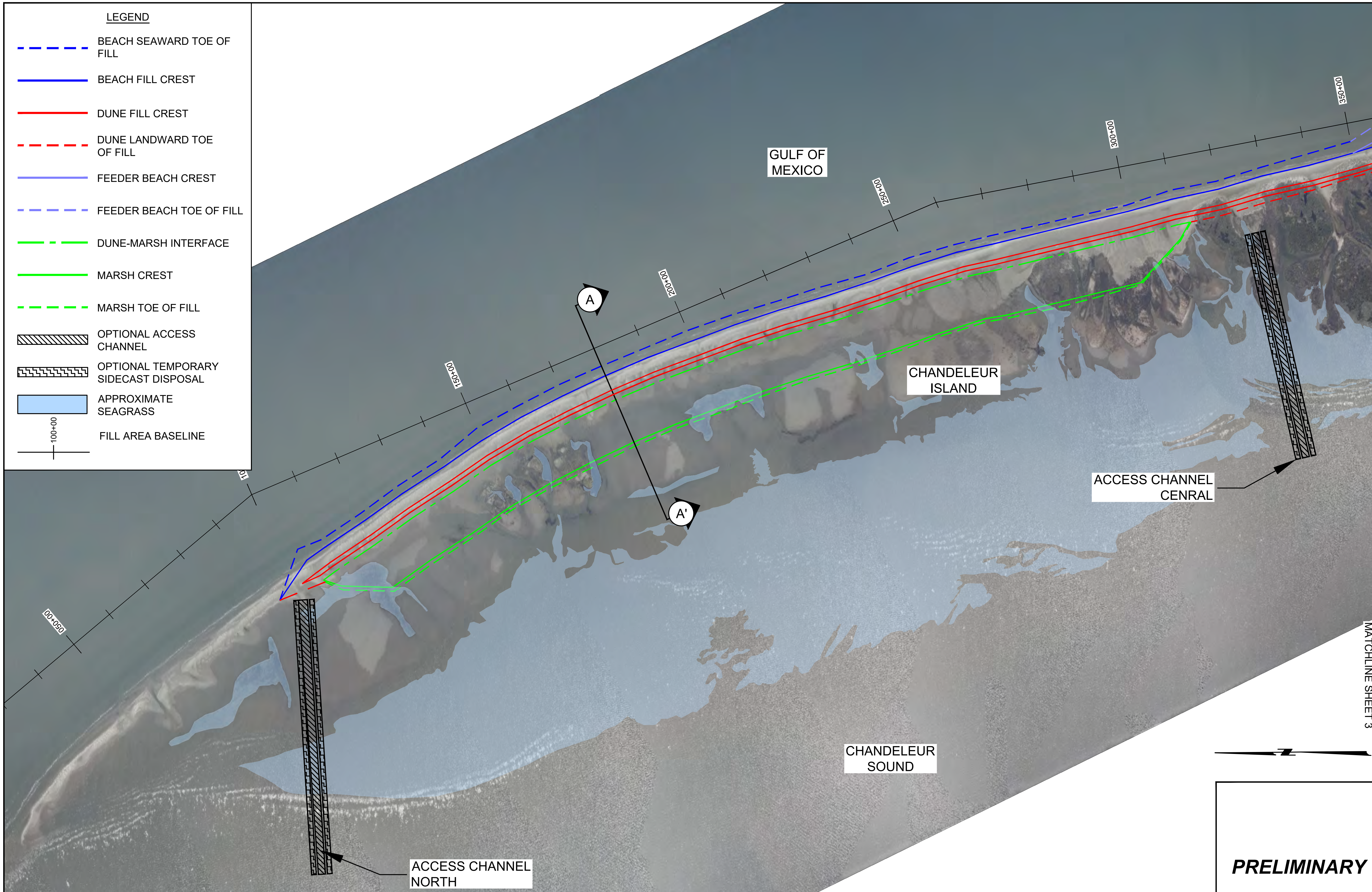
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 4 OVERVIEW

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 1 OF 5



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

2000' 1000' 0' 2000' 4000'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE
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COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

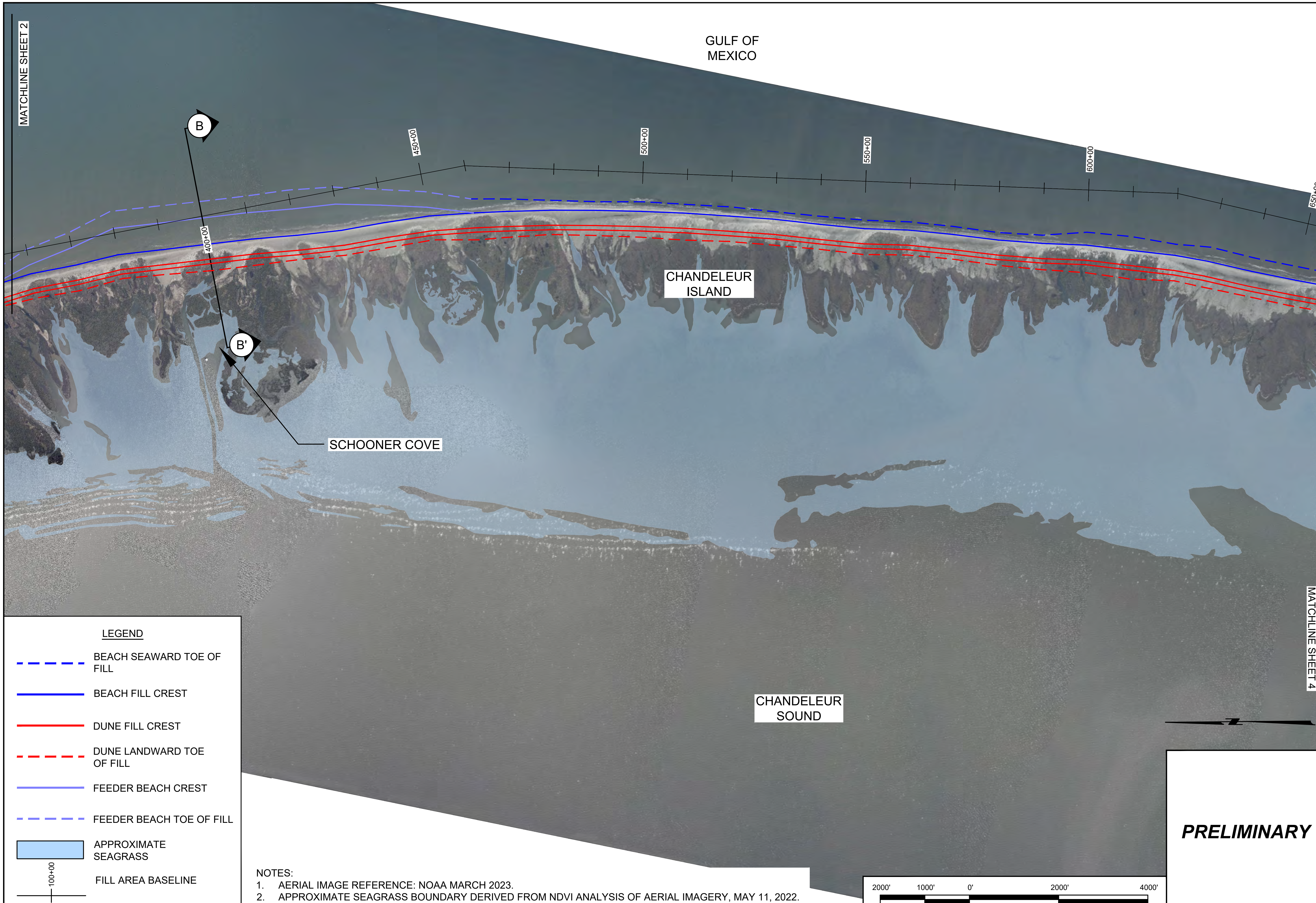
CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 4 PLAN VIEW

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024



LEGEND

- BEACH SEAWARD TOE OF FILL
- BEACH FILL CREST
- DUNE FILL CREST
- DUNE LANDWARD TOE OF FILL
- FEEDER BEACH CREST
- FEEDER BEACH TOE OF FILL
- APPROXIMATE SEAGRASS
- 100+00 FILL AREA BASELINE

NOTES:
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2. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD
01	01/15/2024	REDUCED SIZE OF FEEDER BEACH	SD

COASTAL ENGINEERING CONSULTANTS, INC.
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1211 N. RANGE AVE
SUITE E
DENHAM SPRINGS, LA 70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.

APPROVED BY: MICHAEL POFF, P.E.

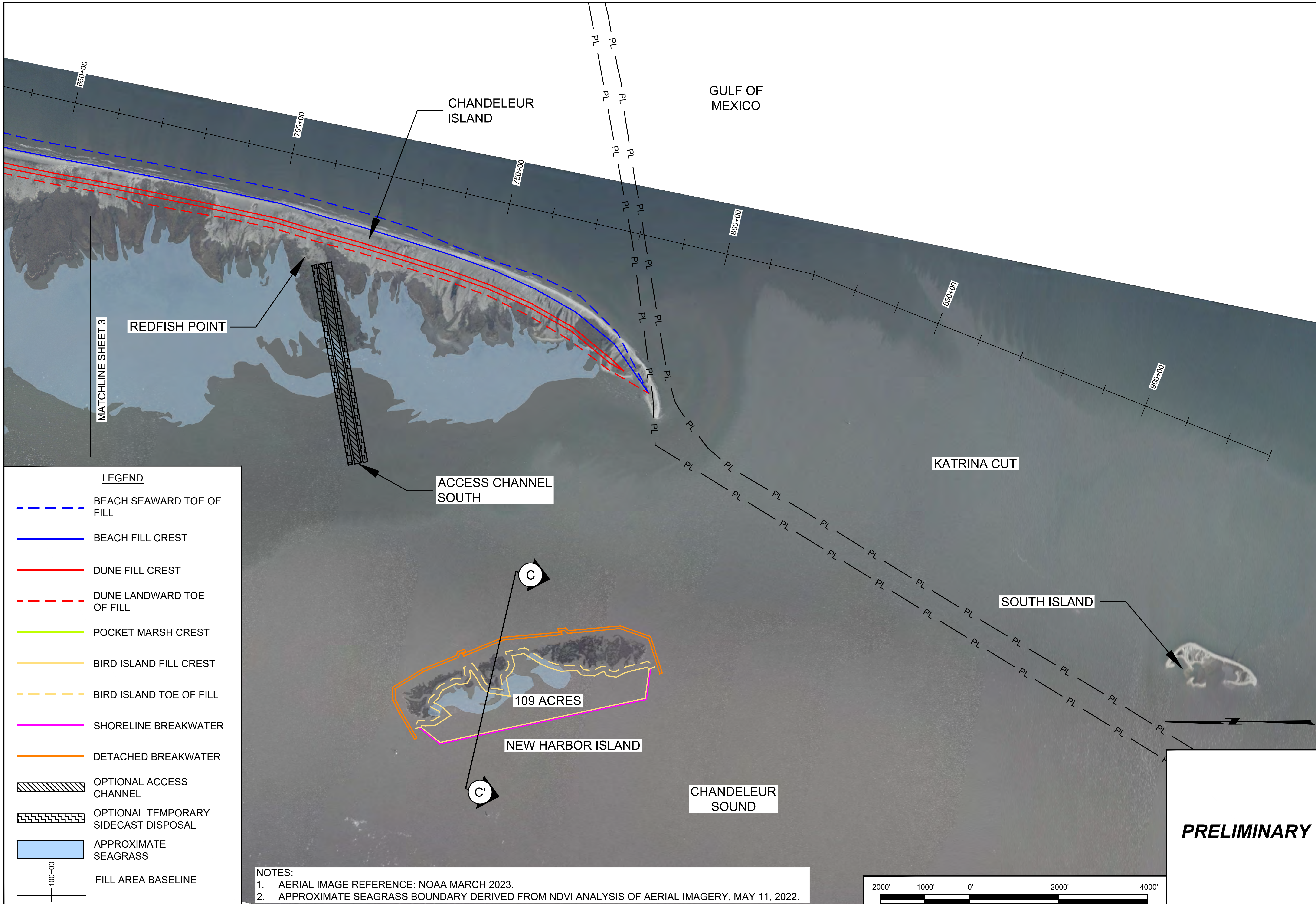
RESTORATION ALTERNATIVE 4 PLAN VIEW

STATE PROJECT NUMBER: PO-0199

DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 3 OF 5



LEGEND

- BEACH SEAWARD TOE OF FILL
- BEACH FILL CREST
- DUNE FILL CREST
- DUNE LANDWARD TOE OF FILL
- POCKET MARSH CREST
- BIRD ISLAND FILL CREST
- BIRD ISLAND TOE OF FILL
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- OPTIONAL ACCESS CHANNEL
- OPTIONAL TEMPORARY SIDECAST DISPOSAL
- APPROXIMATE SEAGRASS
- 100+00 FILL AREA BASELINE

NOTES:
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REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD

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150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

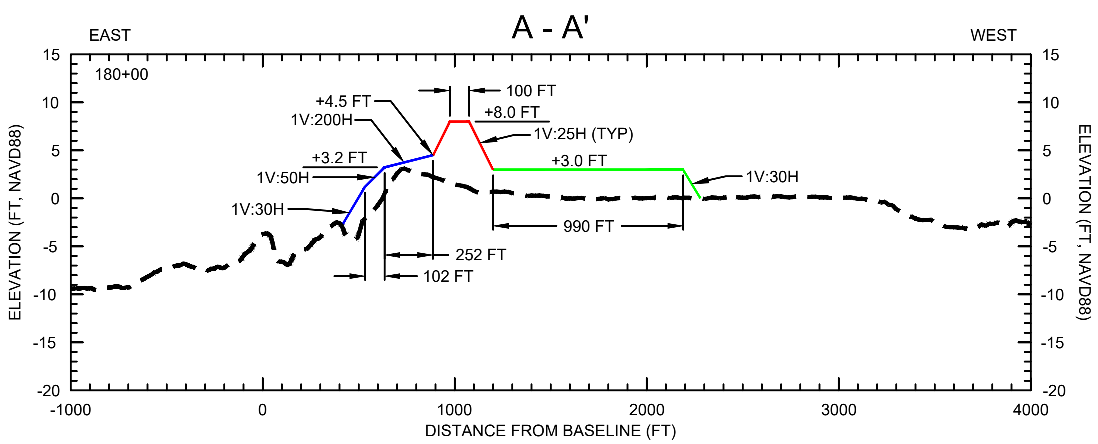
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

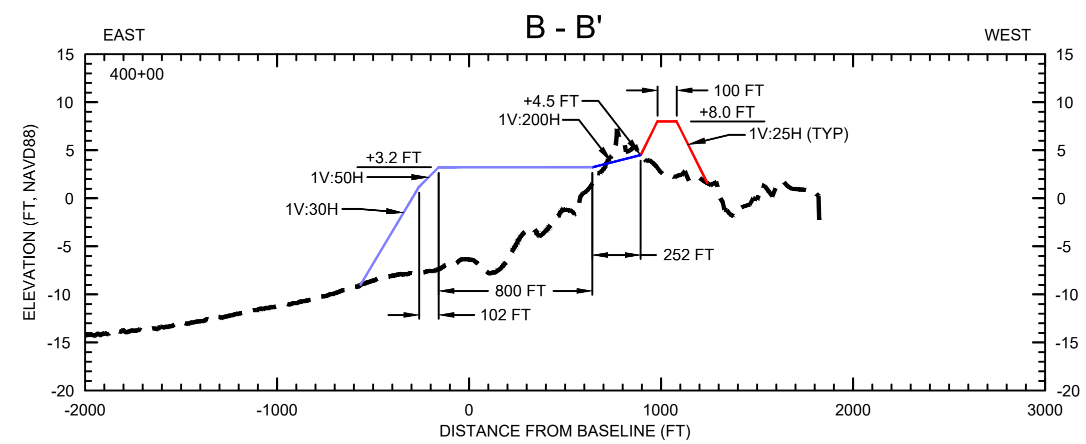
RESTORATION ALTERNATIVE 4 PLAN VIEW

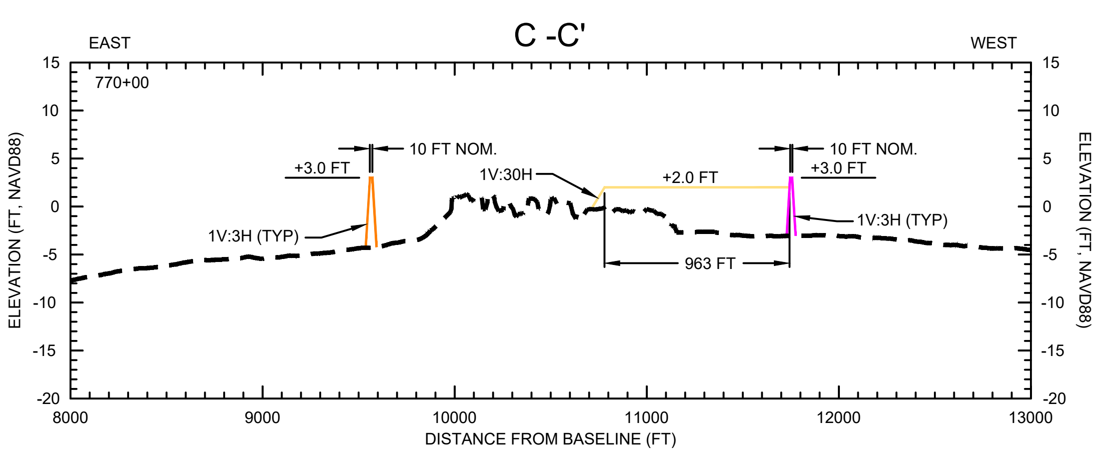
STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 4 OF 5







LEGEND

- BEACH FILL
- DUNE FILL
- MARSH FILL
- FEEDER BEACH FILL
- DETACHED BREAKWATER
- SHORELINE BREAKWATER
- BIRD ISLAND FILL
- EXISTING GRADE (2023)

NOTES:
1. SECTIONS ARE VIEWED LOOKING SOUTH.
2. DESIGN SURVEY CONDUCTED BY EMC, INC ON JUNE - NOVEMBER, 2023.
3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.

SCALE:
H: 1" = 1000'
V: 1" = 20'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
01	01/15/2024	REDUCED SIZE OF FEEDER BEACH	SD

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CHANDELEUR ISLAND RESTORATION

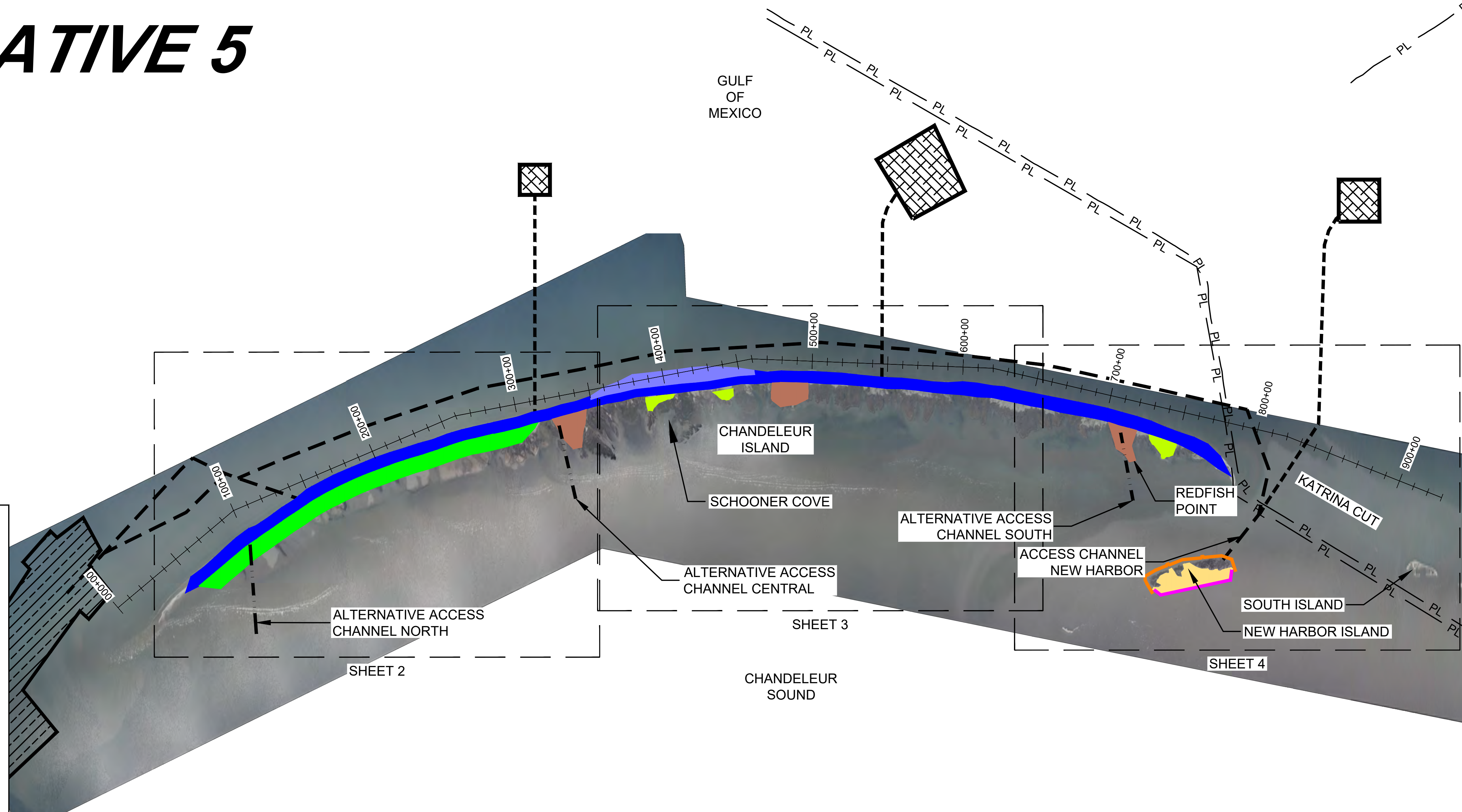
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 4 TYPICAL SECTIONS

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

ALTERNATIVE 5



LEGEND

- BEACH/DUNE FILL AREA
- MARSH FILL AREA
- FEEDER BEACH FILL AREA
- SAND RESERVOIR FILL AREA
- POCKET MARSH FILL AREA
- BIRD ISLAND FILL AREA
- PUMP-OUT AREA LIMITS
- BORROW AREA LIMITS
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- APPROXIMATE SEAGRASS
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT
- OPTIONAL ACCESS CHANNEL ALIGNMENT
- PL — PROBABLE PIPELINE
- 100+00 FILL AREA BASELINE

ALTERNATIVE	DESIGN FEATURES	ACRES BEACH/DUNE	ACRES MARSH	VOLUME (CY)	EST. COST
ALTERNATIVE 5	NORTHERN BEACH, DUNE, & MARSH FROM 40+00 TO 310+00	1,486	592	4,676,700	$350,348,000
	BEACH & DUNE FROM 310+00 TO 790+00 PLUS FEEDER BEACH			4,189,500	
	SAND RESERVOIRS (3)	203	0	1,264,900	
	POCKET MARSHES (3)	0	76	320,600	
	NEW HARBOR ISLAND WITH SHORELINE PROTECTION	0	109	970,300	
	TOTALS	***1,689***	***777***	***11,502,000***	

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. PIPELINE INFORMATION OBTAINED FROM THE STRATEGIC ONLINE NATURAL RESOURCES INFORMATION SYSTEM (SONRIS), NATIONAL PIPELINE MAPPING SYSTEM (NPMS), AND THE BUREAU OF OCEAN ENERGY MANAGEMENT (BOEM) PIPELINE DATABASES.
3. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

8000' 4000' 0' 8000' 16000'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	REFINED FILL VOLUME CALCULATION	SD
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD
01	01/15/2024	UPDATED TABLE	SD

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE
SUITE E
DENHAM SPRINGS, LA 70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

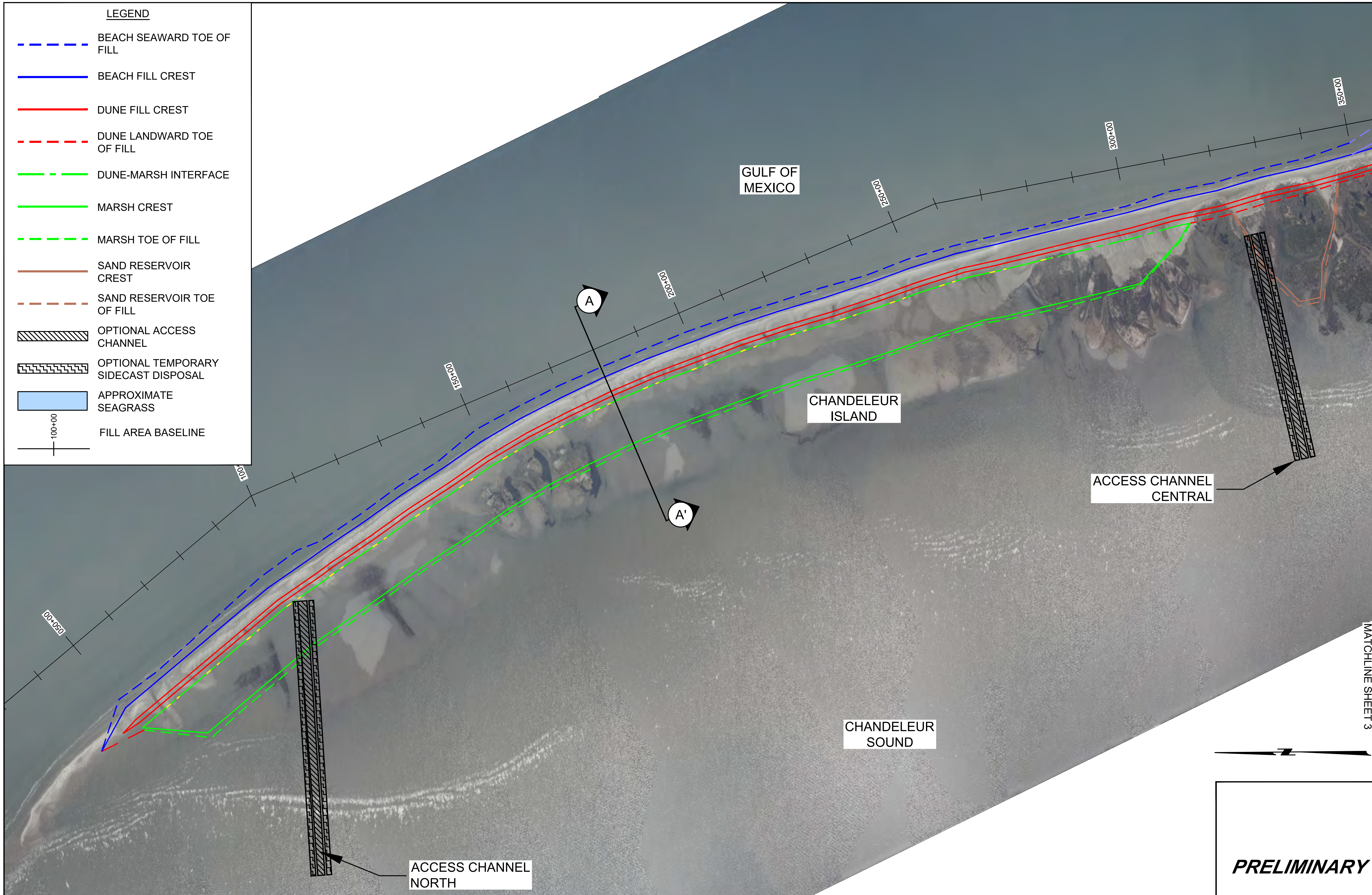
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 5 OVERVIEW

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: OCTOBER 2024

SHEET 1 OF 5



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD

COASTAL ENGINEERING CONSULTANTS, INC.
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COASTAL PROTECTION AND RESTORATION AUTHORITY
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CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.

APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 5 NORTH ZONE PLAN VIEW

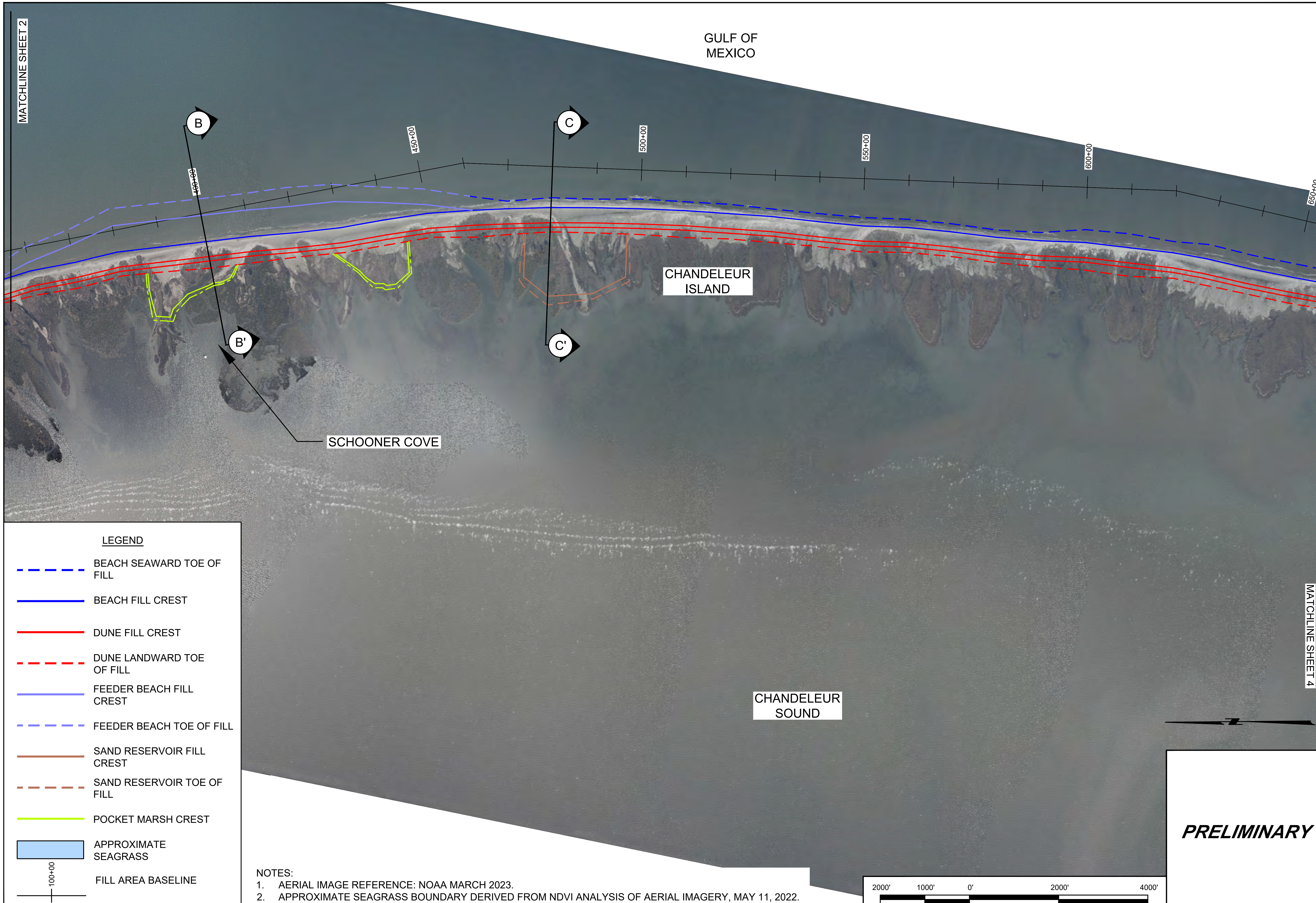
STATE PROJECT NUMBER: PO-0199

DRAWN BY: STEVE DARTEZ

PRELIMINARY

DATE: OCTOBER 2024

SHEET 2 OF 5



LEGEND

- BEACH SEAWARD TOE OF FILL
- BEACH FILL CREST
- DUNE FILL CREST
- DUNE LANDWARD TOE OF FILL
- FEEDER BEACH FILL CREST
- FEEDER BEACH TOE OF FILL
- SAND RESERVOIR FILL CREST
- SAND RESERVOIR TOE OF FILL
- POCKET MARSH CREST
- APPROXIMATE SEAGRASS
- 100+00 FILL AREA BASELINE

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

2000' 1000' 0' 2000' 4000'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD

COASTAL ENGINEERING CONSULTANTS, INC.
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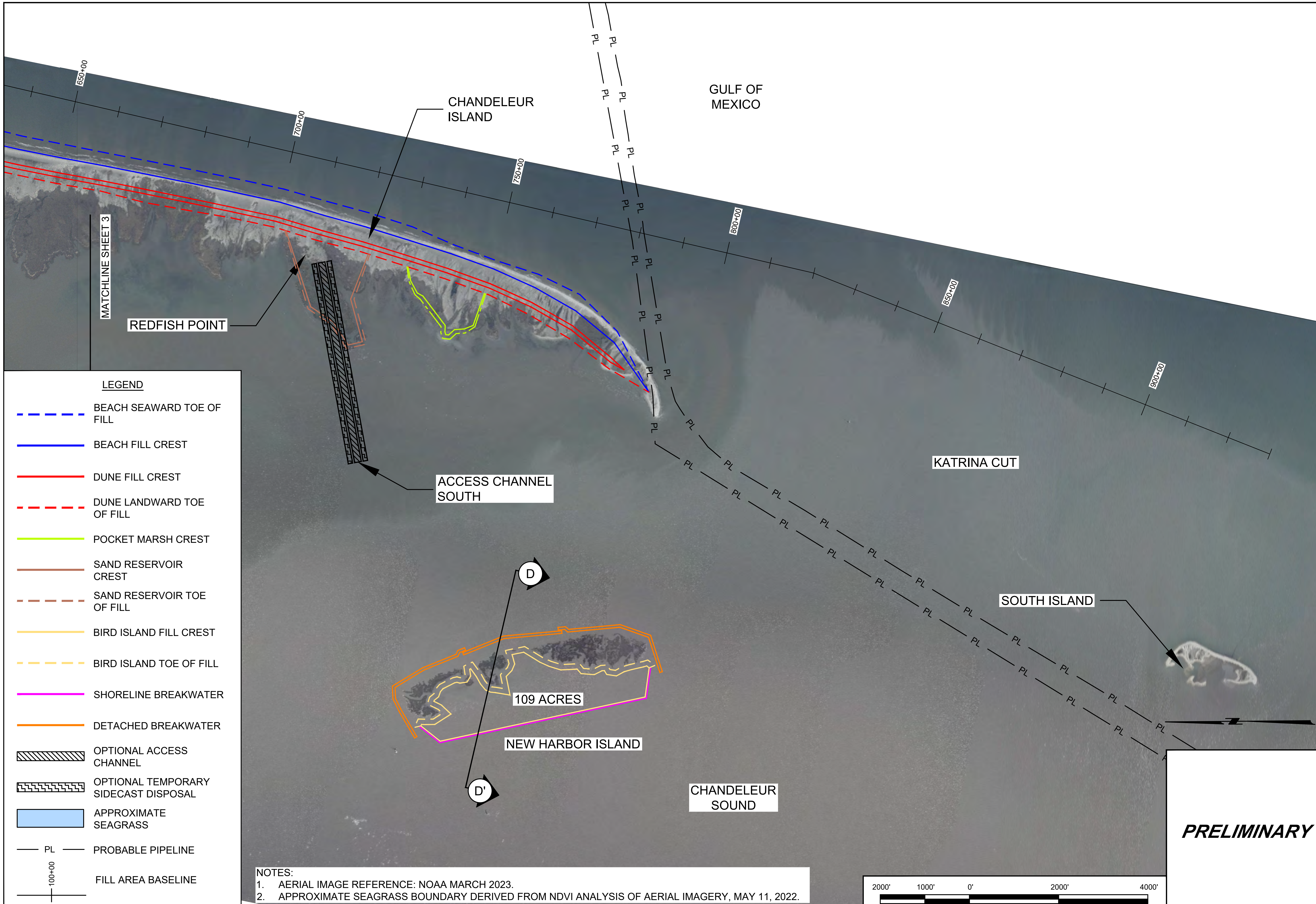
CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 5 CENTRAL ZONE PLAN VIEW

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: OCTOBER 2024



LEGEND

- BEACH SEAWARD TOE OF FILL
- BEACH FILL CREST
- DUNE FILL CREST
- DUNE LANDWARD TOE OF FILL
- POCKET MARSH CREST
- SAND RESERVOIR CREST
- SAND RESERVOIR TOE OF FILL
- BIRD ISLAND FILL CREST
- BIRD ISLAND TOE OF FILL
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- OPTIONAL ACCESS CHANNEL
- OPTIONAL TEMPORARY SIDECAST DISPOSAL
- APPROXIMATE SEAGRASS
- PL — PROBABLE PIPELINE
- 100+00 FILL AREA BASELINE

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. APPROXIMATE SEAGRASS BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

2000' 1000' 0' 2000' 4000'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY
02	02/19/2024	MODIFICATIONS TO ACCESS CHANNELS	SD

COASTAL ENGINEERING CONSULTANTS, INC.
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CHANDELEUR ISLAND RESTORATION

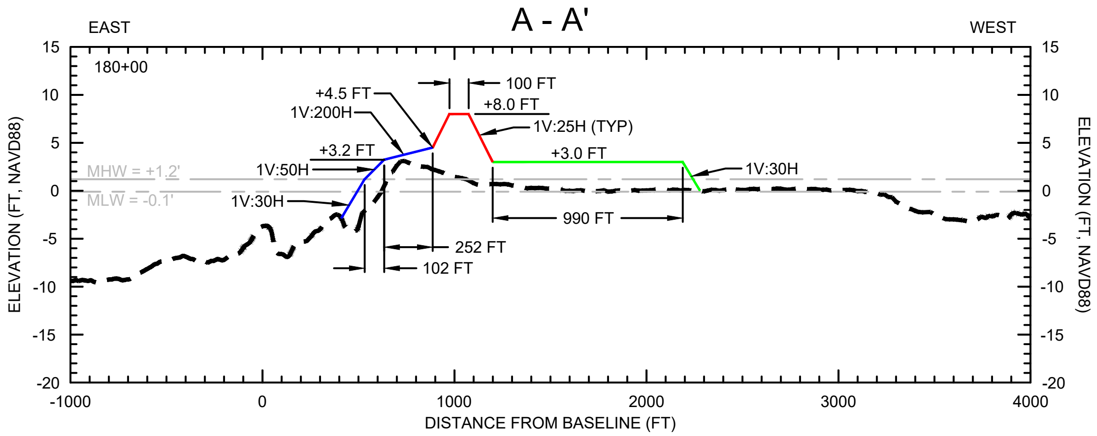
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

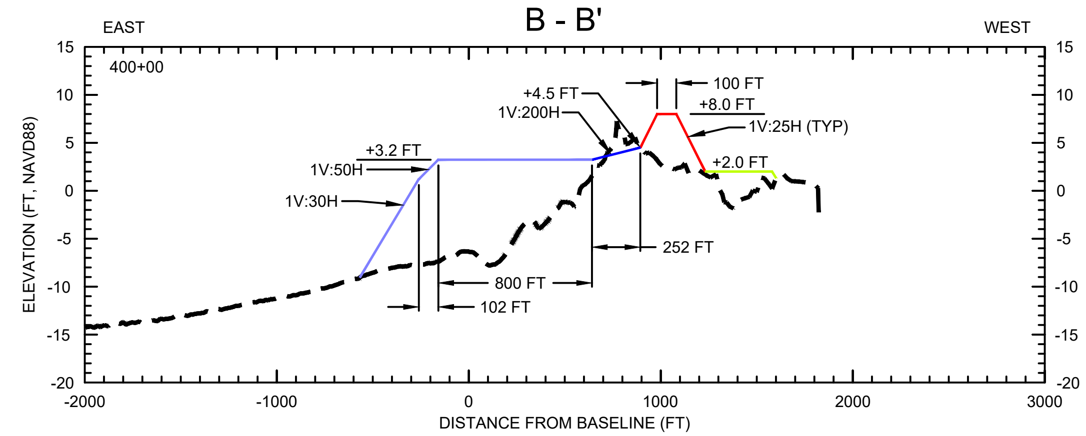
RESTORATION ALTERNATIVE 5 SOUTH ZONE PLAN VIEW

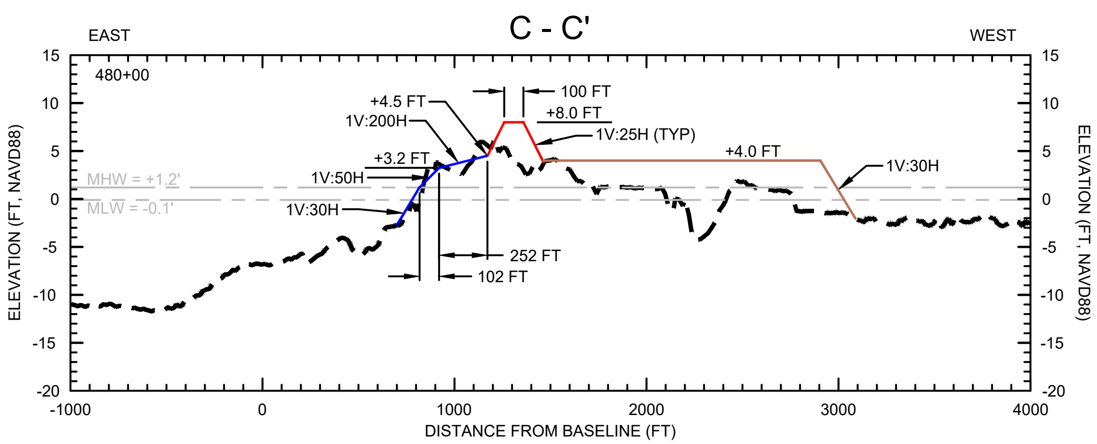
STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

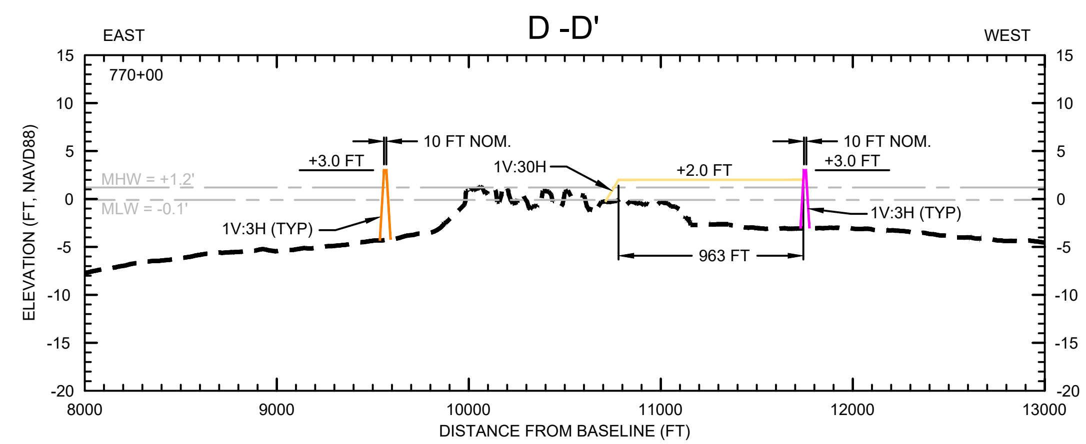
DATE: OCTOBER 2024

SHEET 4 OF 5









LEGEND

- BEACH FILL
- DUNE FILL
- FEEDER BEACH FILL
- SAND RESERVOIR FILL
- MARSH FILL
- POCKET MARSH FILL
- BIRD ISLAND FILL
- DETACHED BREAKWATER
- SHORELINE BREAKWATER
- EXISTING GRADE (2023)

NOTES:
1. SECTIONS ARE VIEWED LOOKING SOUTH.
2. DESIGN SURVEY CONDUCTED BY EMC, INC ON JUNE - NOVEMBER, 2023.
3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.

SCALE:
H: 1" = 1000'
V: 1" = 20'

PRELIMINARY

REV.	DATE	DESCRIPTION	BY

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE
SUITE E
DENHAM SPRINGS, LA 70726

COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

CHANDELEUR ISLAND RESTORATION

DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 5 TYPICAL SECTIONS

STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: OCTOBER 2024

SHEET 5 OF 5

Appendix B:

Monitoring and Adaptive Management Plans

Appendix B-1:

Chandeleur Islands Habitat Restoration Project Monitoring and Adaptive Management Plan

Monitoring and Adaptive Management Plan for Deepwater Horizon NRDA Project: Chandeleur Islands Habitat Restoration Project

Draft Version Date: May 5, 2025

Table of Contents

List of Figures

List of Tables

1. Introduction

The Deepwater Horizon (DWH) Louisiana Trustee Implementation Group (LA TIG) and Open Ocean Trustee Implementation Group (Open Ocean TIG) have cooperatively developed this draft Monitoring and Adaptive Management Plan (MAM Plan) for the Chandeleur Islands Restoration Project (PO-0199; the project), to be included by way of an appendix in the draft *Joint Assessment #1: Chandeleur Islands – Wetlands, Coastal, and Nearshore Habitats, Fish and Water Column Invertebrates, Sea Turtles, Submerged Aquatic Vegetation, and Birds* (Joint RP/EA #1). The project represents one of 11 projects selected by the Regionwide TIG for engineering and design funding within the broader *Deepwater Horizon Oil Spill Regionwide Trustee Implementation Group Final Restoration Plan / Environmental Assessment 1: Birds, Marine Mammals, Oysters, and Sea Turtles* (Regionwide TIG, 2021). If selected for implementation, construction and monitoring and adaptive management activities would be funded in whole or in part from LA and Open Ocean TIG's DWH Natural Resource Damage Assessment (NRDA) settlement funding allocations. This MAM Plan was developed in accordance with Version 2.1 of the *Monitoring and Adaptive Management Procedures and Guidelines Manual* (DWH NRDA Trustees, 2024; MAM Manual).

There are three primary purposes for MAM plans:

1. Identify and document how restoration managers will measure and track progress toward achieving restoration goals and objectives;
2. Prior to implementation, increase the likelihood of success by identifying potential corrective actions that could be undertaken if the project does not proceed as expected; and
3. Capture lessons learned or new information acquired that can be incorporated into future project selection, design, and implementation.

Accordingly, and in compliance with 15 Code of Federal Regulations [CFR] § 990.55(b)(1)(vii), this MAM Plan identifies monitoring activities that will be conducted to document restoration effectiveness, including performance criteria for determining restoration success or need for interim corrective action. Where applicable, this MAM Plan identifies key sources of uncertainty and incorporates monitoring data and decision points that address these uncertainties to ensure that restoration objectives are met and project benefits are maximized. It also establishes a decision-making process for making adjustments where needed.

The MAM Plan is a living document and may be updated as needed to reflect changing conditions and/or new information. Any future revisions to the MAM Plan will be made available through the Restoration Portal (at the following URL: https://www.diver.orr.noaa.gov/web/guest/home) and accessible through the DWH NRDA Trustees' website (at the following URL: https://www.gulfspillrestoration.noaa.gov/).

1.1 Project Overview

The Chandeleur Islands are a series of barrier islands in the Gulf of America (Gulf) marking the outer boundary of the Chandeleur Sound off the southeast coast of Louisiana and eastern St. Bernard and Plaquemines Parishes (Figure 1). These islands, spanning nearly 50 miles, are a first line of defense for Louisiana's coastline against tropical cyclones and provide crucial habitat for a multitude of plant and animal species. More than 80 species of flora and fauna are designated as "species of greatest conservation need" on the Chandeleur Islands, some of which are not found anywhere else in Louisiana (Holcomb et al., 2015). The island complex also serves as a highly productive nursery and adult habitat for economically important fisheries species. However, more than 89% of the island chain has disappeared in the last century due to the combined effects of erosion and inadequate sand supply. The Chandeleur Islands habitats, including associated seagrass beds, are state and federally owned and collectively managed by the U.S. Fish and Wildlife Service via a Memorandum of Agreement with the Louisiana Department of Wildlife and Fisheries as the Breton National Wildlife Refuge.

The Chandeleur Island Restoration Project is designed to increase the elevation and habitat acreage of North Chandeleur Island and New Harbor Island, thereby expanding bird and sea turtle nesting habitat, while increasing the resilience of the barrier island and providing wave attenuation to protect and expand submerged aquatic vegetation (SAV)[1]. Habitat creation and restoration on North Chandeleur Island will be accomplished by transporting sediment from a nearshore borrow area to restoration areas for beach, dune, and marsh fill, for placement of sand reservoirs and/or pocket marshes, and for feeder beach construction (Figure 2). On New Harbor Island, sediment will be placed on the western (landward) side of the island to protect existing mangrove habitat and restore eroded avian habitat. In addition, a detached rock breakwater will be constructed on the eastern (Gulf-facing) side of the island to protect existing habitat from wind- and wave-driven erosion, and a shoreline rock revetment will be constructed along the fill placement boundary off the western side of the island. Construction components include the Hewes Point Borrow Area (HPBA) sand source, a nearshore conveyance corridor for transporting sand to the restoration area(s), offshore pump-out areas with associated conveyance corridors, and temporary access channels for equipment and personnel. Additional details about project construction components are available in the Joint RP/EA #1.

Under the project's selected design alternative for construction, the combination of beach, dune, and marsh habitat; sand reservoirs and/or pocket marsh; and feeder beach features would create approximately 1,841 acres of beach and dune habitat along with 595 acres of marsh habitat on North Chandeleur Island, as well as an additional 145 acres of marsh habitat on New Harbor Island. Plantings on North Chandeleur and New Harbor Islands are planned for dunes, marshes, pocket marshes, sand reservoirs, and marine SAV beds. Anticipated plantings include bitter panicgrass (*Panicum amarum*), black mangrove (*Avicennai germinans)*, matrimony vine *(Lycium barbarum),* smooth cordgrass (*Sporobolus alterniflorus*, previously *Spartina alterniflora*), as well as transplantation of various SAV species, although the specific plantings would be chosen based on site conditions and/or construction variables. Material for SAV transplantation would be taken exclusively from areas within the project footprint that are otherwise likely to experience collateral

[1] The SAV in the project area are made up of marine seagrasses, or mSAV, including turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*) (Poirrier and Handley, 2007; Kenworthy et al., 2017; SWCA, 2023). Within Louisiana, seagrasses are limited to the landward side of the Chandeleur Islands where the clear, high-salinity, low-nutrient waters are suitable for their growth (Poirrier, 2007). Declining seagrass coverage in this area has been documented by aerial mapping efforts conducted from 1992 to 2005 and in 2023 (Pham et al., 2014; SWCA, 2023). Additional information can be found in Appendix D of the accompanying Joint RP/EA #1.

injury during construction—specifically, an area of approximately 159 acres of existing SAV where fill will be placed to restore habitat (CEC, 2024). In addition, sand fences (designed to accumulate sand) would be installed atop the restored dunes.

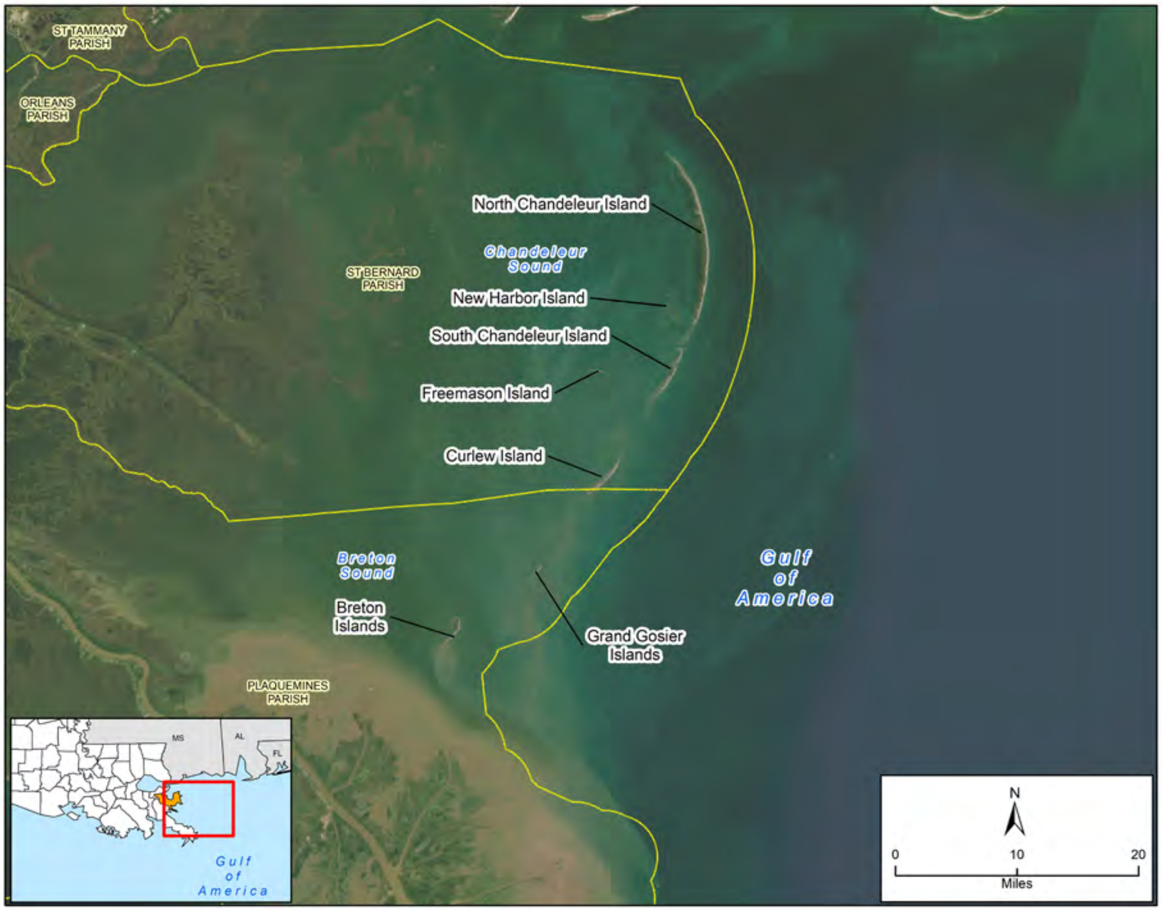


Figure 1. Chandeleur Islands, St. Bernard and Plaquemines Parishes, Louisiana

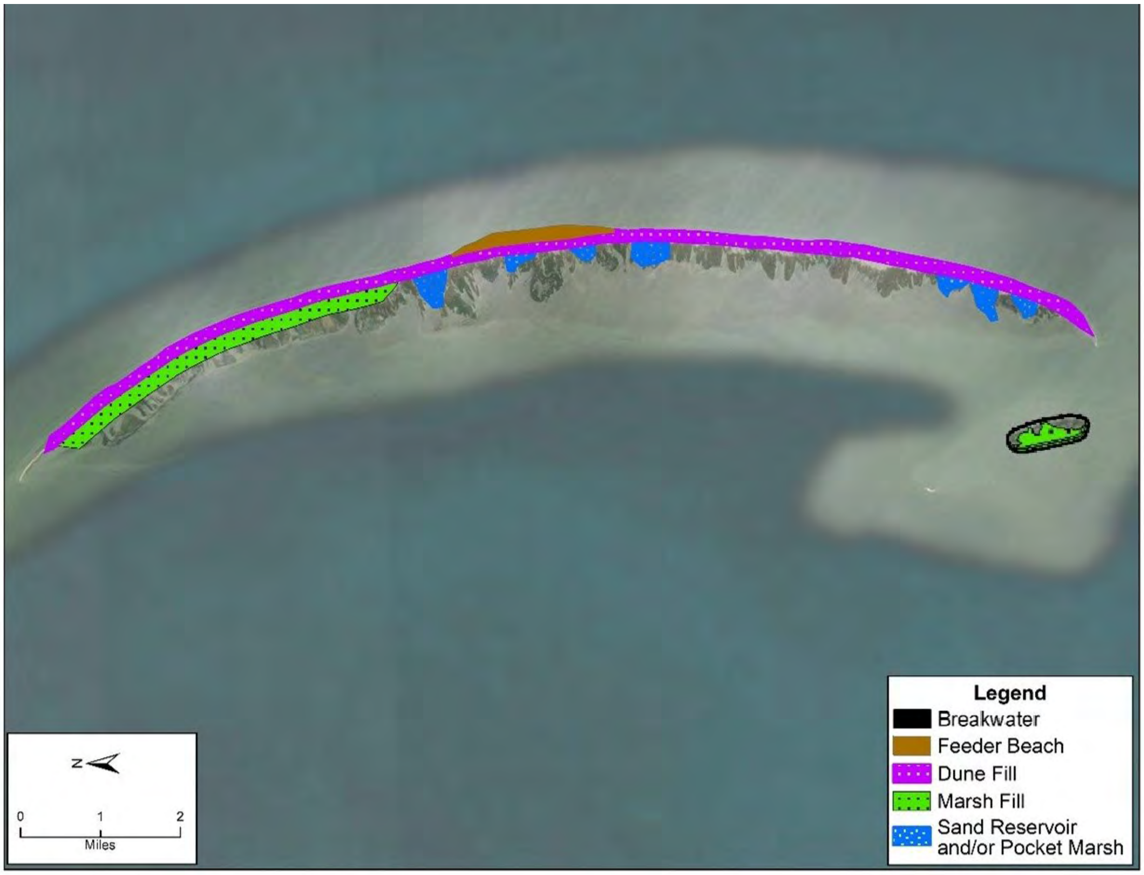


Figure 2. Proposed Restoration Design for North Chandeleur Island and New Harbor Island

The project is being implemented as restoration for the DWH oil spill NRDA, consistent with the *Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (DWH Trustees, 2016), the *Louisiana Trustee Implementation Group Monitoring and Adaptive Management Strategy* (LA TIG, 2021), and relevant Strategic Frameworks developed by the Trustees, including the *Deepwater Horizon Oil Spill Natural Resource Damage Assessment Strategic Framework for Bird Restoration Activities* (DWH Trustees, 2017) and the *Deepwater Horizon Oil Spill Natural Resource Damage Assessment Strategic Framework for Sea Turtle Restoration Activities* (DWH Trustees, 2017). The project is also consistent with the *Deepwater Horizon Oil Spill Regionwide Trustee Implementation Group Final Restoration Plan / Environmental Assessment 1: Birds, Marine Mammals, Oysters, and Sea Turtles* (Regionwide TIG, 2021), which selected data collection and engineering and design efforts under the "Conservation and Enhancement of Nesting and Foraging Habitat for Birds, Component 1: Chandeleur Islands, LA" for funding.

Per the nested framework set out in the Final PDARP/PEIS to guide and direct restoration efforts, the project is characterized by the selection of programmatic goals, restoration types, restoration approaches, and restoration techniques listed below. The implementing state Trustee for the project is the Louisiana Coastal Protection and Restoration Authority (CPRA) and the lead federal Trustee is the U.S. Department of the Interior.

Programmatic Goals:

- *Restore and conserve habitat*
- *Replenish and protect living coastal and marine resources*

Restoration Types:

- *Wetlands, coastal, and nearshore habitats*
- *Habitat projects on federally managed lands*
- *Submerged aquatic vegetation*
- *Birds*
- *Sea turtles*

Restoration Approaches:

- *Create, restore, and enhance coastal wetlands*
- *Create, restore, and enhance barrier and coastal islands and headlands*
- *Restore and enhance dunes and beaches*
- *Restore and enhance submerged aquatic vegetation*
- *Restore and conserve bird-nesting and foraging habitat*
- *Enhance sea turtle hatchling productivity and restore and conserve nesting beach habitat*
- *Protect and conserve marine, coastal, estuarine, and riparian habitats*

Restoration Techniques:

- *Create or enhance coastal wetlands through placement of dredged material*
- *Construct breakwaters*
- *Restore or construct barrier and coastal islands and headlands via placement of dredged sediments*
- *Plant vegetation on dunes and back-barrier marsh*
- *Renourish beaches through sediment addition*
- *Construct groins and breakwaters or use sediment bypass methods*
- *Protect and enhance SAV through wave attenuation structures*
- *Revegetate SAV beds via propagation and/or transplanting*
- *Enhance nesting beach restoration and resiliency*

1.2 Restoration Type Goals and Project Restoration Objectives

The programmatic goals of the Chandeleur Islands Restoration Project are to *Restore and Conserve Habitat*, and in doing so, to *Replenish and Protect Living Coastal and Marine Resources* including SAV, birds, and sea turtles. Restoration activities will place approximately 11,502,000 CY of sediment to create/restore an estimated 1,841 acres of beach and dune habitat along with 740 acres of marsh habitat, comprising 2,326 acres of suitable bird-nesting habitat (> +2.0 ft NAVD88) and 179 acres of sea turtle nesting habitat (>+4.0 ft and <+5.5 ft NAVD88)[2]. The use of dredged sediment to create and sustain habitat will promote low-energy/low-turbidity conditions to allow SAV to thrive, and will add longevity to the island footprint. In providing these benefits, the Trustees envision the project will compensate, in part, for spill-associated injuries to wetlands, coastal, and nearshore habitat (WCNH); SAV; birds; and sea turtles.

1.2.1 Restoration Type Goals

As stated above, the overall programmatic goals for this project are twofold: to *Restore and Conserve Habitat*, and to *Replenish and Protect Living Coastal and Marine Resources*. The project will implement multiple restoration types, each of which corresponds to a suite of restoration type goals as summarized in the PDARP/PEIS (Table 1). To support these identified restoration type goals, Trustees will accomplish the project-specific restoration objectives as described in the subsequent subsection.

Table 1. Nexus of Programmatic Restoration Goals, Restoration Types, and Restoration Type Goals (DWH Trustees, 2016)

Programmatic Restoration Goal	Restoration Type	Restoration Type Goal
Restore and conserve habitat	*Wetlands, coastal, and nearshore habitats*	Restore a variety of interspersed and ecologically connected coastal habitats in each of the five Gulf states to maintain ecosystem diversity, with particular focus on maximizing ecological functions for the range of resources injured by the spill, such as oysters, estuarine-dependent fish species, birds, marine mammals, and nearshore benthic communities.
		Restore for injuries to habitats in the geographic areas where the injuries occurred, while considering approaches that provide resiliency and sustainability.
		While acknowledging the existing distribution of habitats throughout the Gulf of Mexico, restore habitats in appropriate combinations for any given geographic area. Consider design factors, such as connectivity, size, and distance between projects, to address injuries to the associated living coastal and marine resources and restore the ecological functions provided by those habitats.

[2] Bird and sea turtle habitat acreages are calculated based on elevational ranges that partially overlap, and do not equate to the same acreages as created/restored beach, dune, and marsh habitat area (CEC, 2024).

Programmatic Restoration Goal	Restoration Type	Restoration Type Goal
	Habitat projects on federally managed lands	Restore federally managed habitats that were affected by the oil spill and response actions through an integrated portfolio of restoration approaches across a variety of habitats.
		Restore for injuries to federally managed lands by targeting restoration on federal lands where the injuries occurred, while considering approaches that provide resiliency and sustainability.
		Ensure consistency with land management plans for each designated federal land and its purpose by identifying actions that account for the ecological needs of these habitats.
Replenish and protect living coastal and marine resources	*Submerged aquatic vegetation*	Restore for injuries to SAV beds in the Chandeleur Islands chain to provide resiliency and sustainability to this unique habitat.
		Restore ecological functions of SAV beds in the Chandeleur Islands by considering these beds as a component of the Islands' integrated habitat complex.
	Sea turtles	Implement an integrated portfolio of restoration approaches to address all injured life stages (hatchling, juvenile, and adult) and species of sea turtles.
		Restore injuries by addressing primary threats to sea turtles in the marine and terrestrial environment such as bycatch in commercial and recreational fisheries, acute environmental changes (e.g., cold water temperatures), loss or degradation of nesting beach habitat (e.g., coastal armoring and artificial lighting), and other anthropogenic threats.
		Restore sea turtles in the various geographic and temporal areas within the Gulf of Mexico and Atlantic Ocean that are relevant to injured species and life stages.
		Support existing conservation efforts by ensuring consistency with recovery plans and recovery goals for each of the sea turtle species.
	Birds	Restore lost birds by facilitating additional production and/or reduced mortality of injured bird species.
		Restore or protect habitats on which injured birds rely.

Programmatic Restoration Goal	Restoration Type	Restoration Type Goal
		Restore injured birds by species where actions would provide the greatest benefits within geographic ranges that include the Gulf of Mexico.

Note: The use of the name "Gulf of Mexico" in this table is an exact quote from the Final PDARP/PEIS, which was released prior to issuance of EO 14172.

1.2.2 Project Restoration Objectives

This project will deposit dredged sediment to create and/or restore approximately 2,581 acres of habitat, increasing the total habitat area to 5,307 acres (>-1.5 ft NAVD88), of which an estimated 4,637 acres are expected to be retained 10 years post-construction (CEC, 2024). These restoration actions would also protect approximately 5,200 acres of adjacent SAV habitat. Specific project restoration objectives are identified below.

Objective #1: Barrier island habitat is created and restored to provide coastal habitat(s) important for the restoration of ecosystem functions and stability.

Parameter #1-1: Area (acres) of barrier island habitat created
Parameter #1-2: Elevation of beach/dune and marsh areas
Parameter #1-3: Shoreline position
Parameter #1-4: Vegetation percent cover (by taxon)
Parameter #1-5: Vegetation species composition

Objective #2: Enhance SAV habitat restoration to provide coastal habitats important for the restoration of ecosystem functions and stability.

Parameter #2-1: SAV area
Parameter #2-2: SAV percent cover (by taxon)
Parameter #2-3: SAV species composition

Objective #3: Create/restore Chandeleur Islands habitat for use by birds, including nesting colonial waterbirds as well as non-breeding species of concern.

Parameter #3-1: Colonial bird nest abundance (by taxon)
Parameter #3-2: Non-breeding bird abundance (by taxon)
Parameter #3-3: Bird species composition
Parameter #3-4: Nuisance mammal presence or abundance (by taxon)

Objective #4: Create/restore Chandeleur Islands habitat for use by nesting sea turtles.

Parameter #4-1: Area and length of potential nesting habitat for sea turtles

Parameter #4-2: Sea turtle nest abundance (by taxon)

Objective #5: WCNH restoration and SAV enhancement creates interspersed and ecologically connected coastal habitats for fish and invertebrate species

Parameter #5-1: Density of target Fish and Water Column Invertebrates (FWCI) (small epibenthic fish and shellfish)
Parameter #5-2: Abundance of target FWCI (larger pelagic fish and shellfish)
Parameter #5-3: Biomass of FWCI (small epibenthic fish and shellfish)
Parameter #5-4: Biomass of FWCI (larger pelagic fish and shellfish)
Parameter #5-5: Community composition of FWCI (small epibenthic fish and shellfish)
Parameter #5-6: Community composition of FWCI (larger pelagic fish and shellfish)

Specific, measurable performance criteria are defined for monitoring parameters associated with each of the restoration objectives in Section 3.2.

These parameters will be monitored according to the monitoring schedule summarized in Section 4. During the final design process, project team members will have the opportunity to refine design parameters as additional information becomes available. Performance criteria will be identified/implemented to determine restoration success or the need for corrective action in accordance with 15 CFR § 990.55(b)(1)(vii).

1.3 Conceptual Framework

The purpose of the conceptual setting within the MAM Plan is to identify, document, and communicate interactions and linkages among system components at the project site and to understand how the system works and may be affected by the proposed restoration. Understanding the conceptual setting aids in adaptive management of the project by identifying factors that may alter the expected outcome of the project and providing the opportunity to anticipate their effects and plan for contingencies. The conceptual setting for the Chandeleur Islands Restoration Project is summarized in Section 3.2.1 of the Joint RP/EA #1, with key details and additional information incorporated herein.

The Chandeleur Islands have suffered extensive damage from hurricanes, especially Georges in 1998 and Katrina in 2005, and were subsequently damaged by the DWH oil spill. They are also subject to subsidence, sea level rise, and suboptimal sediment input. The project area is experiencing a high rate of land loss, which threatens the SAV beds that depend on the islands for protection from waves, avian and sea turtle species that depend on the islands for nesting habitat, and other aquatic species that rely on habitat that the islands provide. The primary restoration actions for this project are the placement of dredged material in target areas to achieve elevations that are adequate to support and maintain intended habitat uses over time on North Chandeleur Island and New Harbor Island, and the construction of a rock breakwater and revetment to protect and sustain habitat on New Harbor Island (Table 2).

Table 2. Conceptual Model for the Chandeleur Islands Restoration Project

Restoration Actions	As-Built	Interim	Restoration Goal
Placement of dredged sediment Construction of a rock breakwater/revetment Planting vegetation Sand fencing	Create or enhance ~1,841 acres of beaches and dunes and 740 acres of marshes, including: 2,326 acres of suitable bird-nesting habitat (>+2.0 ft NAVD88); and, 179 acres of sea turtle nesting habitat (>+4.0 ft and <+5.5 ft NAVD88).	Sediments compact and dewater to desired elevations for targeted bird and sea turtle nesting habitat. Planted marsh and dune vegetation survives and expands to achieve the establishment of target plant communities, supporting habitat uses and protecting against sediment loss. To support nesting success, periodic investigations of mammalian predators may be conducted as needed and used to inform potential predator removal / control efforts. The restored island integrity will promote conditions favorable to SAV habitat.	Beach, dune, and marsh habitats are restored, and SAV habitat is protected and enhanced. Newly constructed habitat attracts birds and sea turtles for nesting opportunities. Cost, quality, and urgency are balanced effectively. Protected and restored habitats and benefits conferred to target species provide ecological services that contribute to making the environment and the public whole for spill-related injuries to these resources.

The influence diagram below (Figure 3) shows key physical processes, but additional interactions that are not depicted include the influence of changes in the physical environment and vegetation cover on water quality; habitat suitability and species use; fish and shellfish biomass; etc. Key drivers include sediment availability, wind/wave dynamics, storm events, sea level rise, substrate types and composition, and vegetative community structure.

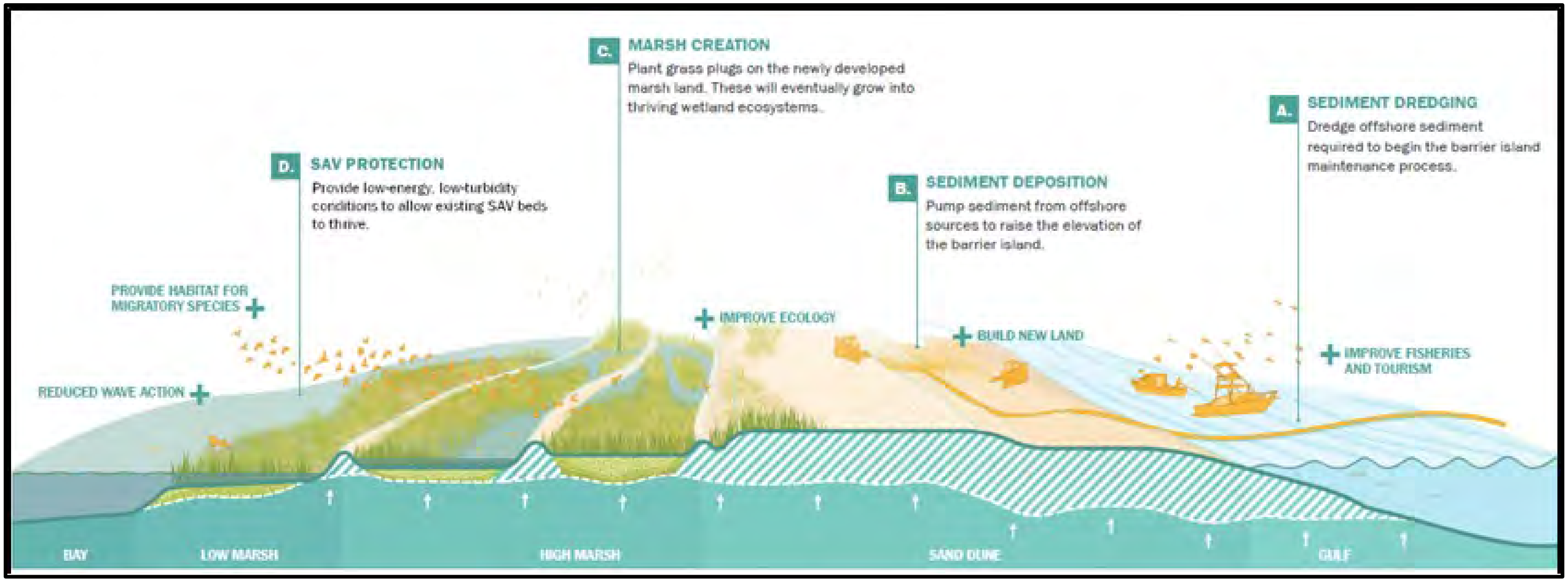


Figure 3. Influence Diagram for Barrier Island Restoration (Adapted from: CPRA, 2023)

1.3.1 Potential Sources of Uncertainty

Potential uncertainties are defined as those that may affect the ability to achieve stated project restoration objective(s). Although the likelihood of project success is evaluated under the Oil Pollution Act (OPA) regulations (15 CFR § 990.54(a)(3)), uncertainties may exist regarding how to best implement projects to achieve the greatest benefits for the injured resources. These uncertainties may arise from an incomplete understanding of the current conceptual setting; from unknown conditions in the future; or from project elements that do not perform as anticipated (e.g., sediment compaction or vegetation success). Potential uncertainties associated with this project are listed in Table 3. Monitoring activities can be selected and implemented to inform these uncertainties and to select appropriate corrective actions in the event that the project is not meeting its performance criteria. Section 3 summarizes project monitoring protocols and describes how this information will be used to inform adaptive management and address uncertainties. Potential options to address key uncertainties may be found in the Strategic Frameworks and other sources.

Table 3. Sources of Project Uncertainty and Potential Impacts

Uncertainty	Potential Impact
Contractor completing the Project on-time	Contractor's inability to complete the project within the designated time frame would delay resource restoration and require allocation of additional resources for project completion.
Project design criteria achieved	If elevations are not achieved and sustained to project design specifications, targets for habitats and species uses may not be attained, and would be more susceptible to wind/wave erosion.
Sea level rise and subsidence	Sea level rise uncertainty could result in poor predictions of geomorphic and ecological responses. Increased water levels would expose beaches and dunes to more wave action, potentially removing sediment, lowering elevation, and reducing shoreline protection afforded by restored habitat. Increased water level would increase the depth and duration of flooding in marsh habitat, causing plant stress and habitat deterioration, subsidence, and potential loss.
Variability in sediment compaction, transport, and other physical processes	Increased sediment compaction would reduce the elevation making the dune, beach, and marsh more susceptible to increased water levels. Uncertainty in sediment dynamics would result in poor predictions of barrier island evolution, including predictions of elevation and habitat area, which can jeopardize project success.
Impacts of extreme weather events such as hurricanes, storms, and droughts	Storm events before or after project construction could result in sediment and elevation loss. Unexpectedly high frequency of overwash, nest site flooding, and similar disturbance events have been shown to cause mortality in avian age classes (adults, juveniles, young of the year) as well as loss of critical nesting and brooding habitats.

Uncertainty	Potential Impact
Vegetation colonization and establishment	Lack of planting success / vegetation establishment would limit or delay the creation of desired habitat, increasing wind and wave-driven sediment loss and limiting creation of preferred nesting habitat for target bird and sea turtle species.
Colonization of the island by invasive vegetative species such as Roseau cane (*Phragmites australis*)	Colonization by invasive plant species could reduce nesting habitat and would therefore not support proposed project objectives. Potential options to address this uncertainty include, but are not limited to, use of chemical, mechanical, or other removal techniques.
Availability of suitable nesting habitat within the Northern Gulf	There are several restoration activities that are taking place across coastal Louisiana and the northern Gulf Coast. Many of these projects could provide habitat for nesting birds, especially Black Skimmers and Terns. This additional amount and diversity of potentially high-quality habitat could lower the number of nesting birds on the Chandeleur Islands, reducing the apparent short-term effectiveness of the project.
Suitability of restored island to mammalian nest predators	Mammalian predators within waterbird colonies have been shown to be highly detrimental to nesting success and hatchling/fledgling survival, and may be present as nuisance species on the Chandeleur Islands (e.g., nutria, raccoons, rats). Potential options to address this uncertainty include, but are not limited to, predator monitoring, predator removal/reduction methods, and/or colony fencing to reduce/eliminate access by nuisance mammals.
Seagrass response to changing conditions and external drivers	There is uncertainty over whether optimal hydrologic conditions for sustainability of SAV will be achieved, or how other external drivers may influence SAV response, including nutrient inputs, chemical pollutants, physical impacts from boats, precipitation, and storm events. Monitoring can help determine whether supplemental transplantation would be beneficial.
Anthropogenic disturbance	Anthropogenic disturbance has been shown to significantly impact nesting success and hatchling/fledgling survival via limiting parental attendance. Potential options to address this uncertainty include, but are not limited to, signage indicating restricted distance to colonies at certain times of the year, law enforcement, or other methods.
Avian disease and other pathogens or pests	Avian disease has the potential to harm birds and cause nesting failure. Potential options to address this uncertainty include, but are not limited to, creation or enhancement of habitat across other locations to reduce bird densities and thereby prevalence of disease presence and frequency. For plant diseases, pests, and/or fungal infections, spraying of appropriate insecticides or fungicides may be necessary.

2. Adaptive Management

Monitoring information collected at the project-level can also inform adaptive management. Adaptive management is a form of structured decision-making applied to the management of natural resources in the face of uncertainty of that individual project (Pastorok et al., 1997; Williams & Brown, 2011). Within the Louisiana TIG, an adaptive management framework has been developed that identifies and characterizes the four main phases and is illustrated within a representative management cycle (Figure 4).

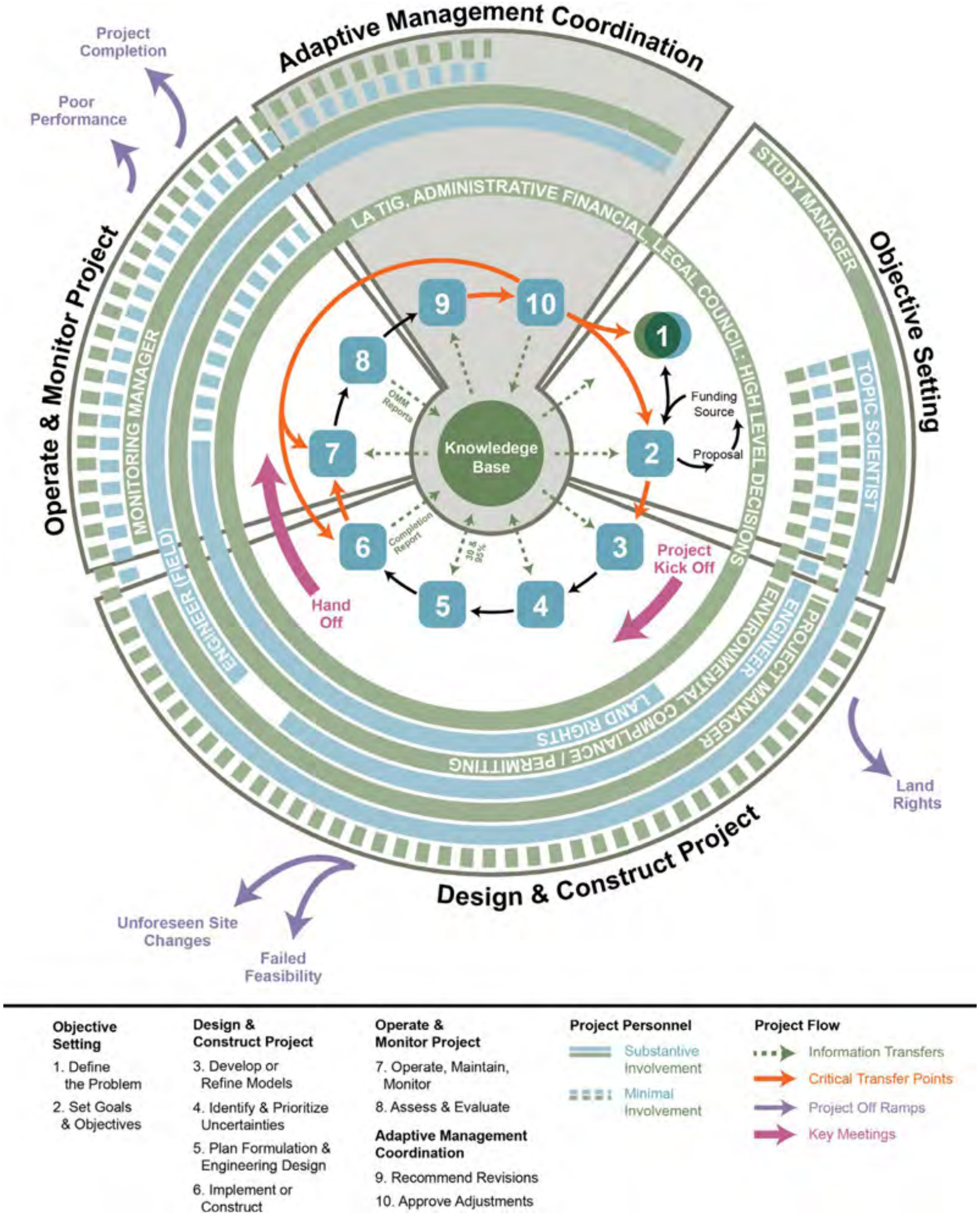


Figure 4. LA TIG Adaptive Management Cycle (Source: The Water Institute of the Gulf, 2020)

- *<u>Objective-Setting Phase</u>: Problem is identified or defined, and project goals and objectives are established based on multiple sources, including lessons learned, data and associated synthesis, and applied research from previous projects and from the knowledge base as a whole. For the Chandeleur Islands Restoration Project (PO-0199), the goal setting phase is already complete – the problem of marsh loss has been defined through the PDARP/PEIS as well as through Louisiana's Coastal Master Plan process, and the goals and objectives of restoration are as described in the restoration plan that accompanies this MAM Plan.*
- *<u>Design and Construct Phase</u>: Project advances through select steps, including model development or refinement, identification and prioritization of uncertainties, plan formulation, engineering, design, and project construction. For this project, the elements of a preliminary design have already been described within the restoration plan, incorporating available data.*
- *<u>Operate and Monitor Phase</u>: Project's operations, maintenance, and monitoring plans are developed, and project assessment and evaluation criteria are identified. Note that for this and other habitat creation projects, the opportunities for adaptive management post-construction may in some cases be limited. For example, if the marsh and/or beach/dune habitat do not achieve the proper elevation post-settlement, supplying additional dredge fill to increase elevation is generally cost-prohibitive. However, supplemental vegetative plantings can be used to improve vegetative cover if proper elevation is not achieved.*
- *<u>Adaptive Management Coordination Phase</u>: Encompasses steps for recommending and approving project revisions so that revisions can achieve one or both of the following:*
    - *Result in alterations and redesign of project elements or changes to project operation*
    - *Provide input to either the understanding of the overall problem statements or the refinement of attainable or realistic goals and objectives for future projects*

Where gaps in scientific understanding exist, project information collected (see Section 3.1, Project Monitoring) and evaluated (see Section 5, Evaluation) may be used to reduce key uncertainties and/or other analyses that inform the selection, design, and optimization of future restoration projects.

3. Project Monitoring, Performance Criteria, and Potential Correction Actions

3.1 Project Monitoring

This MAM Plan was developed to identify methods for evaluating and documenting project performance, key uncertainties, and potential corrective actions, if needed, for the first 10 years following the project's construction. Performance monitoring is organized by restoration objective, with each objective having one or more monitoring parameters. For each of the identified monitoring parameters, information is provided on the intended purpose (e.g., to monitor progress toward meeting one or more of the restoration objectives, support adaptive management of the project, etc.), monitoring methods, timing and frequency, duration, sample size, and sites. Monitoring these parameters will enable the TIG to track progress toward performance criteria targets and will inform the need for corrective actions (see Section 3.2, Performance Criteria and Potential Corrective Action).

The MAM Manual recommends project-level monitoring be conducted at reference or control sites. Given the lack of unrestored barrier islands to serve as controls, other barrier island restoration projects may provide useful reference data that allows project performance to be compared at similar time intervals following construction. The CPRA currently maintains a Barrier Island Comprehensive Monitoring (BICM) program that provides data and research to support the planning, design, construction, evaluation, and adaptive management of Louisiana's barrier/sandy shoreline restoration projects (Kindinger et al., 2013; Enwright et al., 2020; Flocks et al., 2022). Documents summarizing both data collection efforts and products generated from these efforts as well as other available data can be found at https://cims.coastal.louisiana.gov/outreach/Projects/Bicm.

The Coastwide Reference Monitoring System (CRMS) (https://www.lacoast.gov/crms/ Home.aspx) was developed and implemented to improve the effectiveness in evaluating individual restoration projects, as well as the combined effects of multiple projects, by providing a network of reference sites where data are collected on a regular basis (Steyer et al., 2003; Folse et al., 2023). To the extent possible, the monitoring methods used for the project will be consistent with the methods described in Folse et al. (2023). Though additional measures may be implemented to more fully characterize the project's effectiveness, the LA and Open Ocean TIGs propose the continued implementation of the following proven and established monitoring methodologies to monitor project success:

Objective #1: Barrier island habitat is created and restored to provide coastal habitat(s) important for the restoration of ecosystem functions and stability.

Parameter #1-1, Area (acres) of barrier island habitat created

a) *Purpose: To determine the acres of each target habitat type within the project area over time.*
b) *Method: Using geo-rectified aerial imagery, habitat maps will be generated using an object-based classification approach in the Trimble eCognition software or equivalent. Habitat acreage will be evaluated using the same methods and classification scheme as used for the BICM program (Enwright et al., 2020), allowing integration and comparison of multiple datasets if needed. As available, real-time kinematic (RTK) global positioning system (GPS) data and light detection and ranging (LiDAR) elevation data (Parameter #1-2) collected during project monitoring will also be used.*
c) *Timing, Frequency, and Duration: Aerial imagery will be acquired post-construction/as-built to represent year (YR) 0, and will be collected during the fall of YRs 2, 3, 5, 6, 8, 9, and 10; the highest resolution aerial imagery feasible will be collected given budgeted amounts for image acquisition. Aerial imagery will also be acquired through CWPPRA/CRMS for YRs 1, 4, and 7 (however, these will not become available until several months [6-9] after acquisition). Habitat mapping will be conducted YRs 0, 3, 5, and 10.*
d) *Sample Size: High-resolution, near-vertical aerial imagery will be acquired for the entirety of North Chandeleur Island and New Harbor Island.*
e) *Sites: North Chandeleur Island and New Harbor Island.*

Parameter #1-2, Elevation of beach/dune and marsh areas

a) *Purpose: To determine whether target habitat elevations are achieved per the design specifications for construction, and to track average elevation over time.*
b) *Method: LiDAR topography and/or RTK GPS topographic/bathymetric survey data collected as part of project monitoring. Settlement and overwash monitoring plates are included in construction plans but will not be relied on as measures of performance success. Additional data collected by BICM surveys (outside of this project), if available, may also be used to supplement the dataset.*
c) *Timing, Frequency, and Duration: Data will be collected YR 0 (as-built) and YRs 5 and 10 post-construction. In place of or in combination with LiDAR, RTK GPS topographic/bathymetric surveys may be used, including data collected for the YR 0 as-built construction survey and during vegetation surveys (Parameter #1-4).*
d) *Sample Size: An RTK GPS survey will be conducted on transects spaced every 1000 feet apart or as specified in the construction documents for the YR 0 as-built, and possibly for YR 10. Additional RTK GPS surveys during YR 5 would be spaced at a greater distance (likely at 1500 ft or more), but the exact spacing would be contingent on LiDAR acquisition and budget, and is yet to be determined.*
e) *Sites: North Chandeleur Island and New Harbor Island.*

Parameter #1-3, Shoreline position

a) *Purpose: To delineate the shoreline position and determine changes to island extents.*
b) *Method: Derivation from high-resolution, near-vertical aerial imagery, RTK GPS topographic/ bathymetric survey data, and/or LiDAR topography collected as part of project monitoring. Any of several reasonable options for assessing shoreline position may be used or combined depending on available budget (e.g., Terrano et al., 2016), including digitization and use of aerial imagery following the BICM program methods (Enwright et al., 2020).*
c) *Timing, Frequency, and Duration: Aerial imagery will be collected YRs 0, 2, 3, 5, 6, 8, 9, and 10 (Parameter #1-1), and elevation data will be conducted YR 0 (as-built) and YRs 5 and 10 post-construction (Parameter #1-2) and potentially during vegetation surveys (Parameter #1-4). Derivation of shoreline position will be conducted alongside habitat classification (Parameter #1-1) during YRs 0, 3, 5, and 10.*
d) *Sample Size: The entirety of North Chandeleur Island and New Harbor Island shorelines.*
e) *Sites: North Chandeleur Island and New Harbor Island.*

Parameter #1-4, Vegetation percent cover (by taxon)

a) *Purpose: To determine the vegetation cover in the various habitats in the project area over time.*
b) *Method: Ocular estimates of percent cover of each species identified, height measurements of the dominant species, and percent cover of the carpet, herbaceous, shrub, and tree layers, if present, within a 2 meter by 2 meter plot (Folse et al., 2023) randomly placed along the transect lines that were established throughout the project area (Hester and Willis, 2015).*

c) *Timing, Frequency, and Duration: YRs 3 and 10; sampling will occur between mid-August and mid-November with the target being September/October.*
d) *Sample Size: Number of plots per transect and number of transects to sample are TBD depending on other monitoring activities and budget availability.*
e) *Sites: North Chandeleur Island and New Harbor Island.*

Parameter #1-5, Vegetation species composition

a) *Purpose: To determine the vegetation species composition in the various habitats in the project area over time.*
b) *Method: Visual taxonomic identification of plants, resolved at the species level or using species groupings during vegetation surveys (Parameter #1-4).*
c) *Timing, Frequency, and Duration: YRs 3 and 10; sampling will occur between mid-August and mid-November with the target being September/October.*
d) *Sample Size: Number of plots per transect and number of transects to sample are TBD depending on other monitoring activities and budget availability.*
e) *Sites: North Chandeleur Island and New Harbor Island.*

Objective #2: Enhance SAV habitat restoration to provide coastal habitats important for the restoration of ecosystem functions and stability.

Parameter #2-1, SAV area

a) *Purpose: To determine the success of SAV protection by measuring the spatial extent of SAV habitat.*
b) *Method: Continuing methods used for the planning-phase survey (SWCA, 2023), data will be collected using aerial imagery and field surveys.*
c) *Timing, Frequency, and Duration: Post-construction YRs 0, 1, 2, 8, 9, and 10; field data and aerial imagery will be collected as close to peak growing season (September) as possible.*
d) *Sample Size:*
   - *Aerial imagery will provide coverage of the full project area.*
   - *Following Dunton et al. (2010), field observations will be collected from the 143 fixed sample locations that were established across the study area during the 2022-2023 seagrass survey (SWCA, 2023).*
e) *Sites: North Chandeleur Island.*

Parameter #2-2, SAV percent cover (by taxon)

a) *Purpose: To determine the success of SAV protection by characterizing the spatial extent of SAV habitat.*
b) *Method: Continuing methods used for the planning-phase survey (SWCA, 2023), data will be collected using aerial imagery and field surveys (Parameter #2-1), seagrass species will be identified, and percent cover will be visually estimated.*
c) *Timing, Frequency, and Duration: Post-construction YRs 0, 1, 2, 8, 9, and 10; field data and*

aerial imagery will be collected as close to peak growing season (September) as possible.

d) *Sample Size:*
   - *Aerial imagery will provide coverage of the full project area.*
   - *Following Dunton et al. (2010), field observations will be collected from the 143 fixed sample locations that were established across the study area during the 2022-2023 seagrass survey (SWCA, 2023). Within each 10-meter radius sample location, four replicate stations will be sampled using a 0.25 m^2 PVC quadrat frame. Data may be collected for a reduced subset of samples as needed depending on budget constraints.*

e) *Sites: North Chandeleur Island.*

Parameter #2-3, SAV species composition

a) *Purpose: To determine the success of SAV protection by characterizing SAV habitat.*

b) *Method: Visual taxonomic identification of SAV, resolved at the species level during SAV vegetation surveys (Parameter #2-2). Continuing methods used for the planning-phase survey (SWCA, 2023), data will be collected using aerial imagery and field surveys.*

c) *Timing, Frequency, and Duration: Post-construction YRs 0, 1, 2, 8, 9, and 10; field data and aerial imagery will be collected as close to peak growing season (September) as possible.*

d) *Sample Size:*
   - *Aerial imagery will provide coverage of the full project area.*
   - *Following Dunton et al. (2010), field observations will be collected from the 143 fixed sample locations that were established across the study area during the 2022-2023 seagrass survey (SWCA, 2023). Within each 10-meter radius sample location, four replicate stations will be sampled using a 0.25 m^2 PVC quadrat frame. Data may be collected for a reduced subset of samples as needed depending on budget constraints.*

e) *Sites: North Chandeleur Island.*

Objective #3: Create/restore Chandeleur Islands habitat for the use by birds, including nesting colonial waterbirds as well as non-breeding species of concern.

Parameter #3-1, Colonial bird nest abundance (by taxon)

a) *Purpose: To determine the effectiveness of the project in increasing habitat use by nesting colonial birds.*

b) *Method: Photographic counting (i.e., "dotting") of high-resolution aerial digital photography will be used to estimate numbers of nests for colonial bird species (Ford, 2010).*

c) *Timing, Frequency, and Duration:*
   - *Surveys will be conducted post-construction YRs 1, 3, and 5; due to the bimodal nature of the colonial bird-nesting season, two representative surveys will be implemented for each of the years indicated: the initial survey (mid-May) followed by the final survey (mid-June). Years of data collection may change to leverage regional data collection efforts, including surveys conducted as part of the larger Louisiana coast regimented*

surveying effort conducted every 2-3 years.

d) *Sample Size:*
   - *The entire project area will be photographed, and associated images will be analyzed for nests produced by species or guild.*
   - *Data collection and analyses specific to Brown Pelicans (see Section 5) will be constrained to New Harbor Island, where the species is expected to occur.*

e) *Sites: North Chandeleur Island and New Harbor Island.*

Parameter #3-2, Non-breeding bird abundance (by taxon)

a) *Purpose: To determine the effectiveness of the project in maintaining foraging habitat for use by non-breeding birds.*

b) *Method: Data collection will use the pedestrian survey protocols implemented during project planning (SEG Environmental, 2024; CEC et al., 2024).*

c) *Timing, Frequency, and Duration:*
   - *Between one and three sampling events would take place, each of which would involve conducting one survey a month from September to November and from January to April, to align with surveys that occurred during project planning (SEG Environmental, 2024; CEC et al., 2024).*
   - *Based on currently available information, the presence of a substantial number of Piping Plovers, Red Knots, and injured non-breeding shorebirds (SEC Environmental 2024, CEC et al. 2024) indicates that project monitoring of non-breeding shorebirds may be warranted. Accordingly, sampling events are anticipated post-construction YRs 1 and 2; however, the frequency and timing of data collection may change based on recommendations from consulting agencies and budget constraints.*

d) *Sample Size: Survey effort will align with surveys that occurred during project planning (SEG Environmental, CEC et al. 2024), subject to revisions based on recommendations from consulting agencies and budget constraints.*

e) *Sites: North Chandeleur Island.*

Parameter #3-3, Bird species composition

a) *Purpose: To determine the effectiveness of the project in increasing habitat use by nesting colonial birds and maintaining foraging habitat for use by non-breeding birds.*

b) *Method: Visual taxonomic identification, resolved at the species or guild level during bird-nesting photographic analysis (Parameter #3-1) and during non-breeding bird surveys (Parameter #3-2).*

c) *Timing, Frequency, and Duration:*
   - *Bird-nesting surveys will be conducted post-construction YRs 1, 3, and 5 (see Parameter #3-1); non-breeding bird surveys are anticipated post-construction YRs 1 and 2, but are subject to change based on recommendations from consulting agencies and budget constraints (see Parameter #3-2).*

d) *Sample Size:*
    - *Data collection and analyses specific to Brown Pelicans (see Section 5) will be constrained to New Harbor Island, where the species is expected to occur. For other colonial birds, the entire project area will be photographed, and associated images will be analyzed for nests generated by species or guild.*
    - *For non-breeding birds, survey effort will align with surveys that occurred during project planning (SEG Environmental, CEC et al. 2024), subject to revisions based on recommendations from consulting agencies and budget constraints.*

e) *Sites: North Chandeleur Island and New Harbor Island.*

Parameter #3-4, Nuisance mammal presence or abundance (by taxon)

a) *Purpose: To track the presence of nuisance mammals in support of management for bird habitat use and nesting success.*

b) *Method:*
    - *Opportunistic monitoring may be conducted on an as-needed basis to assess the presence of mammalian nuisance species that could pose predation risk to nesting birds.*
    - *Surveys for predators will be conducted on foot and/or using visual imagery, and may be supplemented with game cameras for species detection as needed, subject to availability of funds. More detailed monitoring strategies may be specified if other monitoring suggests high predation pressure is a concern for bird-nesting success.*

c) *Timing, Frequency, and Duration: To be determined based on initial bird-nesting surveys. Nuisance mammal presence may be surveyed opportunistically during other field monitoring activities as needed.*

d) *Sample Size:*
    - *To be determined; sample efforts may span the project area or may be constrained based on initial bird-nesting data.*

e) *Sites: North Chandeleur Island and New Harbor Island.*

Objective #4: Create/restore Chandeleur Islands habitat for use by nesting sea turtles.

Parameter #4-1: Area and length of potential nesting habitat for sea turtles

a) *Purpose: To determine the effectiveness of the project in increasing habitat use by nesting sea turtles.*

b) *Method: Data collected for habitat area and elevation (Parameters #1-1 and #1-2) will be used to categorize and measure habitat available for use by nesting sea turtles, following methods used during project planning (CEC, 2024).*

a) *Timing, Frequency, and Duration: Aerial imagery will be collected YRs 0, 2, 3, 5, 6, 8, 9, and 10 (Parameter #1-1), and elevation data will be conducted YR 0 (as-built) and YRs 5 and 10 post-construction (Parameter #1-2) and potentially during vegetation surveys (Parameter #1-4). Derivation of the area and length of habitat suitable for sea turtle nesting will be conducted alongside habitat classification (Parameter #1-1) during YRs 0, 3, 5, and 10.*

c) *Sample Size: The entirety of North Chandeleur Island.*
d) *Sites: North Chandeleur Island.*

Parameter #4-2: Sea turtle nest abundance (by taxon)

a) *Purpose: to determine the effectiveness of the project in increasing habitat use by nesting sea turtles.*
b) *Methods:*
   - *Pre- and during construction, surveys will be conducted following monitoring procedures specified in the Supplemental Information (adapted from procedures used for the Mississippi Coastal Improvements Program; details TBD). If use of ATVs is not permitted within the refuge, monitoring procedures may be modified as needed for feasibility.*
   - *Post-construction, photographic counting of high-resolution aerial digital photography will be used to detect sea turtle crawls identifiable by species when possible (Lamont et al., 2023). Species Identification will be determined by crawl evidence and photographic documentation.*
c) *Timing, Frequency, and Duration:*
   - *Surveys will be conducted pre and during construction and post-construction, YRs 0, 1, and 2.*
   - *Surveys will be conducted (a) daily April-August or 100 days prior to construction, whichever is later, (b) daily during construction, and (c) once a month April – August post-construction.*
d) *Sample Size:*
   - *Pre- and During construction, the entire project area will be surveyed and any potential nests will be moved following an approved U.S. Fish and Wildlife Service (FWS) nest moving plan (details TBD).*
   - *Post-construction, the entire project area will be aerial photographed and associated images will be analyzed for nests generated by species (Lamont et al., 2023).*
e) *Sites: North Chandeleur Island.*

Objective #5: WCNH restoration and SAV enhancement creates interspersed and ecologically connected coastal habitats for fish and invertebrate species.

Parameter #5-1: Density of target FWCI (small epibenthic fish and shellfish)

a) *Purpose: Project habitat benefits will be assessed to determine secondary productivity as density (# m^{-2}) of nekton (pink shrimp, brown shrimp, blue crab, pinfish, red drum, and spotted seatrout) for the project's seagrass footprint.*
b) *Method: Epibenthic sleds will be deployed using a stratified-random sampling scheme with habitat types (turtle grass, shoal grass, widgeon grass, bare substrate) used as a stratification condition following the methodology historically used in the Chandeleur seagrass meadow (Hayes 2021). The sleds (0.75 m wide x 0.60m high) will be pulled by hand for a distance of 13.3 m at a speed of ~0.3m/s. Samples will be preserved and*

transported to a laboratory where they will be sorted, identified to the lowest taxonomic level possible, counted, weighed, and measured.

c) *Timing, Frequency, and Duration: As-built YR 0 and every five years for the 10 years post-construction (YRs 0, 5, and 10). Samples will be collected twice during monitoring event years, once in late-spring/early-summer and once in late-summer/early-fall, in order to bracket the seagrass growing season and maximize likely encounter with target species and/or their life stages.*
d) *Sample Size: A seasonal total of up to 48 epibenthic sled (0.75 m x 0.6 m frame) pulled a distance of 13.3 m.*
e) *Sites: Samples will be evenly distributed across Turtle Grass, Shoal Grass, Widgeon Grass, and bare substrate.*

Parameter #5-2: Abundance of target FWCI (larger pelagic fish and shellfish)

a) *Purpose: Project habitat benefits will be assessed to determine secondary productivity as abundance (CPUE) of target nekton (pink shrimp, brown shrimp, blue crab, pinfish, red drum, and spotted seatrout) for the project's seagrass footprint.*
b) *Method: Electrofishing gear will consist of a saltwater capable boom mounted electrofishing unit. Following the estuarine electrofishing methodology of Warry et al. (2013), electrofishing will consist of three separate sampling events of 90 seconds total "on-time" each, comprising 270 total seconds electrofishing sampling per station. Each 90 second "on-time" event will be considered a discrete replicate of three; physical measurements will also be collected at each station.*
c) *Timing, Frequency, and Duration: Data collected for target nekton pre- and post-construction. Post-construction data collection begins in YR 0 and is to occur twice annually (late- spring/early-summer and late-summer/early-fall) each year for 10 yrs.*
d) *Sample Size: A seasonal total of up to 48 electrofishing replicates, 96 per year.*
e) *Sites: Sites will align with the seagrass monitoring effort.*

Parameter #5-3: Biomass of FWCI (small epibenthic fish and shellfish)

a) *Purpose: Project habitat benefits will be assessed to determine secondary productivity as standing stock biomass per square area (m^2) of target nekton (pink shrimp, brown shrimp, blue crab, pinfish, red drum, and spotted seatrout) for the project's seagrass footprint.*
b) *Method: Epibenthic sleds will be deployed using a stratified-random sampling scheme with habitat types (turtle grass, shoal grass, widgeon grass, bare substrate) used as a stratification condition following the methodology historically used in the Chandeleur seagrass meadow (Hayes 2021). The sleds (0.75 m wide x 0.60m high) will be pulled by hand for a distance of 13.3 m at a speed of ~0.3m/s. Samples will be preserved and transported to a laboratory where they will be sorted, identified to the lowest taxonomic level possible, counted, weighed, and measured.*
c) *Timing, Frequency, and Duration: As-built YR 0 and every five years for the 10 years post-construction (YRs 0, 5, and 10). Samples will be collected twice during monitoring event*

years, once in late-spring/early-summer and once in late-summer/early-fall, in order to bracket the seagrass growing season and maximize likely encounter with target species and/or their life stages.

d) *Sample Size: A seasonal total of up to 48 epibenthic sled (0.75 m x 0.6 m frame) pulled a distance of 13.3 m.*
e) *Sites: Samples will be evenly distributed across Turtle Grass, Shoal Grass, Widgeon Grass, and bare substrate.*

Parameter #5-4: Biomass of FWCI (larger pelagic fish and shellfish)

a) *Purpose: Project habitat benefits will be assessed to determine secondary productivity as standing stock biomass (g m^2) of target nekton (pink shrimp, brown shrimp, blue crab, pinfish, red drum, and spotted seatrout) for the project's seagrass footprint.*
b) *Method: Electrofishing gear will consist of a saltwater capable boom mounted electrofishing unit. Following the estuarine electrofishing methodology of Warry et al. (2013), electrofishing will consist of three separate sampling events of 90 seconds total "on-time" each, comprising 270 total seconds electrofishing sampling per station. Each 90 second "on-time" event will be considered a discrete replicate of three; physical measurements will also be collected at each station.*
c) *Timing, Frequency, and Duration: Data collected for target nekton pre- and post-construction. Post-construction data collection begins in YR 0 and is to occur twice annually (late- spring/early-summer and late-summer/early-fall) each year for 10 yrs.*
d) *Sample Size: A seasonal total of up to 48 electrofishing replicates, 96 per year.*
e) *Sites: Sites will align with the seagrass monitoring effort.*

Parameter #5-5: Community composition of FWCI (small epibenthic fish and shellfish)

a) *Purpose: Project habitat benefits will be assessed to determine secondary productivity as species richness of nekton for the project's seagrass footprint.*
b) *Method: Epibenthic sleds will be deployed using a stratified-random sampling scheme with habitat types (turtle grass, shoal grass, widgeon grass, bare substrate) used as a stratification condition following the methodology historically used in the Chandeleur seagrass meadow (Hayes 2021). The sleds (0.75 m wide x 0.60m high) will be pulled by hand for a distance of 13.3 m at a speed of ~0.3m/s. Samples will be preserved and transported to a laboratory where they will be sorted, identified to the lowest taxonomic level possible, counted, weighed, and measured.*
c) *Timing, Frequency, and Duration:* As-built YR 0 and every five years for the 10 years post-construction (YRs 0, 5, and 10). *Samples will be collected twice during monitoring event years, once in late-spring/early-summer and once in late-summer/early-fall, in order to bracket the seagrass growing season and maximize likely encounter with target species and/or their life stages.*
d) *Sample Size:* A seasonal total of up to 48 epibenthic sled (0.75 m x 0.6 m frame) pulled a distance of 13.3 m.
e) *Sites: Samples will be evenly distributed across Turtle Grass, Shoal Grass, Widgeon Grass, and bare substrate.*

Parameter #5-6: Community composition of FWCI (larger pelagic fish and shellfish)

a) *Purpose: Project habitat benefits will be assessed to determine secondary productivity as species richness of nekton for the project's seagrass footprint.*
b) *Method: Electrofishing gear will consist of a saltwater capable boom mounted electrofishing unit. Following the estuarine electrofishing methodology of Warry et al. (2013), electrofishing will consist of three separate sampling events of 90 seconds total "on-time" each, comprising 270 total seconds electrofishing sampling per station. Each 90 second "on-time" event will be considered a discrete replicate of three; physical measurements will also be collected at each station.*
c) *Timing, Frequency, and Duration: Data collected for target nekton pre- and post-construction. Post-construction data collection begins in YR 0 and is to occur twice annually (late- spring/early-summer and late-summer/early-fall) each year for 10 yrs.*
d) *Sample Size: A seasonal total of up to 48 electrofishing replicates, 96 per year.*
e) *Sites: Sites will align with the seagrass monitoring effort.*

3.2 Performance Criteria and Potential Corrective Actions

In this section, the LA and Open Ocean TIGs describe how updated knowledge gained from the evaluation of monitoring data will be used at the project-level to determine whether the project is considered successful or whether corrective actions are needed. A project may not be achieving its intended objectives because of previously identified key uncertainties, unanticipated consequences, previously unknown conditions, or unanticipated environmental drivers. The decision to implement (or not implement) corrective actions is one type of decision within the larger adaptive management decision-making framework.

Information gathered through monitoring allows for corrective actions to be made to achieve desired outcomes. Table 4 identifies performance criteria, monitoring parameters, and potential corrective actions that could be taken if the performance criteria are not met (as defined in NRDA regulations 15 CFR § 990.55(b)(1)(vii)). This table should not be considered all encompassing; rather, it represents a listing of potential actions for each individual parameter to be considered if the project is not performing as expected once implemented. Other corrective actions may be identified post-implementation and included in an operations and maintenance (O&M) plan. The decision of whether a corrective action should be implemented for the project should consider the overall outcomes of the restoration project (i.e., looking at the combined evaluation of multiple performance criteria) in order to understand why project performance deviates from the predicted or anticipated outcome. Corrective action may not be taken in all cases based on such considerations. The knowledge gained from this process could also inform future restoration decisions such as the selection, design, and implementation of similar projects.

Table 4. List of Project Monitoring Parameters, Performance Criteria, and Potential Corrective Actions

Monitoring Parameter	Final Performance Criteria Used to Determine Project Success	Potential Corrective Action(s)
Parameter #1-1: Area (acres) of barrier island habitat created	There will be at least 4,637 acres of area classified as habitat other than water or structures 10 years post-construction (i.e., above -1.5 ft NAVD88). [a]	Planting of appropriate species and/or addition of sediments
Parameter #1-2: Elevation of beach/dune and marsh areas	There will be at least 1,929 acres of habitat above +2.0 ft NAVD88 10 years post-construction. [b]	Addition of sediments; addition of sand fencing
Parameter #1-3: Shoreline position	Change in shoreline position should not exceed 34 ft per year. [c]	Addition of sediments; enhanced monitoring to detect and repair potential island breaches
Parameter #1-4: Vegetation percent cover (by taxon)*	Planted beach habitat will consist of no more than 30 percent vegetation cover 10 years post-construction. Planted dune habitat will consist of at least 10 percent vegetation cover 10 years post-construction. Planted marsh habitat will consist of at least 30 percent vegetation cover 10 years post-construction. [d]	Perform supplemental planting(s) of preferred vegetation; eradicate unwanted vegetation
Parameter #1-5: Vegetation species composition*	Species composition will be comparable to what was observed prior to project implementation. [d]	
Parameter #2-1: SAV area	There will be at least 5,084 acres of established SAV 10 years post-construction (representing no net loss).	Addition of sediments and/or perform supplemental planting(s)
Parameter #2-2: SAV percent cover (by taxon)	SAV cover will be comparable to what was observed prior to project implementation.	
Parameter #2-3: SAV species composition	SAV species composition will be comparable to what was observed prior to project implementation.	
Parameter #3-1: Colonial bird nest abundance (by taxon)	There will be at least 1,929 acres of habitat above +2.0 ft NAVD88 that support nesting activity and hatchling/fledgling survival 10 years post-construction. Targets for nest abundance will be updated as they are determined.	Addition of sediments; addition of sand fencing; predation (i.e., nuisance mammal) control as needed using established methods

Monitoring Parameter	Final Performance Criteria Used to Determine Project Success	Potential Corrective Action(s)
Parameter #3-2: Non-breeding bird abundance (by taxon)*	Year 2 abundances will be similar or greater than those observed in 2023-2024.	Enhanced monitoring of non-breeding birds
Parameter #3-3: Bird species composition	Colonial bird species composition will be similar or more diverse than what was observed prior to project implementation. Year 2 non-breeding bird species composition will be similar or more diverse than observed in 2023-2024.	Addition of sediments; addition of sand fencing; vegetation plantings, vegetation control, predation (i.e., nuisance mammal) control as needed using established methods;
Parameter #3-4: Nuisance mammal presence or abundance (by taxon)*	Targets may be set as needed to support the success of bird-nesting habitat use (Parameter #3-1).	Predation control as needed using established methods
Parameter #4-1: Area and length of potential nesting habitat for sea turtles	There will be at least 273 acres of habitat between +4.0 ft and +5.5 ft NAVD88 10 years post-construction.	Addition of sediments; addition of sand fencing or vegetative plantings
Parameter #4-2: Sea turtle nest abundance (by taxon)	The three year average number of sea turtle crawls on the project area will be within 20% of the average pre-project estimate.	
Parameter #5-1: Density of target FWCI (small epibenthic fish and shellfish)*	Density (# m^{-2}) of target nekton species will be maintained in existing seagrass meadows and/or increase in areas where bare substrate transitions into seagrass habitat. Target ranges will be developed using analysis of existing data sources and/or as-built (year 0) data as a part of a separate effort.	Evaluate if changes are habitat-driven or determined by another factor. Consider plantings and other protection measures if changes are habitat-driven, as funding allows.
Parameter #5-2: Abundance of target FWCI (larger pelagic fish and shellfish)*	CPUE of target nekton species will be maintained in existing seagrass meadows and/or increase in areas where bare substrate transitions into seagrass habitat.	Identify potential cause: Evaluate monitoring protocols and substitute sampling gear types
Parameter #5-3: Biomass of FWCI (small epibenthic fish and shellfish)*	Biomass (g m^{-2}) of target nekton species will be maintained in existing seagrass meadows and/or increase in areas where bare substrate transitions into seagrass habitat. Target ranges will be developed using analysis of existing data sources and/or as-built (year 0) data as a part of a separate effort.	Evaluate if changes are habitat-driven or determined by another factor. Consider plantings and other protection measures if changes are habitat-driven, as funding allows.
Parameter #5-4: Biomass of FWCI (larger pelagic fish and shellfish)*	Biomass (g m^{-2}) of target nekton species will be maintained in existing seagrass meadows and/or increase in areas where bare substrate transitions into seagrass habitat.	Identify potential cause: Evaluate monitoring protocols and substitute sampling gear types.

Monitoring Parameter	Final Performance Criteria Used to Determine Project Success	Potential Corrective Action(s)
Parameter #5-5: Community composition of FWCI (small epibenthic fish and shellfish)*	Nekton species richness will be maintained in existing seagrass meadows and/or increase in areas where bare substrate transitions into seagrass habitat. Target ranges will be developed using analysis of existing data sources and/or as-built (year 0) data as a part of a separate effort.	Evaluate if changes are habitat-driven or determined by another factor. Consider plantings and other protection measures if changes are habitat-driven, as funding allows.
Parameter #5-6: Community composition of FWCI (larger pelagic fish and shellfish)*	Nekton species richness will be maintained in existing seagrass meadows and/or increase in areas where bare substrate transitions into seagrass habitat.	Identify potential cause: Evaluate monitoring protocols and substitute sampling gear types.

Notes: Asterisks (*) denote parameters that are not needed to evaluate the success of the project, but are used to provide context or additional information (termed "additional parameters" in the MAM Manual and Data Integration Visualization Exploration and Reporting (DIVER)). All potential corrective actions are subject to the availability of funds, and may involve external funding or coordination to accomplish.

[a] Per the Alternatives Analysis (CEC, 2024), the lower elevation of subtidal is defined as -1.5 feet NAVD88 (hence, any elevation below that would be classified as open water) and 4,637 acres of habitat is expected to persist 10 years post-construction. The design specifications will provide interim performance criteria for as-built assessment.

[b] Design specifications will provide interim performance criteria for as-built assessment.

[c] Using the BICM gulf shoreline positional dataset, the alternatives analysis design team computed the long-term Gulf shoreline change rate (1950 - 1998) for North Chandeleur Island to be -34 ft/year.

[d] Targets are informed by the BICM habitat classification schemes described in Enwright et al. (2020). Vegetation data is being collected to inform the habitat mapping effort and to provide insight into the evolution of constructed barrier islands, thus although performance criteria are provided, they are not necessary to assess the performance of the project and may change.

4. Monitoring Schedule

The project monitoring schedule (Table 5) is separated by monitoring activities. Pre-execution monitoring will occur before project execution, if applicable. Execution of monitoring will occur when the project has been fully executed as planned, although this timeframe may vary for different parameters. Performance monitoring will occur in the years following initial project execution (years 1 - 10).

Table 5. Monitoring Schedule

Monitoring Parameters	Monitoring Timeframe for Each Parameter[1]										
	YR0	YR1	YR2	YR3	YR4	YR5	YR6	YR7	YR8	YR9	YR10
Aerial Imagery Acquisition[2]	X		X	X		X	X		X	X	X
Island Vegetation Survey				X							X
Elevation Survey[3]	X					X					X
Colonial Waterbird Nest Survey[4]		X		X		X					
Non-Breeding Bird Survey		X	X								
SAV Survey	X	X	X						X	X	X
Habitat Mapping	X			X		X					X
Sea Turtle Survey	X	X	X								
Small Epibenthic Fish and Shellfish Sampling	X					X					X
Larger Pelagic Fish and Shellfish Sampling[5]	X	X	X	X	X	X	X	X	X	X	X

Note: X's denote data acquisitions.

[1] Years of data collection may change based on the availability of funds and/or the ability to leverage data collection efforts conducted outside of this project.

[2] Aerial imagery will also be acquired through CWPPRA/CRMS for YRs 1, 4, and 7 (however, these will not become available until several months [6-9] after acquisition).

[3] Additional data collected by BICM surveys (outside of this project), if available, may also be used to supplement the dataset.

[4] Schedule may change based on the availability of surveys conducted every 2-3 years as part of the larger Louisiana coast regimented surveying effort.

[5] Larger pelagic fish and shellfish sampling will occur twice annually.

5. Evaluation

Evaluation of monitoring data is needed to assess the project implementation and performance in meeting restoration objectives, resolving uncertainties to increase understanding, and determining whether corrective actions are needed.

As part of the larger decision-making context, the evaluation of monitoring data from individual projects could also be compiled and assessed at the level of restoration type and restoration area, and the results would be used to update the knowledge base to inform decisions such as future LA and Open Ocean TIG project prioritization and selection, implementation techniques, and the identification of critical uncertainties.

The results of these analyses would be used to answer the following questions:

- *Were the project restoration objectives achieved? If not, is there a reason why they were not met?*
- *Did the restoration project produce unanticipated effects?*
- *Were there unanticipated events unrelated to the restoration project that potentially affected the monitoring results (e.g., hurricanes)?*
- *Were any of the uncertainties identified prior to project implementation resolved?*
- *Were any new uncertainties identified?*

Proposed analysis methods for monitoring parameters are grouped under stated objective headings and will be updated as necessary:

Objective #1: Barrier island habitat is created and restored to provide coastal habitat(s) important for the restoration of ecosystem functions and stability.

Parameter #1-1: Area (acres) of barrier island habitat created

Analysis: Aerial imagery will be used to perform a habitat classification analysis using the protocol set forth by the BICM program. The BICM detailed classification scheme methodology is consistent with the recommendations in the Guidance for Coastal Ecosystem Restoration and Monitoring to Create or Improve Bird-Nesting Habitat (LA TIG, 2023). The current habitat mapping procedure uses any available elevation data to assist in the classification of some habitats. Using multiple time periods, changes in quantity and type of habitat will be evaluated.

Parameter #1-2: Elevation of beach/dune and marsh areas

Analysis: The project's construction documents will establish the desired target elevations of constructed marsh, beach, and dune habitat areas. Data will be processed to create digital elevation models (DEMs) to determine the average elevation within each habitat classified during the habitat mapping effort. Results will be compared to both initial design elevations as well as pre-restoration elevations and change trends. Elevation models generated to show the elevation across the project area and island can also be used to determine elevation changes as well as changes in volume of sediment, allowing change trends to be developed and compared to pre-project trends.

Parameter #1-3: Shoreline position

Analysis: Shoreline position can be delineated from aerial imagery, RTK GPS data, and/or LiDAR topography. It has not been determined yet which method(s) will be used. Any of several reasonable options for assessing shoreline position may be used or combined depending on available budget (e.g., Terrano et al., 2016), including digitization and use of aerial imagery following the BICM program methods (Enwright et al., 2020). Change rates will be calculated from sampled time periods and compared to other data sets for islands in the vicinity of the project, as well as compared with regional and coastwide trends. These data sets are provided through the BICM program or other literature.

Parameter #1-4: Vegetation percent cover, and
Parameter #1-5: Vegetation species composition

Analysis: General descriptive statistical analyses may include, but are not limited to, averages/means of the overall total cover by herbaceous species and/or shrubs (marsh); percent cover of species; and/or average height of dominant/species. After each collection effort, the data will be analyzed and evaluated. In conjunction with the habitat mapping, the vegetation data will provide on the ground verification of the habitat mapping effort and provide insight into the species composition, percent cover, and elevation of those delineated habitats. After multiple collection efforts, comparisons between time periods will be assessed to determine changes.

Objective #2: Enhance SAV habitat restoration to provide coastal habitats important for the restoration of ecosystem functions and stability.

Parameter #2-1: SAV area,
Parameter #2-2: SAV percent cover, and
Parameter #2-3: SAV species composition,

Analysis: Analytical methods will follow those used for the planning-phase seagrass study (SWCA, 2023). Aerial imagery will be digitized using a mixture of photointerpretation and image analysis, following Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach (NOAA Coastal Services Center 2001). Seagrass data interpolation and cover classification mapping will be completed using the ArcGIS suite of software and tools. Using a geodatabase of digitized field data, seagrass densities will be run through an ArcGIS Average Nearest Neighbor tool to calculate seagrass coverage for each species and total coverage across the study area. Analyses will be performed for each sampling event to track changes in performance over time, and to allow comparison with regional seagrass trends.

Objective #3: Create/restore Chandeleur Islands habitat for use by nesting birds.

Parameter #3-1: Colonial bird nest abundance, and
Parameter #3-3: Bird species composition

Analysis: Aerial photographs will be analyzed using accepted methods (Ford, 2010). Photographs from May and June surveys will be evaluated for their representation of peak breeding population size for each species at each colony. For most species, photographs from May surveys will represent peak breeding numbers and will be selected for analysis. For some species, especially Black Skimmer, photos from June surveys will better represent peak numbers and will be used for analysis. Occasionally, especially for Brown Pelican, Royal Tern (*Thalasseus maximus*), and Sandwich Tern (*Thalasseus sandvicensis*), well-developed colonies will be counted using May photographs, but additional large nesting groups that form after the May survey will be counted from June photographs and summed with May counts for a total number of nests.

All images of each individual colony will be inspected for clarity, location within the colony, and extent of colony coverage. Those best suited for nest counts based on those criteria and collectively comprising all areas photographed will be analyzed using counting software (Image-Pro, Media Cybernetics). Nests and birds will be marked on images manually, and the software will automatically tally total counts for each category. Although the primary objective will be to determine number of nests, individual birds and chicks of each species will be counted in each photograph.

For Brown Pelicans, nests will be categorized by their stage of development. These categories will include the following:

- *Well-built nest (with attending adult and with or without chicks)*
- *Poorly built nest (pre-egg laying)*
- *Nest with chicks but without attending adults*
- *Abandoned nest (with eggs but unattended)*
- *Empty nest (early-season unattended without eggs or chicks)*
- *Brood (dependent chicks away from an obvious nest and not attended by an adult)*

Together, these categories will provide numbers of Brown Pelican nests and breeding pairs at each colony based usually on a single aerial photographic survey even though egg-laying dates may span a period of months. For other species, all nests and territories will be marked more generally as "sites." The detailed nest categories that will be used for Brown Pelicans are inappropriate for other species because of their small size (terns and gulls), scrape-nesting habits (terns and skimmers), or partial concealment by vegetation (waders and gulls).

Using the counting software, unique symbol-color combinations will be assigned to different nest and bird categories for each species. Where overlapping images are used to analyze portions of a colony, one or more lines will be drawn on the selected image to delineate the area to be counted using that image. Areas outside any such lines will then be counted using different images. This process will continue until the colony is counted completely with available photographs.

After analyzing an image with the software, a screen capture of the analyzed image will be saved as a jpeg file. The screen capture will show all data, including image number, all symbols that marked nests and birds, total counts for each category, colony name, area number, the initials of the photo analyst, the date the image was analyzed, and any other annotations the photo analyst added. All screen captures will be saved with standardized file names and archived in colony- specific folders. All data from each screen capture will be manually entered into a Microsoft Access database.

Each image analyzed will be evaluated to characterize conditions at each colony. Factors that will be considered include:

- *Stage of the breeding cycle (e.g., early-, mid-, or late-incubation; early chick-rearing) for each species.*
- *Habitat occupancy (numerical and geographic extent to which each species occupied the habitat).*
- *Reproductive performance (e.g., pattern of abandonment, if any, chick production).*

Information specific to a particular image will be entered into a notes field in the main data table in the Access database. Information concerning the colony as a whole will be entered in a separate data table in the same database. Taxonomic data will be available to inform a combined dataset documenting both colonial waterbirds and non-breeding bird species.

Parameter #3-2, Non-breeding bird abundance (by taxon), and
Parameter #3-3, Bird species composition

Analysis: The abundance and diversity of species will be compared to preconstruction surveys using standard descriptive statistics. Additional monitoring of birds could be triggered if abundances are not similar or greater than preconstruction abundances by the fifth year following construction. Taxonomic data will be available to inform a combined dataset documenting both colonial waterbirds and non-breeding bird species.

Parameter #3-4: Nuisance mammal presence or abundance

Analysis: Predation investigations may be conducted opportunistically as needed, leveraging data and resources from colonial and non-breeding bird surveys. If species abundance or nesting success fall below target thresholds, potential predator control methods could be triggered, including removal or reduction methods and/or colony fencing to reduce/eliminate access by nuisance mammal species.

Objective #4: Create/restore Chandeleur Islands habitat for use by nesting sea turtles.

Parameter #4-1: Area and length of potential nesting habitat for sea turtles

Analysis: Data collected for habitat area and elevation (Parameters #1-1 and #1-2) will be used to categorize and measure habitat available for use by nesting sea turtles, following methods used during the project planning phase (CEC, 2024).

Parameter #4-2: Sea turtle nest abundance (by taxon)

Analysis: Number of nests per species and nest locations will be used to determine sea turtle use of the new habitat.

Objective #5: WCNH restoration and SAV enhancement creates interspersed and ecologically connected coastal habitats for fish and invertebrate species.

Parameter #5-1: Density of target FWCI (benthic sled)

Analysis: Data will be analyzed in monitoring syntheses reports to assess if data from recent collections statistically differ from target ranges. Samples will also be used to develop timeseries of density (# m^{-2}) for the target species. Timing of analyses will be determined by the timing of the monitoring effort and appropriate synthesis reporting periods.

Parameter #5-2: Abundance of target FWCI (larger pelagic fish and shellfish)

Analysis: Data will be analyzed in conjunction with monitoring reports for Data Integration Visualization Exploration and Reporting (DIVER) reporting and for monitoring syntheses reports, as appropriate, to assess if abundance (CPUE) of target species remains stable, increases, or decreases in statically meaningful way. Analyses are anticipated to begin in year 4 to allow for sufficient data to conduct trend analysis. Samples will also be used to develop timeseries of abundance (CPUE) for the target species.

Parameter #5-3: Biomass of FWCI (small epibenthic fish and shellfish)

Analysis: Data will be analyzed in monitoring syntheses reports to assess if data from recent collections statistically differ from target ranges. Samples will also be used to develop timeseries of biomass (g m^{-2}) for the target species. Timing of analyses will be determined by the timing of the monitoring effort and appropriate synthesis reporting periods.

Parameter #5-4: Biomass of FWCI (larger pelagic fish and shellfish)

Analysis: Data will be analyzed in conjunction with monitoring reports for DIVER reporting and for monitoring syntheses reports, as appropriate, to assess if biomass (g m^{-2}) of target species remains stable, increases, or decreases in statically meaningful way. Analyses are anticipated to begin in year 4 to allow for sufficient data to conduct trend analysis. Samples will also be used to develop timeseries of biomass (g m^{-2}) for the target species.

Parameter #5-5: Community composition of FWCI (small epibenthic fish and shellfish)

Analysis: Data will be analyzed in monitoring syntheses reports to assess if data from recent collections statistically differ from target ranges. Samples will also be used to develop timeseries of biomass (g m^{-2}) for the target species. Timing of analyses will be determined by the timing of the monitoring effort and appropriate synthesis reporting periods.

Parameter #5-6: Community composition of FWCI (larger pelagic fish and shellfish)

Data will be analyzed in conjunction with monitoring reports for DIVER reporting and for monitoring syntheses reports, as appropriate, to assess if species richness increases, or decreases in statically meaningful way. Analyses are anticipated to begin in year 4 to allow for sufficient data to conduct trend analysis. Samples will also be used to develop timeseries of biomass (g m^{-2}) for the target species.

6. Data Management

6.1 Data Deliverables

Shapefiles, Imagery, and Elevational Data: LA and Open Ocean TIG representatives will receive copies of all data generated (e.g., survey tracks, survey photographs that coincide with those tracks, GIS files, KMZ files, associated metadata and data files) in association with the scheduled sampling events.

Vegetation Surveys: LA and Open Ocean TIG representatives will receive an individual summary report for each of the scheduled sampling events. Reports will include all data collected and analyses performed as well as all associated metadata.

SAV Surveys: LA and Open Ocean TIG representatives will receive a summary report for SAV surveys, including all data collected, analyses performed, and associated metadata.

Bird and Sea Turtle Surveys: LA and Open Ocean TIG representatives will receive copies of all data generated (e.g., survey tracks, survey photographs that coincide with those tracks, GIS files, KMZ files, associated metadata) in association with the scheduled sampling events.

Small epibenthic fish and shellfish: LA and Open Ocean TIG representatives will receive an individual summary report for each of the three scheduled sampling events. Reports will include all data collected and analyses performed as well as all associated metadata.

Larger pelagic fish and shellfish Sampling: LA and Open Ocean TIG representatives will receive an individual summary report for each of the 11 scheduled sampling events. Reports will include all data collected and analyses performed as well as all associated metadata.

6.2 Data Description

To the extent practicable, all environmental and biological data generated during monitoring activities will be documented using standardized field datasheets. If standardized datasheets are unavailable or not readily amendable to record project-specific data, then project-specific datasheets will be drafted prior to conducting any project monitoring activities. Original hard copy datasheets and notebooks and photographs will be retained by the implementing Trustee.

Relevant project data that are handwritten on hard copy datasheets or notebooks will be transcribed (entered) into standard digital format. All field datasheets and notebook entries will be scanned to PDF files. Electronic data files should be named with the date on which the file was created and should include a ReadMe file that describes when the file was created and by whom and any explanatory notes on the file contents. If a data file is revised, a new copy should be made and the original preserved.

All data will have properly documented Federal Geographic Data Committee (FGDC)/ISO metadata, a data dictionary (defines codes and fields used in the dataset), and/or a ReadMe file as appropriate (e.g., how data were collected, quality assurance/quality control [QA/QC] procedures, and other information about data such as meaning, relationships to other data, origin, usage, and format—can reference different documents)

6.3 Data Review and Clearance

Data will be reviewed for QA/QC in accordance with the MAM Manual (DWH Trustees, 2024), and errors in transcription will be corrected. Implementing Trustees will verify and validate data and information and will ensure that all data are entered or converted into agreed upon/commonly used digital format and labeled with metadata following FGDC/ISO standards to the extent practicable and in accordance with implementing Trustee agency requirements.

After identified errors are addressed, data are considered to be cleared. The implementing Trustee will give the other LA and Open Ocean TIG members time to review the data before making such information publicly available (as described below). Before submitting the monitoring data and information package, co-implementing Trustees shall confirm with one another that the package is approved for submission.

6.4 Data Storage and Accessibility

Once data have been cleared, they will be submitted to the designated Amazon Web Service (AWS) server which can be accessed through the Restoration Portal.

Trustees will provide DWH NRDA MAM data and information to the Restoration Portal as soon as possible and no more than 1 year from when data are collected.

6.5 Data Sharing

Data will be made publicly available in accordance with the Federal Open Data Policy through the designated AWS server, which can be accessed through DIVER Explorer Interface within 1 year of when the data collection occurred.

7. Reporting

Based on the anticipated project monitoring schedule (Section 4), associated reporting will be submitted in years 2, 4, 6, and 11. Reports have been scheduled for the year after major data collection efforts with the intention that results will be available to determine whether performance criteria that have been established in Table 4 have been met. If performance criteria have not been met, then potential corrective actions will be identified.

Sea turtle survey reporting will occur after field surveys are complete for each sampling effort. A report will summarize the findings for the sampling period including all worksheets transferred into digital format and presented in tabular and graphical formats. The data should be summarized in such a way that it is meaningful to the reader. Additionally, an annual report would be completed that includes:

- Summary data/synthesized data for all efforts during the year.
- Graphics, if applicable, and associated interpretations of the data.
- Comparisons of pre- and post-project conditions, as applicable.
- Any uncertainties with management actions.
- Potential data collection issues.
- Issues to be resolved to improve data collection or cooperation in getting quality data and/or issues associated with data loss or inability to collect data for a time period.

8. Roles and Responsibilities

The LA and Open Ocean TIGs are responsible for addressing MAM objectives that pertain to their restoration activities and for communicating information to the Trustee Council or work groups. The CPRA is the implementing Trustee for the project. The U.S. Department of the Interior will be the lead federal agency for conducting the environmental evaluation and compliance review for implementation. Additional Trustees, and/or their designees, will be responsible for collection and transmission of QA/QCed data to CPRA for incorporation into annual DIVER reporting and periodic synthesis reporting. The participating Trustees' roles include:

CPRA (Implementing Trustee):

- Coordinating with the project partner(s) to ensure data collection and report composition are completed.
- Ensuring the project partner performs O&M activities as required.
- Providing project progress information to the LA and Open Ocean TIGs.

NOAA:

- Carrying out FWCI (small epibenthic fish and shellfish) MAM activities, providing data collection results to the implementing Trustee, and coordinating with the implementing Trustee to ensure reporting needs are met.

LDWF:

- Carrying out FWCI (larger pelagic fish and shellfish) sampling MAM activities, providing data collection results to the implementing Trustee, and coordinating with the implementing Trustee to ensure reporting needs are met.

9. Monitoring and Adaptive Management Budget

The overall budget for the project monitoring and adaptive management is $15,740,000, and includes aerial imagery acquisition and habitat mapping, aerial nest surveys, vegetation surveys, and oversight of monitoring activities or monitoring data synthesis and reporting costs.

10. References

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11. MAM Plan Revision History

Table 6. MAM Plan Revision History

Old Version #	Revision Date	Changes Made	Reason for Change	New Version #
-	-	-	-	-

12. Supplemental Information

12.1 Guidelines for Monitoring Procedures for Sea Turtles

The following monitoring procedures have been adapted from those used by the Mississippi Coastal Improvements Program (MsCIP), and will be used to provide information necessary to evaluate project objectives for the Chandeleur Islands Restoration Project. These procedures may be further modified for use in the Chandeleur Islands; such modifications remain TBD, and will be provided in subsequent updates to the MAM Plan for this project.

This monitoring will continue during and post-construction to evaluate short-term and long-term response to the proposed restoration. These procedures will be updated as required to provide the necessary information to evaluate ecological success.

Sea turtle monitoring includes documenting defined parameters of sea turtle nesting activity including species, abundance, locating crawls, and marking nests. In order to prevent disturbance to nesting shorebirds, monitoring of sea turtles should be done in the morning prior to any potential shorebird monitoring.

There are five species of sea turtles: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), Kemp's Ridley (*Lepidochelys kempii*), that may be found in the Gulf.

Sea turtle nesting and hatching season for Louisiana starts around April and continues through November. Incubation for the loggerhead sea turtle ranges from about 45 to 95 days and incubation for the green sea turtle ranges from about 45 to 75 days. Potential hatching dates will be determined for each crawl documented and monitored for nesting success 95 days beyond the crawl date.

12.1.1 Monitoring Periods:

There are three monitoring periods: pre-construction, during construction, and post-construction.

A. Pre-Construction:

If project activities are initiated between Nov 30 and April 15, then no pre-project surveys will be required for nesting sea turtles. If the project will be initiated between April 15 and Nov 30, daily pre-project surveys should begin at least 100 days prior to commencement of work in the immediate vicinity of construction.

B. During Construction:

Nesting surveys and marking activities will be conducted daily, weather permitting, while construction activities are on-going during nesting and hatching season in work areas. Surveys will take place where construction activities will be occurring within the next 100 days as the project progresses across the project footprint.

C. Post-Construction:

Weekly sea turtle monitoring shall be conducted and include two full nesting and hatching seasons (April through November). The goal of the post-construction monitoring is to ensure that suitable habitat for sea turtles is established.

12.1.2 Monitoring Protocols:

12.1.2.1 Survey Methods:

1. On native beaches, surveys will be conducted first thing in the morning by All-Terrain Vehicles (ATV/UTV), foot or boat. The ATV will be operated at <6 mph, to provide adequate opportunity to view the beach, to avoid obstacles and hazards, and to visually investigate all possible turtle crawls. **The ATV will be operated low on the beach, on the unvegetated dune face, at or below the last high tide line.** This will allow even the shortest turtle crawls to be located and minimize impacts to bird nests. **Be careful not to drive through a bird-nesting area.** Back track on foot if necessary to survey the area not accessible by ATV.

   If it is high tide during your survey, do not attempt to drive the ATV through water. Also, do not drive the vehicle over dunes and vegetation. If there is a path wide enough for the ATV to drive through without impacting vegetation, use the path to circumvent the area where there is no beach. **Be careful not to drive through a bird-nesting area.** Back track on foot if necessary to survey the area that was missed.

2. During the survey, be alert for tracks, stranded turtles, nests uncovered by predators, hatchlings, etc., or any evidence of a sea turtle incident. Check any marked nests found during previous surveys.

12.1.2.2 Investigating Nesting Activities:

1. If a turtle crawl is discovered, stop and evaluate the incident as thoroughly as possible. A completed "Sea Turtle Nest Data Sheet" form is required for all incidents, false crawl or nest. A copy of the data sheet form is located at the end of this document. The monitor should identify the species of the turtle crawl, record the GPS location, take photos of the turtle crawl, etc.

2. Mark the turtle crawl and/or a nest to prevent double-counting. Look for evidence of a body pit. A body pit will look like a roughly circular area of disturbed sand which may or may not be slightly lower than surrounding areas. If there is not a body pit discovered, the crawl willbe assumed to be a false crawl. False crawls will be recorded on a report form. If a conspicuous area of disturbed sand is found (body pit), assume that a nesting event has occurred. Look for signs of animal depredation or human tampering.

3. Measure the crawl at three different locations and taking an average of the three. Straight-line measurements should be taken from the tip of the flipper mark on one side to the tip of the flipper mark on the other. With loggerheads, since the flipper marks alternate, the

measurements should be from flipper mark on one side to an extended straight line from the flipper mark on the other side.

4. If the incident was a nest, record the distance from the water to the nest site. This does not need to be exact (water level fluctuates with each wave) but it should be fairly accurate. Also, note if the nest is above or below the rack line (highest debris line on the beach).

5. When estimating egg cavity location, determine the direction of travel along the crawl, locate a body pit, and locate an escarpment in the shape of an arc at the front of the pit. Typically, the female faces away from the water during nesting, although this is not always the case. The escarpment is the result of the turtle using her front flippers to cover the nest with sand when she is done laying. The egg cavity is usually centered behind this escarpment, approximately 3-5 ft back. It may be further back, if the turtle was moving forward while covering the nest site.

6. Occasionally, a nest may be uncovered by predators or beach erosion. If you find a nest where eggs or the remains of eggs are visible, the incident will be reported as a nest. If the nest was predated, the nest must be checked for viable eggs. Do not assume the nest has been totally predated.

If a nest is partially depredated, the remaining eggs can be reburied with the necessary precautions. Eggs must be rinsed off with freshwater to remove all albumen and other fluids that came from the damaged eggs. Rough handling and turning of the eggs should be avoided. The nest cavity, if still intact, should be emptied out down to clean sand before the eggs are replaced. Do not dig too deep. Occasionally, most eggs can be left in place and only the top few will need to be removed, cleaned and returned to the nest. The nest should then be filled with moist sand. Compress the sand with your hands using slight to moderate pressure. Damaged eggs and shells should be removed from the area.

If the nest was totally depredated, fill in the hole and clean up the area. If you find an area where eggs are strewn about and there is a hole in the sand, but no crawl, this is an old nest that has been depredated. Fill in a nest report (photo and GPS).

12.1.2.3 Marking Nests for Pre and During Construction:

Equipment for nest perimeter buffer zone marking:

1. 4 wooden perimeter buffer zone stakes. Dimensions 1" x 2", 4 ft long.

2. 1 roll of 3/16" fluorescent orange flagging tape

12.1.2.4 Marking Nest Sites to Protect Buried Eggs from Hazardous Activities:

The goal of this marking method is to clearly identify the nest area and protect it from human activities such as vehicular traffic or other disturbances.

A series of stakes and highly visible survey ribbon or string shall be installed to establish a 10-foot radius around the nest. No activity shall occur within this area nor will any activity occur that could result in impacts to the nest. Nest sites shall be inspected daily to assure nest markers remain in place and that the nest has not been disturbed by the project activity. The stakes should extend more than 36" above the sand. To further identify the nest site, surveyor's ribbon can be tied from the top of one stake to another to create a perimeter around the nest site.

Additionally, a nest sign can be attached to one of the stakes used to create the perimeter. A nest-identifying number and the date the eggs were laid should be placed on at least one of the nest perimeter stakes. At least one additional stake should be placed a measured distance from the clutch location at the base of the dune or seawall to ensure that future location of the nest is possible should the nest perimeter stakes be lost.

Signs should contain the information located between the two dashed lines below:

SEA TURTLE NEST - DO NOT REMOVE

VIOLATORS SUBJECT TO FINES AND IMPRISONMENT

The Endangered Species Act of 1973: No person may take, harass, harm, pursue, hunt, shoot, wound, kill, trap, or capture any sea turtle, turtle nest, and/or eggs, or attempt to engage in any such conduct. Any person who knowingly violates any provision of this Act may be assessed a civil penalty up to $25,000 or a criminal penalty up to $100,000 and up to one year imprisonment.

SHOULD YOU WITNESS A VIOLATION OR OBSERVE AN INJURED OR STRANDED TURTLE OR MISORIENTED HATCHLINGS, PLEASE CONTACT:

US Fish and Wildlife Service at (337) 291-3100

12.1.2.5 Recording Data:

Completely fill in the Sea Turtle Nest Data Sheet form provided for all nests and false crawls. Be as accurate as possible. Pay particular attention to describing the location of the nest and how the nest was marked. Use the back of the sheets for additional information or maps/diagrams. Use a separate data sheet for each nest.

12.1.2.6 Routine Monitoring of All Existing Nest Sites:

1. All sea turtle nests will be monitored throughout the incubation period. This monitoring is for the purpose of determining the duration of incubation, and identifying the incidence of depredation, damage from beach erosion, or disturbance by human activities.

2. Make sure all the stakes are readable and in good condition. If a stake or sign is missing, replace it and note the replacement in the log book and on the nest sheet.

Sites will be evaluated for evidence of disturbance including tracks, digging, ghost crab holes, tire tracks, beach erosion or washovers, or any other indication of nest disturbance. Photographs and observations of any disturbance should be recorded and provided in the report.

12.1.2.7 Monitoring at Expected Time of Hatching:

1. Beginning at the 50th day from initial discovery, each nest will be monitored more closely. This intensive regime of monitoring will be conducted to determine the precise duration of incubation, and to gather data on hatchling emergence, depredation, and disorientation.

2. Nest sites will be evaluated to determine if hatching has occurred by looking for tracks of hatched turtles which have left the nest. In general, the majority of hatchlings will leave the nest as a group during the night. Their tracks will appear as a clutter of small, approximately 2" wide tracks which radiate out from the nest. The area where the eggs are located will usually appear collapsed.

3. Look for evidence of depredation such as ghost crab or bird and any indication of turtle remains. Look for evidence of hatchling disorientation. Note any tracks which deviate from a straight course to the water and attempt to follow any tracks which have headed in the wrong direction. If disoriented hatchlings have been located, contact U.S. Fish and Wildlife Service at (337) 291-3100.

4. Record all observations made at the site on the specific Sea Turtle Nest Data Sheet form developed for that nest. Please be as complete as possible. Any information which can be learned about the fate of the hatchlings after they emerged from the nest is of value.

12.1.2.8 Final Nest Assessment and Excavation:

1. All nests will be assessed at the conclusion of the nesting process to gather data on overall nesting success.

2. In general, the final assessment will be conducted 3 days after hatchlings have been documented as emerging from the nest or 80 days after initial discovery of a nest if no evidence of hatching has been recorded. (This is dependent upon the identified species).

3. When excavated, the sites are evaluated to determine the fate of the nest. The data collected includes, at minimum, the total number of eggs found (both hatched and unhatched), the presence of any hatchlings inside the nest, the number of unhatched eggs with embryonic development, the number of eggs without embryonic development, and any evidence regarding factors which may have affected the nest, such as ghost crab burrows, vegetation roots, etc.

4. Results will be recorded on the Sea Turtle Nest Data Sheet form and all protective material including screens and stakes will be removed from the nest location.

12.1.2.9 Reporting:

1. Report any activity as soon as possible; including nesting, false crawls, etc. (datasheets located at the end of this document). The datasheets shall summarize sea turtle species observed (adults and hatchlings), the location of turtle crawls and/ or nests (GPS coordinates), and construction compliance/noncompliance observations. In addition to datasheet submission, monitoring reporting shall summarize upon locating a dead or injured sea turtle that may have resulted from direct or indirect results of the project. Nests with estimated hatch dates should be supplied with the submitted logs. If an injured or dead sea turtle is discovered, contact US Fish and Wildlife Service at (337) 291-3100.

Appendix B-2:

Chandeleur Islands Fisheries Engagement and Restoration Project Monitoring and Adaptive Management Plan

Chandeleur Islands Fisheries Engagement and Restoration Project Monitoring and Adaptive Management Plan

Prepared by: The National Oceanic and Atmospheric Administration (NOAA)

Introduction

This monitoring and adaptive management (MAM) plan follows guidance provided in the Final Programmatic Damage Assessment and Restoration Plan and Programmatic Environmental Impact Statement (PDARP/PEIS; Deepwater Horizon [DWH] Natural Resource Damage Assessment [NRDA] Trustees, 2016) and the Monitoring and Adaptive Management Procedures and Guidelines Manual Version 2.1 (MAM Manual; DWH NRDA Trustees, 2024) by identifying the monitoring needed to evaluate progress toward meeting project objectives and to support any necessary adaptive management of the project. Where applicable, it identifies key sources of uncertainty and incorporates monitoring data and decision points that address these uncertainties. As not all projects would have the same sources and degrees of uncertainty, this project-specific MAM Plan is scaled according to the level of uncertainty, scope, scale, and Restoration Type associated with this project.

This plan is a living document and will be updated to reflect results and input for the project's stakeholder engagement process, changing conditions, and/or new information. Any future revisions to this MAM Plan would be made publicly available through the Data Integration Visualization Exploration and Reporting (DIVER) Explorer (www.diver.orr.noaa.gov) and accessible through the Trustees' website (www.gulfspillrestoration.noaa.gov).

Project Overview

The Chandeleur Islands are a series of barrier islands in the Gulf of America (Gulf) marking the outer boundary of the Chandeleur Sound off the southeast coast of Louisiana and eastern St. Bernard and Plaquemines Parishes. These islands, spanning nearly 50 miles, are a first line of defense for Louisiana's coastline against tropical cyclones and provide crucial habitat for a multitude of plant and animal species. More than 80 species of flora and fauna are designated as "species of greatest conservation need" on the Chandeleur Islands, some of which are not found anywhere else in Louisiana (Holcomb et al., 2015). However, more than 89% of the island chain has disappeared in the last century due to the combined effects of erosion and inadequate sand supply. The Chandeleur Islands habitats, including associated seagrass beds, are state and federally owned and collectively managed by the U.S. Fish and Wildlife Service via a Memorandum of Agreement with the Louisiana Department of Wildlife and Fisheries as the Breton National Wildlife Refuge (NWR).

This project proposes to fund a planning process to create a specific fisheries engagement and restoration project for the Chandeleur Island area of the Breton NWR. Following development of an action plan, the project would transition into implementation of priority selected actions that will be determined based on stakeholder input. An initial funding allocation would support a process to engage fisheries organizations and subject matter experts and develop a fisheries restoration, communication and outreach plan for the Chandeleur Island area of the Breton NWR. This plan would also support a revision to this preliminary MAM Plan.

The project is located in the Chandeleur Sound off the southeast coast of Louisiana and eastern St. Bernard and Plaquemines Parishes.

The implementing agencies are DOI (U.S. Fish and Wildlife Service) and NOAA. Partner agencies include, but are not limited to, the Gulf States Marine Fisheries Commission, state fishery management partners in Louisiana and Mississippi, and other fisheries organizations.

This project is being implemented as restoration for the DWH NRDA, consistent with the PDARP/PEIS.

- Programmatic goal: Replenish and protect living coastal and marine resources.
- Restoration type: Fish and Water Column Invertebrates (FWCI).
- Restoration approaches: Reduce bycatch and post-release mortality, Reduce impacts of ghost fishing through gear conversion and/or removal of derelict fishing gear.
- Restoration technique: Promote gear conversion, Emerging fishing technologies, illegal fishing, volunteer removal programs.
- Trustee Implementation Groups (TIGs): Louisiana and Open Ocean.
- Restoration plan: Draft Joint Restoration Plan and Environmental Assessment #1: Chandeleur Islands.

Restoration Type Goals and Project Restoration Objectives

The overall goals for this Restoration Type relevant to this project, as identified in the PDARP/PEIS, are to:

- Restore injured fish and invertebrate species across the range of coastal and oceanic zones by reducing direct sources of mortality.
- Increase the health of fisheries by providing fishing communities with methodologies and incentives to reduce impacts to fishery resources.

The specific restoration objectives for this project are:

Objective #1: Reduced post-release mortality in recreational fisheries

Parameter 1-1: Estimates of fishing effort
Parameter 1-2: Estimates of catch and release
Parameter 1-3: Estimates of release survival
Parameter 1-4: Awareness of best angler practices
Parameter 1-5: Organism length by taxon

Objective #2: Reduced bycatch in commercial fisheries

Parameter 2-1: Estimates of fishing effort
Parameter 2-2: Estimates of number or biomass released alive by taxon
Parameter 2-3 Estimates of number or biomass released dead by taxon
Parameter 2-4: Organism length by taxon

Objective #3: Reduced marine debris and vessel related pollution

Parameter 3-1: Area (project footprint)
Parameter 3-2: Debris removed by source, type
Parameter 3-3: Debris prevented from entering system

Objective #4: Fewer interactions between vessels and important fisheries habitats, like seagrass meadows

Parameter 4-1: Education or outreach effort, percent change in awareness
Parameter 4-2: Propeller scar area, depth, length, number

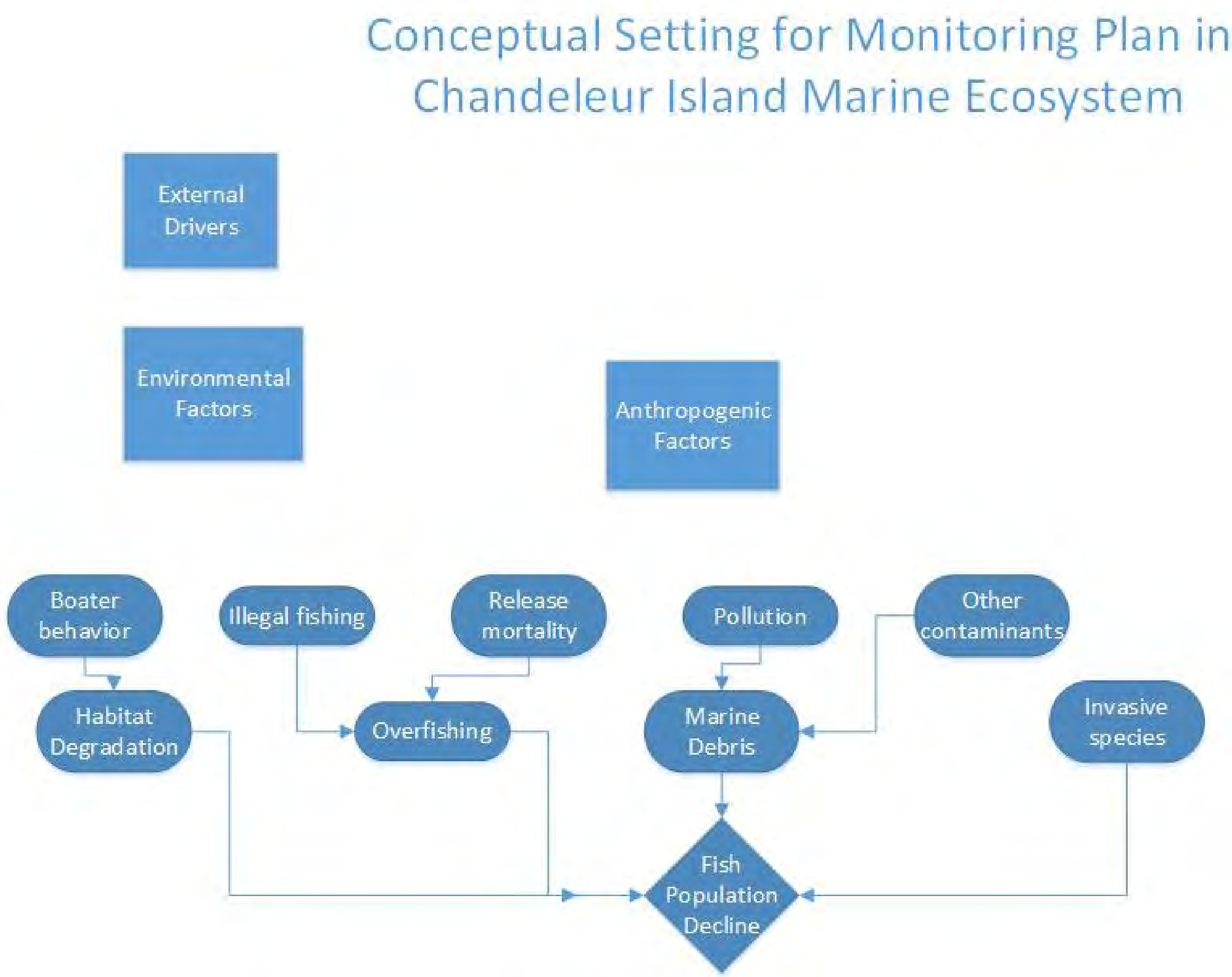
Objective #5: Reduced illegal fishing activities, better compliance of fisheries regulations

Parameter 5-1: Conservation improvements, percent compliance (recreational fisheries)
Parameter 5-2: Conservation improvements, percent compliance (commercial fisheries)

Conceptual Setting

The conceptual setting identifies factors and interactions that may influence the project outcomes. This may include factors affecting whether the project is implemented as planned (e.g., the expected number of samples were obtained), cofactors that may have a significant effect on variance in the data, and factors that may alter the expected outcome of the restoration effort. Understanding the conceptual setting aids in adaptive management of the project, as well as future projects of a similar type by identifying some of these factors and providing the opportunity to anticipate their effects and plan for contingencies.

Chandeleur Sound is a complex ecosystem that supports abundant fish and water column resources. This ecosystem and its fish resources are affected by myriad factors including both natural and anthropogenic, such as climatic, oceanic factors, fishing practices, habitat degradation, pollution and marine debris. This monitoring plan seeks to leverage human use of the ecosystem to support monitoring efforts. Monitoring could include methods that integrate traditional ecological knowledge and citizen science as ways to engage the community and inform restoration planning and success monitoring.



Conceptual Setting for Monitoring Plan in Chandeleur Island Marine Ecosystem
External Drivers
Environmental Factors
Anthropogenic Factors
Boater behavior
Illegal fishing
Release mortality
Pollution
Other contaminants
Habitat Degradation
Overfishing
Marine Debris
Invasive species
Fish Population Decline

Potential Sources of Uncertainty

Potential sources of uncertainty are defined as those that may affect the ability of a project to achieve its restoration objectives. Sources of uncertainty, the degree of uncertainty, and the level of uncertainty associated with projects vary. There are a number of potential sources of uncertainty that could affect project performance and success. Potential sources of uncertainty include:

- Potential fisheries management actions.
- Effects of large-scale environmental perturbations.
- Changes in fishing or ecotourism trends.
- Effectiveness of outreach actions.
- New technologies that influence monitoring.
- Identification of appropriate methods and incentives to encourage behavior change.
- Ability to reach recreational anglers and commercial fishermen with education/outreach strategies.
- Stakeholder priorities for restoration.

Project Monitoring, Performance Criteria, and Potential Corrective Actions

Information gathered through monitoring allows for corrective actions to be made to achieve desired outcomes. Table 4 identifies monitoring parameters, and corrective actions that could be taken if the performance criteria are not met (as defined in NRDA regulations 15 CFR § 990.55(b)(1)(vii)). This table should not be considered all encompassing; rather, it represents a listing of potential actions for each individual parameter to be considered if the Project is not performing as expected once implemented. Other corrective actions may be identified post-implementation and included in an operations and maintenance (O&M) plan. The decision of whether a corrective action should be implemented for the Project should consider the overall outcomes of the restoration project (i.e., looking at the combined evaluation of multiple performance criteria) in order to understand why project performance deviates from the predicted or anticipated outcome. Corrective action may not be taken in all cases based on such considerations. The knowledge gained from this process could also inform future restoration decisions such as the selection, design, and implementation of similar projects.

Table 1 Monitoring Parameters – This table provides potential monitoring parameters for project objectives. Parameters will be updated based upon the engagement process.

Monitoring Parameter (Parameter Detail)	Purpose	Timing, Frequency, Duration of Data Collection	Potential Corrective Action(s)
Objective #1: Reduced post-release mortality in recreational fisheries			
Estimates of fishing effort *Counts or rates*	N/A	Appx Monthly	N/A
Estimates of catch and release *Counts or rates*		Annually	N/A
Estimates of release survival *Rates of survival*	Determine how many anglers implementing best practices and changes over time	Annually	Modify implementation of education and outreach
Awareness of best angler practices	Determine how many anglers are aware of best practices	Annually	Modify the project's education and outreach content
Objective #2: Reduced bycatch in commercial fisheries			
Estimates of fishing effort *Counts or rates*	Performance Monitoring: N/A	Dependent on fishery	N/A
Estimates of number or biomass released alive by taxon	Determine how many fishermen implementing best practices and changes over time	Annually	Modify implementation of education and outreach or technological innovations
Estimates of number or biomass released dead by taxon	Determine how many fishermen implementing best practices and changes over time	Annually	Modify implementation of education and outreach or technological innovations
Organism length by taxon	Used to estimate biomass	Annually	
Objective #3: Reduced marine debris and vessel related pollution			
Area (project footprint)	Determine changes in project scale scope	Three year interval	
Debris removed by source, type	Determine amount of marine debris and changes over time	Three year interval	Modify implementation of education and outreach or technological innovations
Debris prevented from entering system	Determine amount of marine debris and changes over time	Three year interval	Modify implementation of education and outreach or technological innovations

Objective #4: Fewer interactions between vessels and important fisheries habitats, like seagrass meadows			
Education or outreach effort, percent change in awareness	Determine who and the extent of best boater practices to protect habitats	Three year interval	Modify implementation of education and outreach or technological innovations
Propeller scar area, depth, length, number	Determine efficacy of boater education	Annually	Modify implementation of education and outreach or technological innovations
Objective #5: Reduced illegal fishing activities, better compliance of fisheries regulations			
Conservation improvements, percent compliance (recreational fisheries)	Determine awareness of and compliance with fishing regulations		Promote education of fisheries regulations
Conservation improvements, percent compliance (commercial fisheries)	Determine awareness of and compliance with fishing regulations		Promote education of fisheries regulations

Monitoring Schedule

Project monitoring would occur throughout project implementation, with initial activities being conducted within 2 years.

Evaluation

Evaluation of project performance would be conducted to ensure the project is meeting the restoration objectives and inform the need for adaptive management or corrective actions. Specific analyses have not been determined and will be established pending stakeholder engagement.

Evaluation of Project Implementation and Outputs: To be determined

Evaluation of Project Outcomes: To be determined

Adaptive Management

As discussed in the PDARP/PEIS, adaptive management is a form of structured decision-making applied to the management of natural resources in the face of uncertainty (Pastorok et al., 1997; Williams, 2011). It is an iterative process that integrates monitoring and evaluation of management actions with flexible decision-making, where adjustments are made to management approaches based on observed outcomes (NRC, 2004). Within the context of ecological restoration, adaptive management addresses key uncertainties by linking science to restoration decision-making (Steyer and Llewellyn, 2000; Thom et al., 2005). Performance may be evaluated in terms of implementation of the project plan, expected project outputs, or the ability of the project to achieve the desired restoration outcomes.

For this project, the principles of adaptive management would be applied in a number of areas and ways. Evaluations of the MAM data are used to (1) determine whether the project, once implemented, has met its objectives, and (2) inform the need for potential corrective actions (see Table 1). The performance criteria and potential corrective actions described in Table 1 will be adjusted following stakeholder input and over time as the project is implemented.

Data Management

Data collection would occur on an ongoing basis across the Chandeleur system. The data would be compiled as practical and within 18 to 24 months of collection. To the extent practicable, all environmental and biological data generated during monitoring activities would be documented using standardized field datasheets. All data would have proper metadata, including a data dictionary that defines codes and fields used in the dataset; a description of how data were collected; detailed lineages for any data that are standardized, recoded, or otherwise transformed; and other information about the data such as meaning, relationships to other data, origin, usage, and format. Metadata for geospatial data would adhere to Federal Geographic Data Committee (FGDC) standards. All collected data would undergo proper QA/QC protocols, following the process outlined in Section 3 of the MAM Manual Version 2.1. Specific QA/QC procedures would be described in a detailed data management plan that would be available on request. Following QA/QC, NOAA will provide the Louisiana and Open Ocean TIGs time to review the data before making the data publicly available. This project would generate a wide variety of data, and the Implementing Trustees would work with partners, including regional fisheries management bodies and state and federal observer programs to efficiently manage the data. Some data compiled and analyzed as part of this project would be managed using the DIVER Restoration Portal and would be submitted to the portal no more than 2 years after the data are collected.

Data managed in other systems (e.g., recreational fishing data platforms) would be accessible through a link maintained in the DIVER Restoration Portal. Data would be made publicly available, in accordance with the Foundations for Evidence-Based Policymaking Act of 2018. Some of the data collected are protected from public disclosure under federal and state laws, including the Privacy Act and the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and would only be publicly distributed in an aggregated form. In the event of a public records request related to data that are not already publicly available, the Trustee to whom the request is addressed would provide notice to the Louisiana and Open Ocean TIGs prior to releasing any project data that is the subject of the request.

Reporting

MAM activities would be reported in the DIVER Restoration Portal and updated annually to reflect the status of the MAM activities. One interim monitoring report would be developed mid-way through the project. The final monitoring report would be developed within 1 year of monitoring activities being concluded. To the extent practicable, the interim and final monitoring reports would follow the outline in the MAM Manual Version 2.1. These reports would be made publicly available through the DIVER Restoration Portal.

Annual reporting may include:

- A summary of project activities for the year, such as number of individuals educated and gear deployed or number of events held.
- Summarized monitoring data - synthesized data for all efforts during the year.
- Graphics, if applicable, and associated interpretations of the data.
- Comparisons of pre- and post-implementations conditions, as applicable.
- Any uncertainties with management actions.
- Potential data collection issues.
- Reporting on general MAM activities in the DIVER Restoration Portal on an annual basis.
- A Final MAM Report before the project is closed out.

Roles and Responsibilities

DOI and NOAA are the Implementing Trustees for this project and would be responsible for the management of all activities related to project monitoring and adaptive management in cooperation with the Louisiana and Open Ocean TIGs.

Appendix C:

Guidelines for NEPA Impact Determinations

Appendix C: Guidelines for NEPA Impact Determinations

Resource	**Impact Duration**	**Impact Intensity Definitions from Final PDEARP/PEIS**		
		Minor	**Moderate**	**Major**
Geology and Substrates	Short-term: During construction period. Long-term: Over the life of the project or longer.	Disturbance to geologic features or soils could be detectable but could be small and localized. There could be no changes to local geologic features or soil characteristics. Erosion and/or compaction could occur in localized areas.	Disturbance could occur over local and immediately adjacent areas. Impacts to geology or soils could be readily apparent and result in changes to the soil character or local geologic characteristics. Erosion and compaction impacts could occur over local and immediately adjacent areas.	Disturbance could occur over a widespread area. Impacts to geology or soils could be readily apparent and could result in changes to the character of the geology or soils over a widespread area. Erosion and compaction could occur over a widespread area. Disruptions to substrates or soils may be permanent.
Hydrology and Water Quality	Short-term: During construction period. Long-term: Over the life of the project or longer.	Hydrology: The effect on hydrology could be measurable, but it could be small and localized. The effect could only temporarily alter the area's hydrology, including surface and ground water flows. Water quality: Impacts could result in a detectable change to water quality, but the change could be expected to be small and localized. Impacts could quickly become undetectable. State water quality standards as required by the Clean Water Act could not be exceeded.	Hydrology: The effect on hydrology could be measurable, but small and limited to local and adjacent areas. The effect could permanently alter the area's hydrology, including surface and ground water flows. Water quality: Effects to water quality could be observable over a relatively large area. Impacts could result in a change to water quality that could be readily detectable and limited to local and adjacent areas. Change in water quality could persist; however, it could likely not exceed state water quality standards as required by the Clean Water Act.	Hydrology: The effect on hydrology could be measurable and widespread. The effect could permanently alter hydrologic patterns including surface and ground water flows. Water quality: Impacts could likely result in a change to water quality that could be readily detectable and widespread. Impacts could likely result in exceedance of state water quality standards and/or could impair designated uses of a water body.

Resource	Impact Duration	Impact Intensity Definitions from Final PDEARP/PEIS		
		Minor	**Moderate**	**Major**
Hydrology and Water Quality (continued)		Floodplains: Impacts may result in a detectable change to natural and beneficial floodplain values, but the change could be expected to be small and localized. There could be no appreciable increased risk of flood loss including impacts on human safety, health, and welfare. Wetlands: The effect on wetlands could be measurable but small in terms of area and the nature of the impact. A small impact on the size, integrity, or connectivity could occur; however, wetland function could not be affected, and natural restoration could occur if left alone.	Floodplains: Impacts could result in a change to natural and beneficial floodplain values and could be readily detectable but limited to local and adjacent areas. Location of operations in floodplains could increase risk of flood loss, including impacts on human safety, health, and welfare. Wetlands: The action could cause a measurable effect on wetlands indicators (size, integrity, or connectivity) or could result in a permanent loss of wetland acreage across local and adjacent areas. However, wetland functions could only be permanently altered in limited areas.	Floodplains: Impacts could result in a change to natural and beneficial floodplain values that could have substantial consequences over a widespread area. Location of operations could increase risk of flood loss, including impacts on human safety, health, and welfare. Wetlands: The action could cause a permanent loss of wetlands across a widespread area. The character of the wetlands could be changed so that the functions typically provided by the wetland could be permanently lost.
Air Quality	Short-term: During construction period. Long-term: Over the life of the project or longer.	The impact on air quality may be measurable, but could be localized and temporary, such that the emissions do not exceed the Environmental Protection Agency's (EPA's) de minimis criteria for a general conformity determination under the Clean Air Act (40 CFR § 93.153).	The impact on air quality could be measurable and limited to local and adjacent areas. Emissions of criteria pollutants could be at EPA's de minimis criteria levels for general conformity determination.	The impact on air quality could be measurable over a widespread area. Emissions are high, such that they could exceed EPA's de minimis criteria for a general conformity determination.

Resource	Impact Duration	Impact Intensity Definitions from Final PDEARP/PEIS		
		Minor	**Moderate**	**Major**
Noise	Short-term: During construction period. Long-term: Over the life of the project.	Increased noise could attract attention, but its contribution to the soundscape would be localized and unlikely to affect current user activities.	Increased noise could attract attention and contribute to the soundscape including in local areas and those adjacent to the action but could not dominate. User activities could be affected.	Increased noise could attract attention and dominate the soundscape over widespread areas. Noise levels could eliminate or discourage user activities.
Habitats	Short-term: Lasting less than two growing seasons. Long-term: Lasting longer than two growing seasons.	Impacts on native vegetation may be detectable but could not alter natural conditions and could be limited to localized areas. Infrequent disturbance to individual plants could be expected but would not affect local or rangewide population stability. Infrequent or insignificant one-time disturbance to locally suitable habitat could occur, but sufficient habitat could remain functional at both the local and regional scales to maintain the viability of the species. Opportunity for increased spread of non- native species could be detectable but temporary and localized and could not displace native species populations and distributions.	Impacts on native vegetation could be measurable but limited to local and adjacent areas. Occasional disturbance to individual plants could be expected. These disturbances could affect local populations negatively but could not be expected to affect regional population stability. Some impacts might occur in key habitats, but sufficient local habitat could retain function to maintain the viability of the species both locally and throughout its range. Opportunity for increased spread of non- native species could be detectable and limited to local and adjacent areas but could only result in temporary changes to native species population and distributions.	Impacts on native vegetation could be measurable and widespread. Frequent disturbances of individual plants could be expected, with negative impacts to both local and regional population levels. These disturbances could negatively affect rangewide population stability. Some impacts might occur in key habitats, and habitat impacts could negatively affect the viability of the species both locally and throughout its range. Actions could result in the widespread increase of non-native species, resulting in broad and permanent changes to native species populations and distributions.

Resource	Impact Duration	Impact Intensity Definitions from Final PDEARP/PEIS		
		Minor	**Moderate**	**Major**
Wildlife Species (Including Birds)	Short-term: Lasting up to two breeding seasons, depending on length of breeding season. Long-term: Lasting more than two breeding seasons.	Impacts to native species, their habitats, or the natural processes sustaining them could be detectable, but localized, and could not measurably alter natural conditions. Infrequent responses to disturbance by some individuals could be expected, but without interference to feeding, reproduction, resting, migrating, or other factors affecting population levels. Small changes to local population numbers, population structure, and other demographic factors could occur. Sufficient habitat could remain functional at both the local and rangewide scales to maintain the viability of the species. Opportunity for increased spread of non- native species could be detectable but temporary and localized, and these species could not displace native species populations and distributions.	Impacts on native species, their habitats, or the natural processes sustaining them could be measurable but limited to local and adjacent areas. Occasional responses to disturbance by some individuals could be expected, with some negative impacts to feeding, reproduction, resting, migrating, or other factors affecting local population levels. Some impacts might occur in key habitats. However, sufficient population numbers or habitat could retain function to maintain the viability of the species both locally and throughout its range. Opportunity for increased spread of non- native species could be detectable and limited to local and adjacent areas but could only result in temporary changes to native species population and distributions.	Impacts on native species, their habitats, or the natural processes sustaining them could be detectable and widespread. Frequent responses to disturbance by some individuals could be expected, with negative impacts to feeding, reproduction, migrating, or other factors resulting in a decrease in both local and rangewide population levels and habitat type. Impacts could occur during critical periods of reproduction or in key habitats and could result in direct mortality or loss of habitat that might affect the viability of a species. Local population numbers, population structure, and other demo-graphic factors might experience large changes or declines. Actions could result in the widespread increase of non-native species resulting in broad and permanent changes to native species populations and distributions.

Resource	Impact Duration	Impact Intensity Definitions from Final PDEARP/PEIS		
		Minor	**Moderate**	**Major**
Marine and Estuarine Fauna (Fish, Shellfish, Benthic Organisms)	Short-term: Lasting up to two spawning seasons, depending on length of season. Long-term: Lasting more than two spawning seasons.	Impacts could be detectable and localized but small. Disturbance of individual species could occur; however, there could be no change in the diversity or local populations of marine and estuarine species. Any disturbance could not interfere with key behaviors such as feeding and spawning. There could be no restriction of movements daily or seasonally. Opportunity for increased spread of non- native species could be detectable but temporary and localized and these species could not displace native species populations and distributions.	Impacts could be readily apparent and result in a change in marine and estuarine species populations in local and adjacent areas. Areas being disturbed may display a change in species diversity; however, overall populations could not be altered. Some key behaviors could be affected but not to the extent that species viability is affected. Some movements could be restricted seasonally. Opportunity for increased spread of non- native species could be detectable and limited to local and adjacent areas but could only result in temporary changes to native species population and distributions.	Impacts could be readily apparent and could substantially change marine and estuarine species populations over a widescale area, possibly river-basin-wide. Disturbances could result in a decrease in fish species diversity and populations. The viability of some species could be affected. Species movements could be seasonally constrained or eliminated. Actions could result in the widespread increase of non-native species resulting in broad and permanent changes to native species populations and distributions.

Resource	Impact Duration	**Impact Intensity Definitions from Final PDEARP/PEIS**		
		Minor	**Moderate**	**Major**
Protected Species	Short-term: Lasting up to one Breeding/growing season. Long-term: Lasting more than one breeding/growing season.	Impacts on protected species, their habitats, or the natural processes sustaining them could be detectable, but small and localized, and could not measurably alter natural conditions. Impacts could likely result in a "may affect, not likely to adversely affect" determination for at least one listed species.	Impacts on protected species, their habitats, or the natural processes sustaining them could be detectable and some alteration in the numbers of protected species or occasional responses to disturbance by some individuals could be expected, with some negative impacts to feeding, reproduction, resting, migrating, or other factors affecting local and adjacent population levels. Impacts could occur in key habitats, but sufficient population numbers or habitat could remain functional to maintain the viability of the species both locally and throughout their range. Some disturbance to individuals or impacts to potential or designated critical habitat could occur. Impacts could likely result in a "may affect, likely to adversely affect" determination for at least one listed species. No adverse modification of critical habitat could be expected.	Impacts on protected species, their habitats, or the natural processes sustaining them could be detectable, widespread, and permanent. Substantial impacts to the population numbers of protected species, or interference with their survival, growth, or reproduction could be expected. There could be impacts to key habitat, resulting in substantial reductions in species numbers. Results in an "is likely to jeopardize proposed or listed species/adversely modify proposed or designated critical habitat (impairment)" determination for at least one listed species.

Resource	Impact Duration	Impact Intensity Definitions from Final PDEARP/PEIS		
		Minor	**Moderate**	**Major**
Socioeconomics	Short-term: During construction period. Long-term: Over the life of the project or longer.	A few individuals, groups, businesses, properties, or institutions could be affected. Impacts could be small and localized. These impacts are not expected to substantively alter social and/or economic conditions.	Many individuals, groups, businesses, properties, or institutions could be affected. Impacts could be readily apparent and detectable in local and adjacent areas and could have a noticeable effect on social and/or economic conditions.	A large number of individuals, groups, businesses, properties, or institutions could be affected. Impacts could be readily detectable and observed, extend over a widespread area, and have a substantial influence on social and/or economic conditions.
Cultural Resources	Short-term: During construction period. Long-term: Over the life of the project or longer.	The disturbance of a site(s), building, structure, or object could be confined to a small area with little, if any, loss of important cultural information potential.	Disturbance of a site(s), building, structure, or object not expected to result in a substantial loss of important cultural information.	Disturbance of a site(s), building, structure, or object could be substantial and may result in the loss of most or all its potential to yield important cultural information.
Infrastructure	Short-term: During construction period. Long-term: Over the life of the project or longer.	The action could affect public services or utilities, but the impact could be localized and within operational capacities. There could be negligible increases in local daily traffic volumes resulting in perceived inconvenience to drivers but no actual disruptions to traffic.	The action could affect public services or utilities in local and adjacent areas and the impact could require the acquisition of additional service providers or capacity. Detectable increase in daily traffic volumes (with slightly reduced speed of travel), resulting in slowed traffic and delays, but no change in level of service (LOS). Short service interruptions (temporary closure for a few hours) to roadway and railroad traffic could occur.	The action could affect public services or utilities over a widespread area resulting in the loss of certain services or necessary utilities. Extensive increase in daily traffic volumes (with reduced speed of travel) resulting in an adverse change in LOS to worsened conditions. Extensive service disruptions (temporary closure of one day or more) to roadways or railroad traffic could occur.

Resource	Impact Duration	Impact Intensity Definitions from Final PDEARP/PEIS		
		Minor	**Moderate**	**Major**
Land and Marine Management	Short-term: During construction period. Long-term: Over the life of the project or longer.	The action could require a variance or zoning change or an amendment to a land use, area comprehensive, or management plan, but could not affect overall use and management beyond the local area.	The action could require a variance or zoning change or an amendment to a land use, area comprehensive, or management plan, and could affect overall land use and management in local and adjacent areas.	The action could cause permanent changes to and conflict with land uses or management plans over a widespread area.
Tourism and Recreational Use	Short-term: During construction period. Long-term: Over the life of the project or longer.	There could be partial developed recreational site closures to protect public safety. The same site capacity and visitor experience could remain unchanged after construction. The impact could be detectable and/or could only affect some recreationists. Users could likely be aware of the action but changes in use could be slight. There could be partial closures to protect public safety. Impacts could be local. There could be a change in local recreational opportunities; however, it could affect relatively few visitors or could not affect any related recreational activities.	There could be complete site closures to protect public safety. However, the sites could be reopened after activities occur. There could be slightly reduced site capacity. The visitor experience could be slightly changed but still available. The impact could be readily apparent and/or could affect many recreationists locally and in adjacent areas. Users could be aware of the action. There could be complete closures to protect public safety. However, the areas could be reopened after activities occur. Some users could choose to pursue activities in other available local or regional areas.	All developed site capacity could be eliminated because developed facilities could be closed and removed. Visitors could be displaced to facilities over a widespread area and visitor experiences could no longer be available in many locations. The impact could affect most recreationists over a widespread area. Users could be highly aware of the action. Users could choose to pursue activities in other available regional areas.

Resource	Impact Duration	Impact Intensity Definitions from Final PDEARP/PEIS		
		Minor	**Moderate**	**Major**
Fisheries and Aquaculture	Short-term: During construction period. Long-term: Over the life of the project or longer.	A few individuals, groups, businesses, properties, or institutions could be affected. Impacts could be small and localized. These impacts are not expected to substantively alter social and/or economic conditions.	Many individuals, groups, businesses, properties, or institutions could be affected. Impacts could be readily apparent and detectable in local and adjacent areas and could have a noticeable effect on social and/or economic conditions.	A large number of individuals, groups, businesses, properties, or institutions could be affected. Impacts could be readily detectable and observed, extend over a widespread area, and could have a substantial influence on social and/or economic conditions.
Marine Transportation	Short-term: During construction period. Long-term: Over the life of the project or longer.	The action could affect public services or utilities, but the impact could be localized and within operational capacities. There could be negligible increases in local daily marine traffic volumes, resulting in perceived inconvenience to operators but no actual disruptions to transportation.	The action could affect public services or utilities in local and adjacent areas, and the impact could require the acquisition of additional service providers or capacity. Detectable increase in daily marine traffic volumes could occur (with slightly reduced speed of travel), resulting in slowed traffic and delays. Short service interruptions could occur (temporary delays for a few hours).	The action could affect public services utilities over a widespread area resulting in the loss of certain services or necessary utilities. Extensive increase in daily marine traffic volumes could occur (with reduced speed of travel), resulting in extensive service disruptions (temporary closure of one day or more).
Aesthetics and Visual Resources	Short-term: During construction period. Long-term: Over the life of the project or longer.	There could be a change in the view shed that was readily apparent but could not attract attention, dominate the view, or detract from current user activities or experiences.	There could be a change in the view shed that was readily apparent and attracts attention. Changes could not dominate the viewscape, although they could detract from the current user activities or experiences.	Changes to the characteristic views could dominate and detract from current user activities or experiences.

Resource	Impact Duration	Impact Intensity Definitions from Final PDEARP/PEIS		
		Minor	**Moderate**	**Major**
Public Health and Safety, Including Flood and Shoreline Protection	Short-term: During construction period. Long-term: Over the life of the project or longer.	Actions could not result in 1) soil, ground water, and/or surface water contamination; 2) exposure of contaminated media to construction workers or transmission line operations personnel; and/or 3) mobilization and migration of contaminants currently in the soil, ground water, or surface water at levels that could harm the workers or general public. Increased risk of potential hazards (e.g., increased likelihood of storm surge) to visitors, residents, and workers from decreased shoreline integrity could be temporary and localized.	Project construction and operation could result in 1) exposure, mobilization and/or migration of existing contaminated soil, ground water, or surface water to an extent that requires mitigation; and/or 2) could introduce detectable levels of contaminants to soil, ground water, and/or surface water in localized areas within the project boundaries such that mitigation/remediation is required to restore the affected area to the preconstruction conditions. Increased risk of potential hazards to visitors, residents, and workers from decreased shoreline integrity could be sufficient to cause a permanent change in use patterns and area avoidance in local and adjacent areas.	Actions could result in 1) soil, ground water, and/or surface water contamination at levels exceeding federal, state, or local hazardous waste criteria, including those established by 40 CFR § 261; 2) mobilization of contaminants currently in the soil, ground water, or surface water, resulting in exposure of humans or other sensitive receptors such as plants and wildlife to contaminant levels that could result in health effects; and 3) the presence of contaminated soil, ground water, or surface water within the project area, exposing workers and/or the public to contaminated or hazardous materials at levels exceeding those permitted by the federal Occupational Safety and Health Administration (OSHA) in 29 CFR § 1910. Increased risk of potential hazards to visitors, residents, and workers from decreased shoreline integrity could be substantial and could cause permanent changes in use patterns and area avoidance over a widespread area.

Appendix D:

National Environmental Policy Act Supporting Documentation Report

APPENDIX D. NATIONAL ENVIRONMENTAL POLICY ACT SUPPORTING DOCUMENTATION REPORT

This Appendix contains the National Environmental Policy Act (NEPA) supporting documentation that informs the NEPA analysis presented in Chapter 4. This Appendix presents the detailed analysis for each of the Habitat Restoration alternatives impacts on physical, biological, and socioeconomic resources within this Joint Restoration Plan and Environmental Assessment #1 (Joint RP/EA #1). The Appendix is organized as follows.

D.1 Resources Analyzed in this Joint RP/EA #1

The following sections describe the affected environment by resource category followed by the environmental consequences of each Chandeleur Islands Habitat Restoration Alternative. For purposes of this document, the proposed action is considered implementation of the Preferred Alternative, Habitat Restoration Alternative 5, for the Chandeleur Islands Habitat Restoration Project. Three non-preferred alternatives (Habitat Restoration Alternatives 2, 3, and 4) and a No Action Alternative (Alternative 1) are also analyzed. See Chapter 2 for full details on each alternative.

The No Action Alternative (Alternative 1) is analyzed first as a basis for comparison of potential environmental consequences of the action alternatives, followed by the Preferred Alternative (Alternative 5) and the non-preferred alternatives (Alternatives 2, 3, and 4). As noted in Chapter 2, all Project design specifications (for example, acreage, linear feet, etc.) discussed in this document are approximate and would continue to be refined through final Engineering and Design (E&D); however, the environmental consequences would not be expected to diverge from what is analyzed in this Joint RP/EA #1.

D.1.1 Physical Environment

This section discusses resources of the natural and physical environment including geology, soils, topography, hydrology, water quality, noise, and air quality.

D.1.1.1 Geology and Substrates

Affected Environment

The Chandeleur Islands formed through the evolution of the St. Bernard delta complex of the Mississippi River between 1,800 and 2,000 years ago when the river channel transitioned to a new gradient through present day southern Louisiana. Over time, waves reworked the sandy tributary channel sediments from the abandoned delta lobe, turning it into a shoal-tidal inlet system that accumulated sand and eventually emerged to form barrier islands (Flocks et al., 2022). Barrier islands are characterized by their typically low landform and narrow width that are elongated in the alongshore direction (Miner et al., 2021).

The Chandeleur Islands are the oldest barrier island system in the Mississippi River Delta plain that is still emergent. The Chandeleur Islands chain is composed of a 50-mile-long arc-shaped barrier island chain, which includes the northern island arc that extends from Hewes Point in the north to Monkey Bayou in the south; Curlew and Grand Gosier Islands south of Monkey Bayou; and Breton Island (Miner et al., 2021).

The Chandeleur Islands system is in a constant state of change through barrier island dynamics such as wave dominated processes that form beach ridges and overwash deposits stabilized by colonizing marsh vegetation (Flocks et al., 2022). Sediment transport on and around the islands is driven by two processes: 1) littoral transport along the eastern and western faces of the islands, driven by wave action, and 2) overwash transport of sediment from the eastern face to the western face of the islands, which occurs when storm induced waves exceed the height of a dune and transport sand from the top of the dune inland (Flocks et al., 2022; USGS, 2024).

Geologic processes no longer contribute new sediment to the Chandeleur Islands; as such, the islands have experienced accelerating land loss during the last decade, resulting in an average of 31 feet of shoreline change per year, which is 3 times the Louisiana state average (Flocks et al., 2022). These changes are influenced by severe storm events (such as Hurricanes Camille and Katrina) and exacerbated by sea-level rise and scarcity of sediments to nourish the island chain, resulting in increased erosion and the inability to maintain many island subaerial features (Suir et al., 2016; Suir and Sasser, 2019). For example, Hurricane Katrina segmented the island arc into multiple small marsh islets separated by wide hurricane-cut tidal passes, resulting in much less vegetation (mangroves) and elevation (dunes) on the islands that would otherwise impede overwash processes (Miner et al., 2021; Flocks et al., 2022). Over time, this continued land loss could lead to conversion of the islands into shallow sand shoals (Flocks et al., 2022).

The northern islands are more stable due to higher sand content and robust back barrier marshes compared to the southern islands that are sand-starved and lack significant back barrier marshes (Miner et al., 2021). Back barrier marshes provide a platform for sand deposition during overwash processes, which prevents submergence during post-storm recovery (SWCA, 2023). For instance, the northern expanses are characterized by wide sandy beaches at or near intertidal elevations, but this topography varies along the 14 miles southward extension of the North Chandeleur Island as the beaches become narrower with broken vegetated dunes, marshes, and mangrove stands expanding to the western side (Byrnes et al., 2018; Miner et al., 2021). However, as the northern island chain has undergone rapid land loss by thinning and shortening over the past 3 decades, the islands have reached a collapsed stage where sand previously sequestered in beach and dune deposits is increasingly eroded (Miner et al., 2021; Flocks et al., 2022). As such, the largest sediment loss from the barrier island system in the Chandeleur Islands is through sand transport north to Hewes Point from tidal activity (Ellis and Stone, 2006; Flocks et al., 2022). Moreover, the New Harbor Island is a small intertidal 35-acre mangrove stand located on the southwest side of the North Chandeleur Island that is exposed to winds and wave actions through the Chandeleur Sound, making it vulnerable to complete island submergence.

In 2023, soil borings were performed to determine the existing substrate (soils) at different sites within the Project area. These soil borings revealed that the east side of North Chandeleur Island consists of loose to firm sandy soils with some silt and clays extending from 14 to 33 feet below the surface. The shallow water areas contain sandy soil with silt and clay extending from 14 to 58 feet below the surface of the water bottom. Borings performed in the Chandeleur Sound contain mostly loose to dense sand with silt and clays. Additionally, borings performed near New Harbor Island showed 2 to 8 feet of loose sandy silt overlaying very soft to soft clay with some silt and sand (GeoEngineers, 2024).

Results from a high-resolution geophysical and survey (Ocean Surveys, Inc. [OSI] Report No. 23ES011) performed in the Project area found that the shallow subsurface of the pump-out area is characterized by unconsolidated sediments composed primarily of varying assemblages of silt and clay with a slight buildup of sand nearshore and in the vicinity of a shoal encroaching into the conveyance corridor near New Harbor Island. The Hewes Point Borrow Area (HPBA) contains 30.9 million cubic yards (MCY) of sand and is composed of 93 percent sand, mainly fine sand with shell overlaying silty sand with clay, that is greater than the #200 sieve and has a median grain size of 0.13 millimeters (OSI, 2024).

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented. There would be no adverse impacts in the short term as geology and substrate conditions would remain the same as existing conditions. In the long term, the lack of sediment input combined with continued subsidence and sea-level rise, as described above, would contribute to continued shoreline erosion, accelerated land loss, and increased inundation of North Chandeleur and New Harbor Islands which would leave the islands more vulnerable to breaching and segmentation during storm events. Continued land loss could lead to conversion of the islands into shallow sand shoals. Therefore, under the No Action Alternative, impacts on geology and substrates would be adverse, major, and long term.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Short-term, minor to moderate, adverse impacts on terrestrial substrates would be expected during construction of the Preferred Alternative, such as localized soil disturbances and compaction from sediment placement and the use of several types of land-based earth-moving equipment and transportation equipment during site preparation and fill activities. Short-term, minor to moderate, adverse impacts on aquatic substrates may result from the use of sea-borne equipment during site preparation and excavation activities at the HPBA. The scale of these terrestrial and underwater impacts under the Preferred Alternative would be slightly greater than the other action alternatives, as the footprint is larger, the quantity of fill material is greater (see Table D-1), and the construction duration is longer. Construction activities for the Preferred Alternative are estimated to last 868 days (CEC, 2024a).

Table D-1. Total Estimated Sediment Excavation Volumes

Alternative	Required Excavated Volume (cubic yards)
Alternative 1 – No Action	0
Alternative 5 – Preferred	14,297,412
Alternative 2	10,969,800
Alternative 3	10,888,920
Alternative 4	11,018,880

Moderate, long-term, adverse impacts on aquatic substrates would result from dredging activities that would remove material from the HPBA. An estimated 14,297,412 cubic yards (cy) of material would be dredged from the HPBA (CEC, 2024a; OSI, 2024). However, while this removal of substrate from the HPBA would be moderate and long term (lasting longer than the duration of Project construction), it would likely not be a permanent impact because littoral transport of material from subsequent erosion of North Chandeleur Island would redeposit material in the HPBA over time.

The anticipated method for mining the HPBA and conveying it to the placement sites would be a hydraulic cutterhead dredge with booster pumps, hopper dredge, or cutterhead dredge-scow barge operation. The in-water construction activities would result in localized disturbances on aquatic substrates, constituting short-term and minor, adverse impacts. There would be anticipated minor to moderate, short-term, adverse impacts on soils along the nearshore conveyance corridor and on the three offshore pump-out areas and associated offshore conveyance corridors resulting from ground disturbance from placement of material and dredge outfall pipe as well as from the earthwork required for site preparation and construction activities. The sediment pipeline installed within the conveyance corridors and pump-out areas would not require excavation for pipeline installation, as the sediment pipelines would be placed directly on the sea floor. There could be short-term and minor adverse impacts on the seafloor from strumming of the pipeline, however, these impacts would be minor and would not be expected to lead to scouring because the Project could anchor or ballast the pipelines (for example implementing weighted coatings, weighted collars or weighted mats) to reduce their movement if needed. There would be short-term and minor adverse impacts from the dredging of temporary access channels to provide construction access to North Chandeleur and New Harbor Islands for equipment and personnel, which would be refilled with side-cast material at the end of construction.

The Preferred Alternative would create and restore approximately 2,466 acres of the Chandeleur Islands, including a total of approximately 1,689 acres of beach and dune habitat and approximately 777 acres of marsh habitat. While placement of large quantities of fill material on and adjacent to both islands would cause short-term, minor to moderate, adverse impacts on the existing substrates, this fill material placement, vegetation planting, and installation of sand fencing would help stabilize terrestrial and underwater soils and reduce erosion in the long term by restoring and increasing soil surface, resulting in an overall long-term, beneficial impact on substrates, contributing to the restoration of geomorphologic and ecologic form and function. There would also be long-term, beneficial impacts on New Harbor Island from permanently converting bottom sediment substrate to rock, which would protect the substrate and geology of the shoreline of New Harbor Island and create habitat. The Preferred Alternative is expected to result in long-term benefits to sediments and soils in the Project area for a longer period than the other action alternatives.

Overall, the Preferred Alternative would result in short-term and long-term, minor to moderate, adverse impacts on geology and terrestrial and aquatic substrates during construction activities and long-term, beneficial impacts on geology and substrates from an expansion in the island's footprint, higher elevation, and reduced erosion.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Similar to the Preferred Alternative, short-term and long-term, minor to moderate, adverse impacts on terrestrial and aquatic substrates would be expected during construction of Alternative 2, but the impacts would be less than those in the Preferred Alternative because construction activities would cover a smaller area and for a shorter duration (752 days).

Alternative 2 would create and restore approximately 2,087 acres of the Chandeleur Islands, including a total of approximately 1,510 acres of beach and dune habitat and approximately 613 acres of marsh habitat. Fill material type would be the same as in the Preferred Alternative and would help stabilize soils and reduce erosion in the long term by restoring and increasing soil surface. Long-term, beneficial impacts would be similar to those described for the Preferred Alternative, except that Alternative 2 would result in less placed volume retention in the fill areas on North Chandeleur Island. Like the Preferred Alternative, there would be also long-term, beneficial impacts on the breakwater and revetment features in New Harbor Island from permanent changes in substrate from converting bottom sediment to rock, which would protect the substrate and geology of the shoreline in New Harbor Island and create habitat.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Similar to the Preferred Alternative, short-term and long-term, minor to moderate, adverse impacts on terrestrial and aquatic substrates would be expected during construction of Alternative 3, but the impacts would be less than those in the Preferred Alternative because construction activities would cover a smaller area and for a shorter duration (749 days).

Alternative 3 would create and restore approximately 2,148 acres of the Chandeleur Islands, including a total of approximately 1,341 acres of beach and dune habitat and approximately 843 acres of marsh habitat. Fill material type would be the same as in the Preferred Alternative and would help stabilize soils and reduce erosion in the long term by restoring and increasing soil surface. Long-term, beneficial impacts would be similar to those described for the Preferred Alternative, except that Alternative 3 would result in less placed volume retention in the fill areas on North Chandeleur Island. Like the Preferred Alternative, there would also be long-term, beneficial impacts on the breakwater and revetment features in New Harbor Island from permanent changes in substrate from converting bottom sediment to rock, which would protect the substrate and geology of the shoreline in New Harbor Island and create habitat.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Similar to the Preferred Alternative, short-term and long-term, minor to moderate, adverse impacts on geology and terrestrial and aquatic substrates would be expected during construction of Alternative 4, but the impacts would be less than those in the Preferred Alternative because construction activities would cover a smaller area and for a shorter duration (754 days).

Alternative 4 would create and restore a total of approximately 1,974 acres of the Chandeleur Islands, including approximately 1,397 acres of beach and dune habitat and approximately 613 acres of marsh. The fill material type is the same as the Preferred Alternative and would help stabilize soils and reduce erosion in the long term by restoring and increasing soil surface. Long-term, beneficial impacts would be similar to those described for the Preferred Alternative, except that Alternative 4 would result in less placed volume retention in the fill areas on North Chandeleur Island. Like the Preferred Alternative, there would also be long-term, beneficial impacts on the breakwater and revetment features in New Harbor Island from permanent changes in substrate from converting bottom sediment to rock, which would protect the substrate and geology of the shoreline in New Harbor Island and create habitat.

D.1.1.2 Hydrology and Water Quality

<u>Affected Environment</u>

The Chandeleur Islands are part of the Pontchartrain Basin, which is an abandoned delta generally bounded by the Pleistocene Terrace on the north and west, by Chandeleur Sound on the east, and by the Mississippi River and the disposal area of the Mississippi River Gulf Outlet on the south (CWPPRA, 2024). The major tidal inlets in the Chandeleur Islands system include the inlet north of Hewes Point and south of Breton Island and are responsible for the majority of tidal flow into and out of Chandeleur and Breton Sounds and the Pontchartrain Basin (Miner et al., 2021).

Barrier islands influence the hydrology of the nearshore environment in various ways. Barrier islands dissipate wave energy, thereby reducing inland surge and wave propagation (Stone et al., 2005). Conversely, erosion and breaching of barrier islands allow for increased tidal exchange which enlarges existing tidal inlets and can create new inlets, further exacerbating shoreline erosion (Georgiou et al., 2005).

The Chandeleur Islands regulate the balance of freshwater from the Mississippi River with saltwater from the Gulf of America (the Gulf) (Flocks et al., 2022). While the more southern islands of the barrier island chain (Curlew Island, Grand Gosier Island, and Breton Island) are close to major outlets of the Mississippi River (approximately 8 miles) and receive seasonal freshwater inputs that increase nutrient and turbidity levels in the vicinity of the southern islands, the northern island chain (North Chandeleur Island, New Harbor Island, and Freemason Island) is not subject to substantial freshwater influence or nutrient inputs from the Mississippi River, Pearl River, Lake Pontchartrain, or other freshwater outlets (SWCA, 2023).

Previous in situ water quality measurements indicate that pH, water, salinity, and dissolved oxygen in the Project area were typical of a shallow, coastal environment with limited anthropogenic influence, and indicated overall good water quality (SWCA, 2023). The Chandeleur Islands modulate estuarine salinities in the region by offering a natural barrier that blocks the influx of high-salinity waters of the Gulf, preventing them from penetrating further into the Chandeleur Sound and being transported into the Mississippi Sound (Miner et al., 2021). Based on the 2024 Louisiana Water Quality Inventory Integrated Report (LDEQ, 2024), the proposed Project area is in the coastal zone boundary and the Chandeleur Sound (subsegment LA042201_00). The subsegment is listed as fully supporting the designated use for fish and wildlife propagation, not supporting primary contact recreation, and insufficient data for making a reliable determination for secondary contact recreation and oyster propagation. The cause of water quality impairment for primary contact recreation is enterococcus, the source of which is unknown. Enterococcus was cited as the cause of water quality impairment for primary contact recreation for this subsegment in the 2022 and 2020 Louisiana Water Quality Inventory Integrated Reports as well.

Water depths vary within the Project area. Open water areas are shallower closer to islands and shoals and become deeper with distance either into the Gulf or toward the mainland. For example, bathymetric surveys of the proposed northern offshore conveyance corridor and pump-out area showed that water depths on the seaward side of North Chandeleur Island gradually increase from the shoreline to approximately 40 feet at the eastern extent of the pump-out area. Water depths within the limits of the HPBA range from approximately 12 to 44 feet (OSI, 2024).

The Project area is located within the Federal Emergency Management Agency (FEMA)-designated Flood Zone V, which is subject to inundation by the 1-percent annual chance flood event (FEMA, 2024). Significant wave heights (defined as the mean wave height of the highest third of the waves) along the Project area have a peak of 1.5 feet on average, with less frequent waves higher than 3.3 feet occurring approximately 4 percent of the year and waves higher than 6.6 feet occurring approximately 1 percent of the year (Miner et al., 2021).

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term and long-term adverse impacts on water quality and hydrology associated with construction of the action alternatives would not occur. However, over the long term, the continued land loss discussed in Section D.1.1.1 would make North Chandeleur and New Harbor Islands more susceptible to inundation and lead to increased tidal exchange in the Project area, which could lead to increased salinities in Chandeleur Sound due to overtopping and inundation (Schindler, 2010). Overall, the No Action Alternative would have a long-term, moderate, adverse impact on the ongoing hydrology and water quality trends in the Project area.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

In the short term, sediment disturbance during dredge and fill operations that would occur during construction would result in localized and temporary increases in suspended sediment concentrations and turbidity in the work areas, representing a short-term, minor, adverse impact on water quality. These impacts are expected to be slightly greater under the Preferred Alternative than the other action alternatives because of the larger construction area and longer construction period (868 days) but would still be considered short term and minor. These dredge and fill operations during the construction period could also result in minor changes in dissolved oxygen, nutrients, temperature, and salinity in the immediate vicinity of sediment disturbance. However, these impacts would be temporary, limited to periods of active dredging, and are expected to dissipate rapidly after the construction period.

The use of different types of sea-borne equipment, land-based earth-moving equipment, and transportation equipment during construction could result in minor to moderate, short-term, adverse impacts on water quality due to potential fuel leaks or vehicle fluid leaks. The severity of the impact would depend upon the quantity and type of material released. Construction debris would be disposed of properly, and construction would comply with applicable permit conditions, including any requirements for the protection of water quality. Best management practices (BMPs), including vehicle maintenance and implementation of measures in a Spill Prevention, Response, and Reporting Plan, would be implemented to minimize the potential for spills and leaks of hazardous materials. These construction BMPs, in addition to other avoidance and mitigation measures as required by state and federal regulatory agencies, would minimize hydrology and water quality impacts.

Once constructed, the Project would provide long-term, beneficial impacts on water quality due to the presence of the breakwater and revetment features in New Harbor Island and vegetation plantings within the beach, dune, and marsh features on North Chandeleur Island. The breakwater and revetment features and plantings would be expected to reduce turbidity from potential island erosion. The breakwater and revetment features could also serve as habitat for filter feeders such as barnacles growing over time that would improve water quality. The Preferred Alternative would also create areas of marsh and sediments that could support natural physical, chemical, and biological processes that improve water quality via nutrient exchange (O'Donnell et al., 2018). The constructed habitat on North Chandeleur Island would protect and enhance adjacent seagrass beds, which would further improve water quality as submerged aquatic vegetation (SAV) stabilizes water bottom sediment. The Project would also provide long-term, beneficial impacts on hydrology by increasing island longevity which, in turn would prolong the barrier island system's ability to regulate tidal exchange and salinity in Chandeleur Sound.

According to the Louisiana Water Quality Inventory (LDEQ, 2024), there is insufficient data available to determine the suspected cause of increased enterococcus for subsegment LA042201_00. A potential contributing cause could be the presence of avian populations that utilize the Chandeleur Islands. Bird populations are expected to increase as a result of the proposed Project, which could increase concentrations of avian fecal matter in waters surrounding the area, causing a long-term, minor impact on water quality in the vicinity of the island. Water quality in the subsegment LA042201_00 would be expected to continue to fully support the designated use for fish and wildlife propagation and not support primary contact recreation (LDEQ, 2024).

Overall, the Preferred Alternative would result in short-term, minor to moderate, adverse impacts on hydrology and water quality during construction activities; long-term, minor, adverse impacts on water quality from continued contribution of avian fecal matter; long-term, beneficial impacts on water quality from reduced erosion, reduced turbidity, and potential growth of filter feeders on the breakwater and revetment features; and long-term, beneficial impacts on hydrology through increased island longevity.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Similar to the Preferred Alternative, short-term, minor to moderate, adverse impacts on hydrology and water quality would be expected during construction of Alternative 2, but the impacts would be less than those in the Preferred Alternative because construction activities would cover a smaller area and for a shorter duration (752 days).

After construction is complete, impacts would be similar to those described for the Preferred Alternative resulting in long-term, minor, adverse impacts on water quality from continued contribution of avian fecal matter; long-term, beneficial impacts on water quality from reduced erosion, reduced turbidity, and potential growth of filter feeders on the breakwater and revetment features; and long-term, beneficial impacts on hydrology through increased island longevity.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Similar to the Preferred Alternative, short-term, minor to moderate, adverse impacts on hydrology and water quality would be expected during construction of Alternative 3, but the impacts would be less than those in the Preferred Alternative because construction activities would cover a smaller area and for a shorter duration (749 days).

After construction is complete, impacts would be similar to those described for the Preferred Alternative resulting in long-term, minor, adverse impacts on water quality from continued contribution of avian fecal matter; long-term, beneficial impacts on water quality from reduced erosion, reduced turbidity, and potential growth of filter feeders on the breakwater and revetment features; and long-term, beneficial impacts on hydrology through increased island longevity.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Similar to the Preferred Alternative, short-term, minor to moderate, adverse impacts on hydrology and water quality would be expected during construction of Alternative 4, but the impacts would be less than those in the Preferred Alternative because construction activities would cover a smaller area and for a shorter duration (754 days).

After construction is complete, impacts would be similar to those described for the Preferred Alternative resulting in long-term, minor, adverse impacts on water quality from continued contribution of avian fecal matter; long-term, beneficial impacts on water quality from reduced erosion, reduced turbidity, and potential growth of filter feeders on the breakwater and revetment features; and long-term, beneficial impacts on hydrology through increased island longevity.

D.1.1.3 Air Quality

<u>Affected Environment</u>

In accordance with the Clean Air Act of 1970 (as amended), the U.S. Environmental Protection Agency (USEPA) developed the National Ambient Air Quality Standards (NAAQS) that list six atmospheric criteria pollutants considered harmful to public health: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone(O_3), particulate matter (PM), and sulfur dioxide (SO_2). The primary NAAQS are established to protect public health; secondary standards also provide protection against decreased visibility and damage to animals, crops, vegetation, and buildings. The Louisiana Department of Environmental Quality (LDEQ) is responsible for regulating and ensuring compliance with the Clean Air Act in Louisiana. The USEPA is the regulatory authority for air pollution sources on the Outer Continental Shelf, although pollution sources within 25 miles of the state seaward boundary are required to comply with the air quality requirements of the corresponding onshore area (in this case, LDEQ requirements). For compliance purposes, geographic areas within the United States are classified as either in attainment, unclassifiable, or nonattainment for air quality. Geographic areas that have all six criteria pollutants below NAAQS are considered in attainment, whereas areas exceeding these levels are considered nonattainment areas. A designation of unclassifiable applies to geographic areas which cannot be classified due to lack of available information. In nonattainment areas, USEPA requires states to develop and/or revise a state implementation plan to ensure the standards would be attained.

The Project would be located in St. Bernard Parish, Louisiana. USEPA has determined that St. Bernard Parish is designated as nonattainment for SO_2 and in attainment for all other criteria pollutants (USEPA, 2024a). However, St. Bernard Parish is classified as a Section 185A maintenance area for the 1979 1-hour ozone standard, which was revoked for all areas except the 8-Hour Ozone nonattainment Early Action Compact (EAC) areas on June 15, 2005 (USEPA, 2024a). St. Bernard Parish is not an 8-Hour Ozone nonattainment EAC area.

USEPA has defined different Prevention of Significant Deterioration (PSD) increments based on land classifications. Federal Class I areas are those areas designated as pristine or wilderness areas and require more rigorous safeguards to prevent deterioration of the natural pristine air quality. The Chandeleur Island Restoration Project is located within the Breton National Wildlife Refuge (NWR), a designated Class I area. However, the Project is not subject to PSD program requirements as no new, operating emissions sources are proposed.

The Chandeleur Island Restoration Project area is uninhabited and only accessible by water or air. As a result, existing air pollution sources are limited to boat, helicopter, and seaplane traffic, and pollutants that are transported by winds to the Project area. Given the distance to onshore sources of airborne pollutants, the primary sources of air pollution in the Project area include transient sources, such as exhaust from ships, boats, and other modes of marine transportation.

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term adverse air quality impacts associated with implementation of the action alternatives would not occur. However, any long-term benefits (including any potential air quality benefits associated with marsh creation) would also not occur. Overall, the No Action Alternative would have no measurable effect on air quality.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Short-term, minor, adverse air quality impacts would occur during construction of the Preferred Alternative due to the dust and exhaust from equipment and earthwork activities, such as grading, bulldozing, dredging, excavating, and welding. Additional impacts would also arise from combustion emissions due to an increase in vessel use to deliver equipment, materials, and construction workers to the Project area, as well as quarters barges to house workers. The estimated construction duration for the Preferred Alternative (868 days) is the longest of all the action alternatives, such that the activities causing air impacts would last approximately 4 months longer than the other action alternatives.

These localized, temporary activities are not likely to increase any of the six criteria pollutant levels above the NAAQS. Although the Preferred Alternative would place the greatest overall volume of fill material (11,914,510 cy) compared to the other action alternatives, fugitive dust emissions are expected to be minor since the earth disturbance would be of coarse-grained (sandy) material. Fugitive dust control and capture techniques on construction equipment, such as baghouse filters, scrubbers, or electrostatic precipitators may also be implemented to further limit particulate emissions, where feasible during construction activities. Combustion emissions from construction equipment, including on-road and off-road engines, would be mitigated by only using and operating engines in accordance with all state and federal emission and performance laws and standards. After construction, an increase in marsh vegetation could potentially provide a long-term benefit to the air quality for the area (USEPA, 2024b).

Overall, the duration and type of construction and quantity of construction equipment for the Preferred Alternative would be similar to but slightly greater than each of the other action alternatives described below. Therefore, the short-term minor impacts on air quality would be greatest for this alternative when compared with the other action alternatives.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Alternative 2 would require a similar type and quantity of construction equipment when compared with the Preferred Alternative, described above. Overall, impacts are expected to be short-term, minor, and adverse; the general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 2, although impacts would be less than those under the Preferred Alternative given the smaller area and shorter duration (752 days) for construction.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Alternative 3 would require a similar type and quantity of construction equipment when compared with the Preferred Alternative, described above. Overall, impacts are expected to be short-term, minor, and adverse. The general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 3, although impacts would be less than those under the Preferred Alternative given the smaller area and shorter duration (749 days) for construction.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Alternative 4 would require a similar type and quantity of construction equipment when compared with the Preferred Alternative, described above. However, while each of the other action alternatives include multiple, dispersed fill areas (that is, sand reservoir fill areas along Alternative 2, pocket marshes along Alternative 3, and both for Alternative 5), Alternative 4 has a single feeder beach. Therefore, Alternative 4 may require fewer vessel transits or material handling when compared with alternatives using more disparate placement locations. Overall, impacts are expected to be short-term, minor, and adverse. The general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 4, although impacts would be less than those under the Preferred Alternative given the smaller area and shorter duration (754 days) for construction.

D.1.1.4 Noise

<u>Affected Environment</u>

Ambient sound captures the total sound in a specific environment, including both natural and anthropogenic sound; noise is unwanted sound. The level of noise varies depending on the season, time of day, number and types of noise sources, and distance from the noise source. The *Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and*

Final Programmatic Environmental Impact Statement (Final PDARP/PEIS) states that the primary sources of terrestrial noise in the coastal environment are typically marine transportation and construction-related activities; sources of noise in the marine environment of the Gulf Coast region include marine transportation, military activities, and energy development. However, given that the Project area is uninhabited, the primary sources of ambient noise likely to be present are boating vessels (recreational and commercial), occasional transient noise from aircraft (including seaplanes), and natural sounds from wind, wave action, and wildlife. St. Bernard Parish has an established noise ordinance that establishes permissible sound levels for residential, commercial, agricultural, and industrial land, and restricts the timing of construction in residential and commercial districts; however, the Project is not within a residential, commercial, or industrial area (St. Bernard Parish Code of Ordinances, Article VI).

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term adverse localized noise impacts with implementation of the action alternatives would not occur. Overall, the No Action Alternative would have no effect on noise levels.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Short-term, minor increases in local airborne and underwater noise would occur during construction of the Preferred Alternative due to the operation of vessels, dredging and construction equipment, all-terrain vehicle traffic, and earthwork activities. The dominant airborne noise sources from Project construction are expected to be earth-moving and sediment-hauling activities as well as dredging and discharge of sediment from the dredge pipe, which could potentially occur up to 24 hours per day. Crew boats would also be stationed nearby and may also result in increased noise levels from construction personnel. However, the greatest potential for impacts from underwater noise would occur during pile-driving to install an estimated 30 timber piles for rock breakwaters and rock revetment warning signs near New Harbor Island, and potentially for submerged pipeline warning markers or submerged spoil markers along the temporary access channels. Noise impacts from pile-driving would be temporary and limited to the duration of pile installation (conservatively assumed to take about 30 days), and pile-driving would be limited to daylight hours.

Noise during construction would be mitigated by maintaining all equipment with properly functioning mufflers. Project construction would contribute to ambient sound levels; however, given the distance of the Project area to residential areas and implementation of mitigation measures, Project construction is not expected to result in the generation of, or exposure of persons to, excessive noise or vibration levels. Noise would temporarily disturb and displace wildlife in the Project area and vicinity, as described further in Sections D.1.2.2 through D.1.2.4. See Section D.1.2.4 for a detailed discussion of pile-driving noise impacts on marine species. Recreational users on and around North Chandeleur Island (see Section D.1.3.5) would not be substantially affected by noise as they would likely not expend their time in or near areas undergoing active construction.

The Preferred Alternative would involve the greatest total restoration and habitat modification actions as it includes all potential Project features. It would also take the longest amount of time to complete. Therefore, temporary noise increases would be greatest for this alternative when compared with the other action alternatives.

Overall, noise impacts associated with the Preferred Alternative would remain limited to construction activities and would be short-term, minor, and adverse, depending on proximity to those activities.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Alternative 2 would require a similar type and quantity of construction equipment (including pile-driving equipment). Overall, impacts are expected to be short-term, minor, and adverse, and the general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 2, although impacts would be slightly less given the smaller area and shorter duration for construction. Impacts of noise on wildlife are described further in Sections D.1.2.2 through D.1.2.4.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Alternative 3 would require a similar type and quantity of construction equipment (including pile-driving equipment). Overall, impacts are expected to be short-term, minor, and adverse, and the general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 3, although impacts would be slightly less given the smaller area and shorter duration for construction. Impacts of noise on wildlife are described further in Sections D.1.2.2 through D.1.2.4.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Alternative 4 would require a similar type and quantity of construction equipment (including pile-driving equipment). However, while each of the other action alternatives include multiple, dispersed fill areas (for example, sand reservoir fill areas along Alternative 2, pocket marshes along Alternative 3, and both for the Preferred Alternative), Alternative 4 has a single feeder beach. Therefore, Alternative 4 may require fewer vessel transits and associated noise when compared with alternatives using more disparate placement locations. Overall, impacts are expected to be short-term, minor, and adverse, and the general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 4, although impacts would be slightly less than those under the Preferred Alternative given the smaller area and shorter duration for construction. Impacts of noise on wildlife are described further in Sections D.1.2.2 through D.1.2.4.

D.1.2 Biological Environment

This section discusses the resources within the biological environment including vegetation communities, wetlands, marine and estuarine aquatic fauna, wildlife, essential fish habitat (EFH), protected species, and submerged aquatic vegetation (referred to as marine SAV [mSAV] or seagrass beds in this section).

D.1.2.1 Habitats

Affected Environment

The Project area consists of terrestrial and wetland habitats on North Chandeleur and New Harbor Islands, along with aquatic habitats including seagrass beds and open water habitat characterized by soft-bottom substrate. The Chandeleur Islands provide sandy beach habitat suitable for nesting sea turtles, as well as bird foraging, roosting, breeding, fledging, and loafing habitat. Smaller islands and ephemeral shoals southwest of North Chandeleur and New Harbor Islands provide limited vegetation cover (USFWS, 2008; Flocks et al., 2022). However, North Chandeleur and New Harbor Islands, where restoration activities are proposed, are wider and support vegetated habitats dominated by shrubs, including black mangrove, groundsel bush (or eastern baccharis; *Baccharis halimifolia*), and wax myrtle (*Morella cerifera*), as described further below (USFWS, 2008). In general, vegetation distributions on barrier islands are dependent on elevation gradients as well as saltwater exposure via overwash (LDWF, 2019). General habitats and vegetation types in the Project area are depicted on Figure D-1.

Terrestrial and Wetland Habitat

North Chandeleur Island

North Chandeleur Island is approximately 14 miles in length with an average width of 0.5 mile. Its topography varies from north to south with the northern expanses being bare sandy beaches at or near intertidal elevations. As the island progresses to the south, the beaches become narrower with broken vegetated dunes and overwash locations. From the Gulf-facing beach extending westward, the island is characterized by sparsely vegetated sand mounds and dunes, with more dense cover and species typically associated with barrier island coastal dune grasslands and shrub thickets as the island progresses westward and elevation increases (LDWF-LNHP, 2009). These upland habitats extend into intertidal marsh and salt flats, and smooth cordgrass and black mangrove dominate the back marshes at the westernmost extent of the island. Coastal dune grasslands and coastal mangrove-marsh shrublands are classified as critically imperiled and imperiled natural communities in Louisiana, respectively (LDWF, 2019). Saltmarsh and mangrove habitats provide a nursery area for fish and shellfish, the root system of mangroves provides shoreline stabilization and reduces island erosion, and colonial waterbirds use the mangroves as nesting habitat (LDWF-LNHP, 2009; LDWF, 2019). Marsh and mangrove habitat are also discussed in this section, along with seagrass beds and open water habitats.

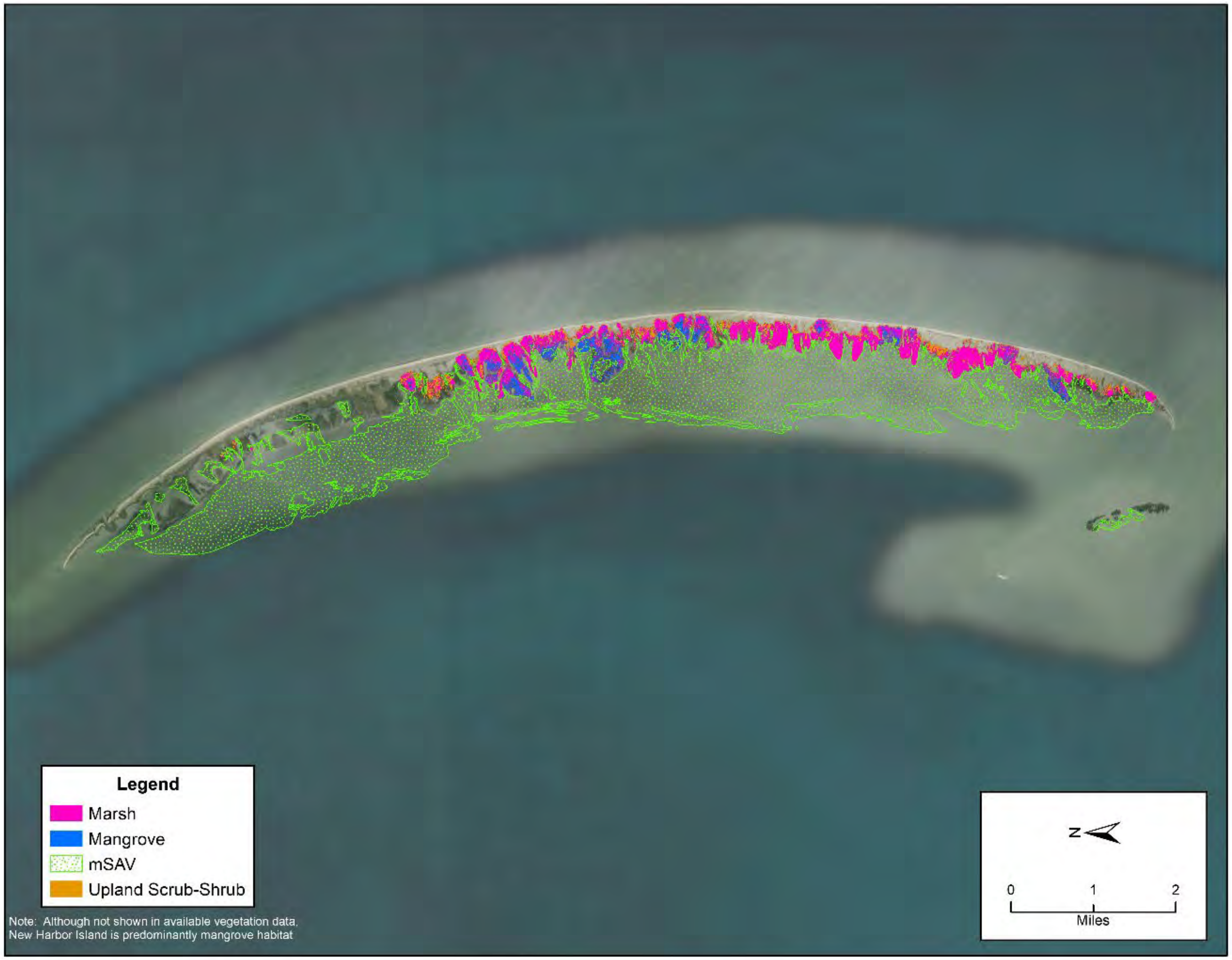


Figure D-1. Spatial Extent of General Vegetation Types in the Project Area as of 2022

In November of 2023, soil and vegetation characteristics along select survey transects were documented to characterize wildlife habitat on North Chandeleur Island (CEC et al., 2024). Vegetation observed on the sparsely vegetated beach faces and extending west into the dunes and salt flats behind the dune line include shoreline purslane (*Sesuvium portulacastrum*), black bog-rush (*Schoenus nigricans*), groundsel bush, beach morning glory (*Ipomoea pes-caprae*), saltmeadow cordgrass (*Sporobolus pumilus*, previously *Spartina patens*), saltgrass *(Disticlis spicata)*, bitter panicgrass (*Panicum amarum*), seaside goldenrod (*Solidago sempervirens*), and largeleaf pennywort (*Hydrocotyle bonariensis*). Terrestrial vegetation Species of Greatest Conservation Need (SGCN) that occur on the Chandeleur Islands include sea oats (*Uniola paniculata*), arrow-grass (*Triglochin striata*), coastal ground-cherry (*Physalis angustifolia*), dune sandbur (*Cenchrus tribuloides*), earleaf greenbrier (*Smilax auriculata*), sand dune spurge (*Euphorbia bombensis*), sand rose-gentian (*Sabatia arenicola*), and southern hairgrass (*Muhlenbergia capillaris var. filipes*). Stands of Roseau cane *(Phragmites australis*), a nonnative species that has become established in Louisiana, are also present on the island.

New Harbor Island

New Harbor Island is exposed to Katrina Cut, a breach in Chandeleur Island formed as a result of Hurricane Katrina in 2005, which created North and South Chandeleur Islands. Due to this cut, New Harbor Island is exposed to winds and wave action that increase its vulnerability to land and habitat loss from erosion and inundation. Mangroves are the dominant species on the island with few herbaceous salt marsh species intermixed. New Harbor Island is currently a mangrove stand of approximately 35 acres. Mangrove habitat has not been identified as at a high risk for impacts from invasive species in the state (LDWF, 2019).

Seagrass Beds

Marine seagrass beds (mSAV) are a highly productive and ecologically important habitat for a variety of invertebrates, fish, reptiles, and mammals, serving as foraging and nursery habitat. Within Louisiana, seagrasses are limited to the landward side of the Chandeleur Islands where the clear, high-salinity, low-nutrient waters are suitable for their growth (Poirrier, 2007). Although mSAV beds are a relatively small part of the coastal Louisiana ecosystem, they are expansive in the Chandeleur Island complex and believed to play an extremely important and underestimated role in the marine ecosystem (LDWF, 2019).

As summarized in Project-specific seagrass surveys (SWCA, 2023; see Appendix E of Joint RP/EA #1), decades of studies have reported varying coverage of seagrasses along the Chandeleur Islands; however, the species composition has remained fairly consistent and includes turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*) (Poirrier and Handley, 2007; Kenworthy et al., 2017). Areas that are sheltered from storm damage are dominated by dense turtle grass meadows, a climax species that grows in more stable environments (Franze, 2002; Poirrier and Handley, 2007). Areas subject to higher levels of damaging forces have some turtle grass, but mainly manatee grass and shoal grass. Star grass was also found to be present in disturbed areas but was quite rare (Handley et al., 2007). Furthermore, a comparison of aerial mapping efforts at the Chandeleur Islands from 1992 to 2005 documented rapid rates of land loss and declining seagrass coverage along the islands, supporting the causation between land loss and declining seagrass coverage (Pham et al., 2014).

Similarly, Project-specific seagrass surveys conducted along the western side of North Chandeleur Island in 2022 identified a higher coverage of shoal grass in the northern and southern portions of North Chandeleur Island, as well as isolated patches of widgeon grasses in the southern areas; turtle grass was not dominant in these zones and manatee grass was limited to one identified location. The more central locations of the island, where the seagrass beds are more protected from wave energy, supported the highest coverage of turtle grass, with moderate coverage of shoal and star grasses. Only one location supporting seagrass was identified at New Harbor Island, which included a relatively low coverage of shoal grass. In total, 5,194 acres of seagrass beds were identified in the survey area, much of which included multiple species of seagrasses. Of the total acreage identified in that survey, shoal grass was found across 4,970 acres, turtle grass across 2,580 acres, widgeon grass across 2,260 acres, star grass across 2,260 acres, and manatee grass across 475 acres. Normalized Difference Vegetation Index (NDVI) analysis of high-resolution imagery from 2022 identified an additional 93 acres of seagrass along the undulating western shoreline of North Chandeleur Island, bringing the total identified seagrass habitat in the Project area to 5,243 acres as of 2022.

Open Water

Outside of the islands and seagrass beds, the Project area is characterized by open water, with measured salinities during Project-specific seagrass surveys ranging from 21.8 to 35.9 parts per thousand (ppt). The open waters of the Chandeleur Islands include both estuarine habitat within the Chandeleur Sound and marine habitat along the Gulf-facing side of the island chain. The western side of North Chandeleur Island contains seagrass beds and relatively calm waters when compared to the Gulf-facing side, which is subject to more wave action and higher salinities.

Water depths vary within the Project area; open water areas are shallower nearer the islands and shoals and deeper with distance either into the Gulf or toward the mainland (see Section D.1.1.2). As described in Section D.1.2.1, measurements of pH, water, salinity, and dissolved oxygen in the Project area are typical of a shallow, coastal environment with limited anthropogenic influence, and indicated overall good water quality (SWCA, 2023).

<u>Environmental Consequences</u>

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term and long-term adverse impacts on existing terrestrial and marine habitat associated with implementation of the action alternatives would not occur. However, the long-term benefits from habitat creation and increased longevity would also not occur. Over time, coastal processes, shoreline change, overwash, and erosion and migration of sediments into adjacent waters would contribute to habitat loss, with a total loss of terrestrial habitat above +2.0 feet North American Vertical Datum of 1988 (NAVD88) projected to occur on North Chandeleur Island within the first 10 years of the 20-year analysis period (see Table D-2, below). While the No Action Alternative would provide the greatest area of subtidal habitat with the potential to support mSAV, over time, sediment is expected to migrate away from the Project area and the loss of beach and dune habitat would leave the subtidal mSAV habitat more vulnerable to wave action, resulting in long-term conversion to open water. The No Action Alternative would result in major, long-term, adverse impacts on available habitats over time.

Table D-2. Direct Impacts on Existing Vegetation and Habitat from Construction[a]

Alternative	Upland Vegetation (acres)	Intertidal Vegetation (acres)	Mangrove Vegetation (acres)	mSAV (acres)
Existing Vegetation	25	944	197	5,243
Alternatives Impacts (acres)[b]				
Alternative 1[b]	0	0	0	0
Alternative 5	19	315	47	159
Alternative 2	17	253	45	128
Alternative 3	18	219	22	148
Alternative 4	16	169	21	112

[a] All acreages of existing habitat and habitat impacts are approximate, based on field survey and aerial imagery review as of 2022.

[b] Although no direct impacts on vegetation and habitat would occur under the No Action Alternative, significant habitat loss and degradation is projected to occur over time under this scenario.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Short-term and long-term, minor to moderate, adverse impacts on the existing terrestrial habitat types on North Chandeleur Island are expected due to construction activities associated with the Preferred Alternative. These impacts are expected to be localized, with habitat disruption occurring primarily in areas of active construction. Land-based activities, such as site preparation, materials staging, and dredged material placement would disturb and displace existing vegetation until construction activities have ceased and vegetation coverage has been reestablished. Vessels and construction equipment used to support restoration activities would result in temporary soil and sediment disturbance, including potential leaks from vehicle fuels and fluids.

Short-term, moderate, adverse impacts would occur in aquatic habitats that are actively dredged, or in which the sediment pipelines are laid directly on the sea floor. Sediment disturbance and dredging would also increase suspended sediment concentrations, causing a localized decrease in water quality during active restoration.

BMPs, including vehicle maintenance and implementation of measures in a Spill Prevention, Response, and Reporting Plan, would be implemented to minimize the potential for spills and leaks of hazardous materials to impact habitats. Construction debris would be disposed of properly, and construction would comply with applicable permit conditions, including any requirements for the protection of water quality.

Some areas of seagrass habitat would be filled with dredged material to construct elevated marsh habitat, resulting in long-term, moderate, adverse impacts on mSAV. The placement of fill at New Harbor Island, adjacent to mangrove habitat, could cause some localized vegetation mortality (including mSAV); however, mangrove habitat on New Harbor Island would not be lost or converted to open water or uplands as a result of construction. A comparison of impacts on the existing vegetation acreages for each of the action alternatives is provided in Table D-2. BMPs would be used during the placement of material to minimize the potential for impacts on sensitive habitats due to misplacement or migration of materials into areas not planned for Project impacts.

Habitat on North Chandeleur and New Harbor Islands is subject to continuous loss due to relative sea-level rise, wind and wave action, and other coastal processes. Once construction is complete, the Preferred Alternative would result in long-term benefits on both terrestrial and aquatic habitats within the Project area by increasing the total quantity of available barrier island habitat. In addition, the placement of beach, dune, and marsh fill would increase the elevation of North Chandeleur and New Harbor Islands, reducing the long-term susceptibility of the Project area to habitat loss. Areas where beach and dune restoration occur would also protect seagrass beds from accelerated loss and erosion. The northernmost area of seagrass is expected to see an enhancement of mSAV as this high energy environment would be improved to a low-energy/low-turbidity habitat that is expected to experience a substantial expansion of seagrass coverage and increased species diversity.

The habitat features that would be constructed under the Preferred Alternative are shown in Figure 7 (see Section 2.2.2). The beach and dune fill areas were designed to create sustainable beach slopes that meet slope requirements for sea turtle nesting beaches. Marsh fill would be completed on the north end of North Chandeleur Island behind the constructed beach and dune fill, where a narrow bare sandy beach and an expansive low-lying, nearly unvegetated, sandy intertidal platform currently exists. Marsh fill elevations were selected to provide bird foraging habitats as well as a stable platform to accept overwash sediments, enhancing the longevity of the Project. Newly constructed dunes, marshes, pocket marshes, and sand reservoirs would be planted with appropriate vegetation; anticipated plantings include bitter panicgrass and smooth cordgrass. New Harbor Island would be planted with black mangrove. Planting appropriate species would reduce the potential for the establishment or spread of invasive plants in newly constructed habitat; see Section D.1.2.2 for control measures proposed for invasive animals. These vegetation plantings would also reduce erosion and enhance dune and mangrove wetland vegetation. Sand fences (porous barriers designed such that windblown sand accumulates on the fences) would increase sand deposition and associated dune elevations, as well as protecting vegetated plantings.

In addition to providing sandy shoreline habitat, the sand reservoirs would provide sediment supplies as North Chandeleur Island migrates over time. Similarly, the pocket marshes would provide bird foraging habitat with the added benefit of providing a stable platform to accept overwash sediments, enhancing the longevity of the Project. The feeder beach would provide an immediate source of sediment, allowing longshore transport to nourish beach sediment over time and sustain existing sandy beach habitat. In addition, the placement of fill at New Harbor Island would create marsh, providing colonial nesting waterbird and migratory shorebird habitat. The breakwater and revetment features would support habitat longevity on New Harbor Island by reducing potential erosion due to currents and wave action. Table D-3 summarizes the habitat creation on North Chandeleur Island and New Harbor Island immediately following completion of restoration actions.

Table D-3. Total Area of Habitat Created on North Chandeleur Island and New Harbor Island

Alternative	Beach and Dune Habitat (acres)	Marsh Habitat (acres)[a]	Total
Alternative 1 (No Action)	0	0	0
Alternative 5 (Preferred Alternative)	1,841	740	2,581
Alternative 2	1,510	613	2,123
Alternative 3	1,341	843	2,184
Alternative 4	1,397	613	2,010

[a] Marsh habitat benefits include 145 acres of habitat supporting mangrove and scrub/shrub vegetation on New Harbor Island for Alternatives 2, 3, 4, and 5; all other habitat impacts quantified herein are on North Chandeleur Island.

Table D-4, below, provides the total acreage of habitat types projected to be present on North Chandeleur over a 20-year analysis period based on a modeling analysis, reflecting changes in habitat due to coastal processes such as erosion, sea-level change, subsidence, and overwash that would affect the Project area. In Target Year (TY)-10, a major storm consistent with a Category 2 hurricane was assumed to occur, causing washover and movement of the projected dunes. The analysis of habitat longevity is based on habitat elevation, rather than vegetation class; however, in general, supratidal habitats include beach and dune areas, while subtidal and intertidal habitats include sand flats, marsh, and mangroves. A settlement and overwash monitoring system is proposed for installation to monitor post-construction elevations over time.

Table D-4. Habitat Sustainability on North Chandeleur and New Harbor Islands

Alternative	Target Year[a]	Subtidal Habitat	Intertidal Habitat	Supratidal Habitat	Dune Habitat	Total Acres in the Project Area[b]
		Acres at Elevation -1.5 ft to 0.0 ft	Acres at Elevation 0.0 ft to 2.0 ft	Acres at Elevation 2.0 ft to 5.0 ft	Acres at Elevation > 5.0 ft	
Alternative 1 (No Action)[c]	TY-0	1,596	2,339	966	39	4,941
	TY-5	1,557	2,193	319	0	4,069
	TY-10	1,591	1,615	0	0	3,206
	TY-15	1,469	913	0	0	2,381
	TY-20	1,205	337	0	0	1,543
Alternative 5 (Preferred Alternative)[c]	TY-0	1,430	1,475	1,805	410	5,120
	TY-5	1,420	1,447	1,539	410	4,816
	TY-10	1,397	1,311	1,929	0	4,637
	TY-15	1,381	1,307	1,739	0	4,427
	TY-20	1,371	1,300	1,565	0	4,235
Alternative 2[c]	TY-0	1,496	1,609	1,523	379	5,007
	TY-5	1,489	1,566	1,283	379	4,717
	TY-10	1,462	1,416	1,550	0	4,428
	TY-15	1,452	1,393	1,283	0	4,128
	TY-20	1,439	1,438	953	0	3,830
Alternative 3[c]	TY-0	1,449	1,596	1,557	410	5,011
	TY-5	1,439	1,568	1,299	410	4,716
	TY-10	1,416	1,423	1,591	0	4,431
	TY-15	1,404	1,419	1,307	0	4,130
	TY-20	1,390	1,411	1,029	0	3,831

Alternative	Target Year[a]	Subtidal Habitat Acres at Elevation -1.5 ft to 0.0 ft	Intertidal Habitat Acres at Elevation 0.0 ft to 2.0 ft	Supratidal Habitat Acres at Elevation 2.0 ft to 5.0 ft	Dune Habitat Acres at Elevation > 5.0 ft	Total Acres in the Project Area[b]
Alternative 4[c]	TY-0	1,504	1,802	1,424	379	5,110
	TY-5	1,493	1,765	1,167	379	4,804
	TY-10	1,470	1,587	1,569	0	4,627
	TY-15	1,458	1,562	1,402	0	4,422
	TY-20	1,446	1,534	1,248	0	4,228

[a] TY-0 is representative of the expected beach profile and conditions immediately following Project implementation.

[b] Totals may not equal the sum of addends due to rounding.

[c] Acreages associated with New Harbor Island are excluded from the modeled alternative data as they are consistent across all action alternatives.

Overall, the Preferred Alternative would result in the greatest total area of habitat impact and conversion during construction. However, construction of the full suite of features would also result in the greatest overall restoration and enhancement of North Chandeleur and New Harbor Islands when compared with the other action alternatives. Following construction, the combined material volumes from the restoration features would create and sustain the most habitat acreage compared to the other action alternatives, providing the greatest long-term benefits. The restoration features would also indirectly benefit adjacent mSAV beds by helping protect existing vegetation from loss and erosion and providing hydrologic conditions conducive to increased mSAV density and species diversity. Overall, while construction impacts are expected to be short-term to long-term, minor to moderate, and adverse, impacts following Project implementation are expected to be long-term and beneficial, with 2,692 more acres of habitat (with elevations above -1.5 feet) projected to be present on North Chandeleur Island compared to the No Action Alternative by TY-20 and its associated mSAV protection and enhancement.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

The general impacts described for the Preferred Alternative described above capture the impacts anticipated for implementation of Alternative 2, including habitat creation, increased habitat longevity, and mSAV protection and enhancement. Alternative 2 would include four placement areas (sand reservoirs) along the western side of North Chandeleur Island but would not include the feeder beach or pocket marshes described for Alternative 5, above. Construction of Alternative 2 would have the greatest total impacts on intertidal vegetation and mangroves (other than the Preferred Alternative) when compared with the other action alternatives (see Table D-2) while creating less initial habitat than the Preferred Alternative or Alternative 3 (see Table D-3). Following construction, the sand reservoirs would provide future sediment supplies for the

Chandeleur Island system. Overall, impacts from construction are expected to be short-term to long-term, minor to moderate, and adverse; impacts following Project implementation are expected to be long-term and beneficial, but with approximately 405 fewer acres of habitat (with elevations above -1.5 feet) present on North Chandeleur Island at TY-20 when compared to the Preferred Alternative (see Table D-4).

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

The general impacts described above for Alternative 5 capture the impacts anticipated for implementation of Alternative 3, including habitat creation, increased habitat longevity, and mSAV protection and enhancement. Alternative 3 would have four placement areas (pocket marshes) along the western side of North Chandeleur Island but would not include the feeder beach or sand reservoirs described for Alternative 5, above. Construction of Alternative 3 would have the greatest total impacts on mSAV (other than the Preferred Alternative) when compared with the other action alternatives (see Table D-2) while creating more initial habitat than Alternatives 2 and 4 (see Table D-3). The alternative would provide approximately 5,000 more linear feet of restored beach and dune habitat on North Chandeleur Island when compared with Alternatives 2 and 4, resulting in additional benefits through the protection of seagrass beds. Overall, impacts from construction are expected to be short-term to long-term, minor to moderate, and adverse; impacts following Project implementation are expected to be long-term and beneficial, but with approximately 404 fewer acres of habitat on North Chandeleur Island (with elevations above -1.5 feet) present at TY-20 when compared to the Preferred Alternative (see Table D-4).

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

The general impacts described above for Alternative 5 capture the impacts anticipated for implementation of Alternative 4, including habitat creation, increased habitat longevity, and mSAV protection and enhancement. Alternative 4 would have the lowest impacts from construction on upland vegetation, intertidal vegetation, mangroves, and mSAV (see Table D-2). Alternative 4 includes the placement of material within the feeder beach feature, near the nodal zone identified along the Gulf shoreline of North Chandeleur Island but would not include the pocket marshes or sand reservoirs described for the Preferred Alternative, above. The location of the feeder beach near the nodal zone would take advantage of longshore sediment transport to the northern and southern points of North Chandeleur Island, allowing natural processes to nourish the beach over time, thus slowing the shoreline erosion rate. By TY-20, only the Preferred Alternative would create greater long-term benefits to island habitat when compared with Alternative 4; although Alternative 4 would only provide about 7 fewer acres of overall habitat on North Chandeleur Island, it would provide approximately 317 fewer acres of higher elevation habitat (between +2.0 and +5.0 feet). Overall, impacts from construction are expected to be short-term to long-term, minor to moderate, and adverse; impacts following Project implementation are expected to be long-term and beneficial. The general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 4.

D.1.2.2 Terrestrial Wildlife Species

Affected Environment

Breton Island NWR was established to provide a refuge and breeding habitat for colonial birds, migratory birds, and other wildlife. Birds dominate the terrestrial wildlife community on the refuge, which includes North Chandeleur and New Harbor Islands. The refuge provides important habitat for waterfowl, gulls and terns, wading, marsh, and shorebirds, including supporting large colonies of nesting waterbirds (USFWS, 2008; 2013). Barrier islands in Louisiana provide isolated nesting sites protected from predators (such as terrestrial mammals) and are therefore important for successful reproduction for many avian species (Remsen et al., 2019). The Chandeleur Islands are designated as a Globally Significant Important Bird Area given their historic significance as a breeding area for colonial waterbirds, as well as an important wintering area for Redheads (*Aythya americana*) and other species using the Mississippi Flyway (National Audubon Society, 2024; USFWS, 2013). Migratory bird species generally nest in the United States and Canada during the summer months, migrating south to the tropical regions of Mexico, Central and South America, and the Caribbean during the winter or non-breeding season. Some species of migratory birds winter along the Gulf Coast, including along coastal Louisiana and on North Chandeleur and New Harbor Islands. The Migratory Bird Treaty Act (MBTA) prohibits the take or killing of migratory birds, including their eggs, chicks, and active nests (40 Stat. 755, as amended; 16 U.S. Code [U.S.C.] Section [§] 703 et seq.). The islands support 35 avian SGCN, as well as provide nesting beaches for sea turtles and important habitat for marine and estuarine aquatic species, as described in in Section D.1.2.3, below.

Bird surveys have been conducted on the Project-area islands to document solitary and small colonial nesting species, as well as separate surveys for larger colonial nesting bird species and colonies (CEC et al., 2024; SEG Environmental, 2024). Pedestrian surveys conducted in May and June 2023 and June 2024 confirmed that at least 11 species of solitary or small colonial birds use North Chandeleur Island as breeding habitat, as summarized in Table D-5 (CEC et al., 2024; SEG Environmental, 2024). Wintering bird surveys conducted between September 2023 and April 2024 observed non-breeding solitary and small individuals of several species, including six SGCN (see Table D-5). The Chandeleur Gull (*hybrid, Larus argentatus x Larus dominicanus*) is a rare hybrid of species (Kelp Gull [*Larus dominicanus]* and Herring Gull [*Larus argentatus*]) with reproductive ranges that do not typically overlap and is known only to occur in the Chandeleur Islands (Dittmann and Cardiff, 2005).

Table D-5. Summary of Solitary and Colonial Nesting Birds Observed During Surveys of the Chandeleur Islands

Bird Species	Scientific Name	Survey or Assessment Type and Observations of Target Species		
		Solitary Breeding and Small Colony Nesting Birds, Pedestrian Survey[b]	Wintering Birds, Pedestrian Survey[c]	Colonial Nesting Waterbirds, Aerial Survey[d]
American Oystercatcher[a]	*Haematopus palliatus*	X	X	X
Black Skimmer[a]	*Rynchops niger*			X
Black-crowned Night Heron	*Nycticorax nycticorax*			X
Brown Pelican[a]	*Pelecanus occidentalis*			X
Caspian Tern[a]	*Hydroprogne caspia*			X
Chandeleur Gull	*hybrid, Larus argentatus x Larus dominicanus*	X	X	
Common Nighthawk	*Chordeiles minor*	X		
Common Tern[a]	*Sterna hirundo*	X		
Forster's Tern[a]	*Sterna forsteri*	X		X
Great Egret	*Ardea alba*			X
Gull-billed Tern[a]	*Gelochelidon nilotica*	X		X
Herring Gull	*Larus argentatus*	X		
Laughing Gull	*Leucophaeus atricilla*			X
Least Tern[a]	*Sternula antillarum*	X		X
Piping Plover[a]	*Charadrius melodus*		X	
Red Knot[a]	*Calidris canutus*		X	

Bird Species	Scientific Name	Survey or Assessment Type and Observations of Target Species		
		Solitary Breeding and Small Colony Nesting Birds, Pedestrian Survey[b]	Wintering Birds, Pedestrian Survey[c]	Colonial Nesting Waterbirds, Aerial Survey[d]
Reddish Egret[a]	*Egretta rufescens*	X	X	X
Royal Tern[a]	*Thalasseus maximus*			X
Sandwich Tern[a]	*Thalasseus sandvicensis*			X
Snowy Egret	*Egretta thula*			X
Snowy Plover[a]	*Charadrius nivosus*		X	
Sooty Tern[a]	*Onychoprion fuscatus*	X		
Tricolored Heron	*Egretta tricolor*			X
Wilson's Plover[a]	*Anarhynchus wilsonia*	X	X	
Yellow-crowned Night Heron	*Nyctanassa violacea*			X

Sources: SEG Environmental, 2024; and CEC et al., 2024, which describes methodology and target species for each pedestrian survey. Windhoffer et al., 2023, provides details of the colonial nesting waterbirds survey. The species observations represented in the table reflect observations of species targeted by each survey, and not a comprehensive list of all birds observed during each assessment or survey event.

[a] SGCN. The federally listed Piping Plover and Red Knot are addressed further in Section D.1.2.4; although documented during the breeding season, the species do not breed in the Project area.

[b] Pedestrian breeding bird surveys conducted to target SGCN and other species that use North Chandeleur Island during the breeding season.

[c] Pedestrian wintering bird surveys conducted to target SGCN that use North Chandeleur Island during winter months.

[d] Colony nesting aerial photographic surveys for North Chandeleur and New Harbor Islands. Where species have not been clearly identified in the survey results, they have been excluded from the table. Summary data were collected between 2010 and 2022.

Colonial nesting waterbird surveys for larger species have been conducted across Louisiana via aerial photography since the Deepwater Horizon (DWH) oil spill (beginning in 2010), including the Project area. Predominant nesting species include the Brown Pelican (*Pelecanus occidentalis*), Black

Skimmer (*Rynchops niger*), Laughing Gull (*Leucophaeus atricilla*), and Royal and Sandwich Terns (*Thalasseus maximus* and *T. sandvicensis*, respectively); a summary of species documented, including scientific names, is presented in Table D-5. As of 2022, Brown Pelicans are the dominant species nesting on New Harbor Island (where they are a year-round resident), with the number of identified nests increasing from about 660 in 2010 to more than 7,400 in 2022 (Windhoffer et al., 2023). The nesting population on New Harbor Island represents an estimated 25 percent of the Louisiana nesting population of the species (SEG Environmental, 2024). However, the number of Royal and Sandwich Tern colonies have decreased over the same period. Overall, the colonial waterbird nests in the Chandeleur Islands are estimated to represent more than 20 percent of waterbird nests in Louisiana (CEC et al., 2024; Windhoffer et al., 2023). However, because barrier island colonies are isolated and support significant, concentrated nesting areas, they are vulnerable to disruption from tropical cyclones, land loss, and human disturbance (Remsen et al., 2019).

In addition to those species summarized in Table D-5, wintering (non-breeding) waterfowl surveys conducted via aerial overflight by the U.S. Fish and Wildlife Service (USFWS) in 2024 documented about 115,725 diving ducks. A vast majority of the wintering waterfowl observed were Redhead ducks; however, Lesser Scaup (*Aythya affinis*), Greater Scaup (*Aythya marila*), and Buffleheads (*Bucephala albeola*) were also observed (USFWS [unpublished] as presented in SEG Environmental 2024).

Records of non-avian species in the Breton NWR are limited, likely due to the refuge's separation from the mainland, but include raccoons and diamondback terrapin (USFWS, 2013). Nonnative animal species including the red imported fire ant (*Solenopsis invicta*) and Norway and black rats (*Rattus norvegicus* and *Rattus rattus*), if present, have the potential to affect native bird species through predation, including of eggs (LDWF, 2019). In addition, nonnative nutria (*Myocastor coypus)* can threaten native habitat through herbivory, where present (LDWF, 2019).

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term adverse impacts on terrestrial wildlife (including resident and migratory birds) associated with the action alternatives would not occur. However, the long-term benefits to wildlife from habitat creation and increased habitat longevity would also not occur. Over time, coastal processes, shoreline change, overwash, and erosion would contribute to habitat loss on both North Chandeleur and New Harbor Islands. No suitable nesting bird habitat is projected to be present on North Chandeleur Island by TY-10 (see Table D-6), resulting in moderate to major, long-term, adverse impacts on wildlife from habitat loss over time.

Table D-6. Bird Nesting Habitat Sustainability on North Chandeleur Island[a]

Alternative	Total (Constructed and Existing) Bird Habitat Modeled Year[b]				
	TY-0	TY-5	TY-10	TY-15	TY-20
Alternative 1 (No Action)	1,005	319	0	0	0
Alternative 5 (Preferred Alternative)	2,215	1,948	1,929	1,929	1,565
Alternative 2	1,902	1,663	1,550	1,283	953
Alternative 3	1,967	1,709	1,591	1,307	1,029
Alternative 4	1,803	1,547	1,569	1,402	1,248

[a] The acreages presented herein represent locations on North Chandeleur Island at elevations greater than +2.0 feet NAVD88. The placement of fill on New Harbor Island would be consistent across action alternatives and would create approximately 145 additional acres of bird habitat, which would settle to lower elevations by TY-5.

[b] TY-0 is representative of the expected beach profile and conditions immediately following Project implementation.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Short-term, moderate, adverse impacts on birds and other wildlife in the Project area would include displacement and disturbance year-round (including during the breeding and wintering seasons) due to habitat disturbance, noise, lighting, and the presence of construction workers, vessels, and equipment during construction of the Preferred Alternative. Impacts would also be associated with bird abatement (typically the use of scare eye balloons, predator decoys, flagging, and kites or other hazing techniques such as cannons or flares to cause bird avoidance) during construction. The bird species that dominate the terrestrial wildlife community in the Project area on North Chandeleur and New Harbor Islands are highly mobile and would likely avoid areas of active construction. As such, the Project is not expected to directly harm individual birds. Construction of the Project would likely occur when birds that migrate to, and overwinter in, the Project area are present, such as Redheads and federally protected shorebirds, discussed in Section D.1.2.4, below. Wintering birds in the Project area during construction activities may be disturbed by the operation (movement and noise) of heavy equipment and machinery or placement of fill material. In addition, placement of fill could result in smothering and mortality of invertebrates that provide forage for birds. Where restoration is ongoing, typical roosting and foraging activities would likely be disrupted, and birds may expend additional energy relocating to undisturbed habitat during Project activities. These impacts would be short term for the duration of construction, and suitable habitat along other sections of North Chandeleur Island would be available to support foraging and loafing. Although the vast majority of the Gulf-facing beach habitat would be affected by beach and dune restoration activities, with sand placement and equipment movement occurring throughout the construction period, the beach activities along North Chandeleur Island would occur sequentially, along three segments. The three segments would vary in length, with Segment 1 affecting about 5.7 miles of beach at the northern end of the island, Segment 2 affecting the central 5.1 miles, and Segment 3 affecting about 3.2 miles at the southern end of the island. Because restoration activities along the Gulf-facing beach would be segmented, about 8.3 miles of beach (or more) would always be absent of direct construction activities. Prey species would be expected to re-colonize areas disturbed by construction and populate newly available habitat following restoration. If present, terrestrial mammals, reptiles, and amphibians are also expected to avoid active Project activities.

Because Project construction is scheduled to require 868 days for the Preferred Alternative, construction would continue year-round, including times when birds that use the islands are breeding or overwintering, and when colonial waterbirds and other species are nesting. Disturbance from construction could disrupt nesting birds or result in the abandonment of nests by adults; in addition, any nests present in the locations where fill is proposed would be lost. The Louisiana (LA) and Open Ocean Trustee Implementation Groups (TIGs) are consulting with Louisiana Department of Wildlife and Fisheries (LDWF) and the USFWS to develop mitigation measures to minimize disturbance to colonial nesting waterbirds. Such measures could include restrictions on work in the vicinity of nesting colonies to the non-nesting period, and implementation of nest buffers during the nesting window. If work must be conducted during the nesting season, the LDWF would be contacted to obtain recommendations for the protection of bird colonies, such as nest monitoring or pre-construction surveys and associated avoidance buffers, and those recommendations would be implemented. Measures may include bird abatement to reduce the potential impacts on nesting or other birds. Furrowing may be used in selective areas to prevent nesting. Implementation of mitigation measures would ensure that spoil is not placed on active nests and would minimize disturbance of nesting birds. Birds and any other wildlife would return to the Project area and new habitat quickly after restoration is complete. Construction would not begin until consultation with LDWF and USFWS is complete and final agency consultation documents would be made available on the publicly available administrative record for the Natural Resource Damage Assessment (NRDA) for the DWH oil spill (see Section 1.11 of Joint RP/EA #1 for more information).

Mammalian nuisance species such as native raccoons and invasive nutria and rats if present on the island, would consume beach, dune, and marsh vegetation and can reduce breeding success of shorebirds through nest predation. Control measures may be implemented to identify and remove mammalian nuisance species. Measures would include monitoring for nuisance mammalian species and use of established lethal and non-lethal removal methods, which may include shooting, traps and/or nets with transport offsite to reduce populations.

Once construction is complete, the Preferred Alternative would result in long-term, beneficial impacts on birds that use the Project area either for nesting or as wintering habitat. Impacts would be associated with the increase in available habitat for nesting, foraging, and loafing; the acreages of projected habitat changes are summarized in Table D-6, above. The Project design considers those areas about +2.0 feet NAVD88 in elevation to be suitable for nesting birds, based on the elevation of bird nests observed on North Chandeleur Island, including tern, black skimmer, American Oystercatcher, Chandeleur Gull, and Reddish Egret; one species, Wilson's Plover, was observed nesting at a lower elevation (CEC et al., 2024). Table D-6 provides the acreage of bird nesting habitat that is projected to be present on North Chandeleur Island over a 20-year analysis period based on a modeling analysis of coastal processes, shoreline change, overwash, and erosion.

In addition, the placement of fill at New Harbor Island would create approximately 145 acres of bird habitat, which would receive long-term protection from the proposed shoreline protection features.

Overall, the Preferred Alternative would incorporate all the potential Project features described for Alternatives 2, 3, and 4 (each discussed below), resulting in the greatest overall restoration of North Chandeleur Island (with 1,565 acres of nesting habitat projected to be present in TY-20), as well as the most extensive habitat modifications. The types and quantities of construction equipment would be similar to each of the other action alternatives; however, the Preferred Alternative would require the longest construction duration. Overall, while construction impacts are expected to be short-term, moderate, and adverse, impacts following Project implementation are expected to be long-term and beneficial.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

The duration of construction for Alternative 2 would be similar to, although shorter than, Alternative 5 (754 compared to 868 days), and the alternative would require a similar type and quantity of construction equipment, which is expected to disturb wildlife present in the Project area.

By TY-20, Alternative 2 would provide the smallest area of total nesting bird habitat when compared to the other action alternatives (953 acres, as compared with 1,565 acres under the Preferred Alternative) (see Table D-6). Impacts from construction are expected to be short-term, moderate, and adverse; impacts following Project implementation are expected to be long-term and beneficial. The general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 2.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

The duration of construction for Alternative 3 (749 days) would be similar to, although shorter than, each of the other action alternatives, and would require a similar type and quantity of construction equipment, which is anticipated to disturb wildlife present in the Project area. The alternative would provide approximately 5,000 more linear feet of restored beach and dune habitat on North Chandeleur Island when compared with Alternatives 2 and 4, and would provide more sustainable bird habitat throughout the 20-year analysis period when compared with Alternative 2 (see Table D-6). Overall, impacts from construction are expected to be short-term, moderate, and adverse; impacts following Project implementation are expected to be long-term and beneficial. The general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 3.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

The duration of construction for Alternative 4 (754 days) would be similar to each of the other action alternatives, requiring comparable types and quantities of construction equipment, which are expected to disturb wildlife present in the Project area. By TY-20, only the Preferred Alternative would create greater long-term benefits to bird nesting habitat than Alternative 4 (see Table D-6). Overall, impacts from construction are expected to be short-term, moderate, and adverse; impacts following Project implementation are expected to be long-term and beneficial. The general impacts described above for the Preferred Alternative capture the impacts anticipated for implementation of Alternative 4.

D.1.2.3 Marine and Estuarine Aquatic Fauna (including Managed Fish Species) and Essential Fish Habitat

<u>Affected Environment</u>

Marine and Estuarine Aquatic Fauna

The marine and estuarine habitat within the Project area provide essential nursery and foraging habitat to a variety of marine and estuarine aquatic fauna. The seagrass beds (mSAV) provide habitat for a variety of invertebrate and fish species, serve as foraging grounds for bottlenose dolphins (*Tursiops truncates*) and sea turtles, and provide shelter and a nursery habitat for juvenile fishes and shrimp. Additionally, emergent marsh and mangrove habitat within the Project area also provide habitat and shelter to an abundance of fish and shellfish populations and play a vital role in supporting recreational and commercial fisheries within the Gulf. Based on Project-specific surveys, salinity within the Project area ranges from 21.8 ppt to 35.9 ppt, indicating both estuarine and marine waters.

The Chandeleur Islands provide habitat for many SGCN including species of mollusk, crustacean, and various finfish species. Mollusk SGCN occurring at the Chandeleur Islands include the bay scallop (*Argopecten irradians*), lightning whelk (*Busycon sinistrum*), sawtooth penshell (*Atrina serrata*), half-naked penshell (*Atrina seminuda*), and the channeled whelk (*Busycotypus canaliculatus*). Crustacean SGCN occurring at the Chandeleur Islands include the beach ghost shrimp (*Calliochirus islagrande*) and the Carolinian ghost shrimp (*Callichirus major*). A total of 11 fish SGCN occur at the Chandeleur Islands, some including the opossum pipefish (*Microphis brachyurus*), diamond killifish (*Adinia xenica*), dwarf seahorse (*Hippocampus zosterae*), frillfin goby (*Bathygobius soporator*), smalltooth sawfish (*Pristis pectinata)* and the southern puffer (*Sphoeroides nephelus*). Other species potentially occurring within the Project area are relative to the known habitat types found along North Chandeleur Island based on the Project-specific seagrass surveys and publicly available data on common fauna within similar habitat in the northern Gulf (Peterson, 2004). Shellfish populations (shrimp and crab species) that may occur within the Project area include Atlantic blue crab (*Callinectes sapidus*), American broad-front fiddler crab (*Tribe minucini*), Atlantic ghost crab (*Ocypode quadrata*), and the thinstripe hermit crab (*Clibanarius vittatus*). Other marine invertebrate species potentially occurring within the Project area include the eastern oyster (*Crassostrea virginica*), angelwing (*Cyrtopleura costata*), marsh periwinkle (*Littoraria irrorata*), gray sea star (*Luidia clathrata*), southern moon jelly (*Aurelia marginalis*), Florida fighting conch (*Strombus alatus*), cannonball jelly (*Stomolophus meleagris*), and the southern Quahog (*Mercenaria campechinensis*) (Peterson, 2004; iNaturalist, 2024).

The marine and aquatic fauna of the Chandeleur Islands support valuable recreational and commercial fisheries and also play a vital ecological role in the estuarine food web. Primary producers (for example, seagrasses, phytoplankton, algae) convert sunlight into energy, which cycles nutrients into and out of the water column, forming the basis of the estuarine food web (NOAA NMFS, 2019). Primary producers serve important ecological roles by transferring energy up the estuarine food web to primary consumers (for example, zooplankton, small fish, crustaceans), when eaten (Education Development Center, 2024). That energy is then transferred from primary consumers to secondary consumers, such as fish predators, marine mammals, sea turtles, and seabirds within the northern Gulf.

Estuarine fishery species consist of resident fishes that inhabit the emergent marsh and mangrove habitat throughout their entire life cycle, as well as transient fishes that only utilize these habitats for a portion of their life cycle. Outside of these habitats, many fishes inhabit the lower portions of estuarine habitats, where prey is abundant and salinity levels are higher, as well as the nearshore waters of the Gulf. Some common fish species found within the estuarine and marine habitats of the Chandeleur Islands may include the striped blenny (*Chasmodes bosquinanus*), mullet (*Mugil* spp.), naked goby (*Gobiosoma bosc*), pinfish (*Lagodon rhomboides*), sailfin molly (*Poecilia latipinna*), bay anchovy (*Anchoa mitchilli*), inland silverside (*Menidia beryllina*), Gulf menhaden (*Brevoortia patronus*), Atlantic croaker (*Micropogonias undulatus*), and Gulf killifish (*Fundulus grandis*) (Peterson, 2004; iNaturalist, 2024).

Many sport fish species within the Project area are commonly sought after for recreational harvest. These species include the gray snapper (*Lutjanus griseus*), red drum (*Sciaenops ocellatus*), spotted sea trout (*Cynoscion nebulosus*), sand seatrout (*Cynoscion arenarius*), southern flounder (*Paralichthys lethostigma*), sheepshead (*Archosargus probatocephalus*), tarpon (*Megalops atlanticus*), and black drum (*Pogonias cromis*). Several of these species vary in abundance within the waters around Chandeleur Island due to seasonal migrations, habitat preferences based on life stages, and salinity levels. For instance, tarpon is found in the waters surrounding the Chandeleur Islands each spring and summer as they migrate through to southern Florida and Texas each fall and winter, while species such as snapper and spotted seatrout utilize seagrass beds as important nursery habitat. In addition to sport fish, several marine species that are economically important for both commercial and recreational harvest also inhabit the waters in and around the Project area, including several species of Penaeid shrimp, blue crab, Gulf menhaden, and Atlantic croaker. Additional information on commercial and recreational fishing is included in Section D.1.3.8.

Essential Fish Habitat and Managed Fish Species

The National Marine Fisheries Service (NMFS) and Fishery Management Councils (FMC) created under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), jointly manage fishery resources in the U.S. Exclusive Economic Zone (EEZ). The Gulf Fishery Management Council (GFMC) was established for the Gulf to regulate commercially and recreationally valuable species and stocks through fishery management plans (FMP). Together, NMFS and GFMC maintain FMPs for specific species or species groups to regulate commercial and recreational fishing within their geographic regions. NMFS also manages the FMP for Highly Migratory Species (HMS), including billfish, tuna, swordfish, and sharks in the Gulf. Jurisdiction is determined by species rather than location, as species ranges often cross administrative boundaries.

FMCs are required to identify EFH for each fishery covered under an FMP, as well as Habitat Areas of Particular Concern (HAPC). EFH is defined as the waters and seafloor necessary for spawning, breeding, or growth to maturity of managed fish species (16 U.S.C. § 1802[10]). HAPCs are defined as subsets of EFH that exhibit one or more of the following traits: rare, stressed by human development, provide important ecological functions for federally managed species, or are especially vulnerable to anthropogenic (or human impact) degradation (NOAA NMFS, 2020). EFH and managed species identified within the Project area are included in the following five FMPs:

- Coastal Migratory Pelagics (3 species);
- Red Drum;
- Reef Fish (6 species);
- Shrimp (3 species); and
- Highly Migratory Species (12 species).

The specific species within each FMP are presented in Appendix F of Joint RP/EA #1. No HAPCs were identified within the Project area. Additional information on managed species and EFH is provided in Appendix F of Joint RP/EA #1.

Based on available data and Project-specific surveys conducted to date, EFH types expected or known to be present within the Project area include mSAV, mangroves, emergent marshes, sand/shell bottoms, soft bottoms, and water column habitat. Drift algae (*Sargassum*) would also be occasionally present, particularly on the Gulf-facing side of the Project area. The primary categories of EFH present within the Project area are summarized below.

- **Seagrass:** Marine seagrass habitat, also known as mSAV, is notably expansive on the western side of North Chandeleur Island within the Project area and is the only area containing seagrass habitat in the State of Louisiana. The Chandeleur Islands contain the most expansive seagrass beds in the northern Gulf, with North Chandeleur Island having approximately 5,194 acres and comprised of five seagrass species. The species observed in the Chandeleur Island seagrass beds include turtle grass, manatee grass, shoal grass, star grass, and widgeon grass. The seagrasses provide habitat for a variety of invertebrate and fish species, serve as foraging grounds for bottlenose dolphins, and provide shelter and a nursery habitat for juvenile fish and shrimp. See Section D.1.2.1 for more details on seagrass beds.
- **Mangroves:** Mangrove habitat consists of communities of halophytic trees and shrubs in typically soft sediments with regular tidal inundation, some freshwater inputs, and low to moderate wave energy. Mangrove habitat within the Project area comprises black mangrove stands. This habitat type within the Project area expands to the western side of North Chandeleur Island. New Harbor Island is predominantly a mangrove stand of approximately 35 acres.
- **Emergent Marsh:** Emergent marshes, including tidal wetlands and salt marshes, consist of vegetated wetlands with typically soft sediments, regular tidal inundation, some freshwater inputs, and low to moderate wave energy. This habitat type within the Project area consists of *Sporobolus* marshes along North Chandeleur Island and salt marshes intermixed with mangrove habitat within New Harbor Island. Emergent marsh habitat is important nursery ground for many fish, shellfish, and other invertebrate species.

- **Soft Bottom:** Soft-bottom habitats are areas where the bottom sediments are soft mud, clay, or silt. This habitat type supports a diverse assemblage of organisms living within or on the sediment, including shrimp and many demersal species of fish. However, lower densities of fishes and invertebrates occur in soft-bottom communities compared to areas with hard bottom substrates.
- **Sand/Shell Bottom:** Areas where the bottom sediments consist of soft sand and/or shell, generally included in the term "soft bottom."
- **Water column:** Water column habitat consists of all waters from the surface to the ocean floor (but not including the ocean bottom). This habitat type is particularly important for planktonic animals or life stages (eggs or larvae).
- **Drift algae (*Sargassum*):** Floating mats of seaweed that travel through the Gulf with the currents and support a diverse assemblage of marine organisms. Highest amounts of *Sargassum* occurrence in the Gulf are typically during May, June, and July.

Environmental Consequences

This section includes a discussion of aquatic fauna and their habitats. Although habitat impacts are also discussed in Section D.1.2.1, a specific, detailed assessment of impacts on EFH and managed fish species are included as Appendix F of Joint RP/EA #1. Impacts from that assessment are summarized below.

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term and long-term adverse impacts on marine and estuarine aquatic fauna (including EFH) associated with construction of the action alternatives would not occur. However, any long-term benefits from habitat creation and increased longevity would also not occur. Over time, coastal processes, shoreline change, overwash, and erosion would contribute to habitat loss. While the No Action Alternative would provide the greatest area of subtidal habitat, mSAV abundance and diversity is expected to decline over time as sediment is expected to migrate away from the Project area and result in long-term conversion to open water, resulting in major, long-term, adverse impacts on aquatic fauna (and EFH) as habitat transitions to the more ubiquitous soft-bottom habitat and decreased protection from wave action results in lower quality or absent mSAV beds.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Short-term to long-term, minor to moderate, adverse impacts on marine and estuarine aquatic fauna, including managed fish species and EFH present in the Project area are expected due to construction activities associated with the Preferred Alternative. These impacts include displacement and disturbance of aquatic fauna during construction of the action alternatives due to noise and the presence of vessels and equipment, as well as temporary impacts on water quality due to increased turbidity and suspended sediment concentrations, and potential leaks from construction equipment and vehicle fuels and fluids. Specifically, sediment movement within the HPBA and pump-out areas would cause short-term, minor, adverse impacts on aquatic fauna due to the disruption of prey sources, disturbance due to noise, and temporary impacts on habitat quality due to increased turbidity and sedimentation. These adverse impacts are expected to be slightly greater under the Preferred Alternative than the other action alternatives because of the larger construction area and longer construction period for this alternative, but would still be short term and minor.

Fish species that are present in the Project area within the marine and estuarine habitats of North Chandeleur and New Harbor Islands are highly mobile and would likely avoid areas of active construction. Mobile aquatic fauna disturbed and displaced in these areas would likely find refuge in nearby suitable habitats and then return to the Project area after construction. However, direct effects on less mobile species, such as benthic invertebrates, would occur through injury or mortality due to dredging, placement of the sediment pipeline onto the sea floor, or sediment placement for island restoration. The acreage of direct impacts on vegetated EFH, such as mSAV and mangrove habitats, due to fill activities associated with construction of the action alternatives is provided in Table D-2 in Section D.1.2.1 above; in addition, the Project would affect soft-bottom and water column habitat, particularly in the HPBA and pump-out areas. While the Project area overlaps Tier 3 public oyster seed grounds (POSG), the Project is not expected to affect oyster reefs or other hardbottom habitat. Any permit conditions for the protection of oyster resources would be implemented.

While dredging and placement of material for the restoration components on North Chandeleur and New Harbor Islands would have short-term, moderate, adverse impacts on aquatic habitat, the temporary access channels would be backfilled following completion and were sited to minimize impacts on mSAV. The placement of shoreline protection features at New Harbor Island would cause the permanent loss of soft-bottom habitat, but would also provide hardbottom substrate for sessile aquatic fauna to colonize and provide a source of prey for managed fish. Further, the shoreline protection features would provide long-term benefits by protecting mangrove habitat on New Harbor Island from erosion and loss. BMPs for protection of habitat and water quality described in Section D.1.2.1 would minimize the potential for detrimental impacts on EFH during construction.

The placement of fill materials for restoration features would cause the long-term conversion of open water and mSAV habitat to marsh, mangroves, and sandy shoreline habitat, as well as hardbottom where the shoreline protection features are installed. The Project would provide a benefit to those species that depend on marsh and bare sand habitats. Restoration of the beach, dune and marsh features would benefit mSAV beds along North Chandeleur Island by creating hydrologic conditions conducive to increased mSAV density and species diversity, extending the longevity of available seagrass habitat to support marine fauna, including managed species. Marine and estuarine habitats that would be affected by the placement of sediment for the action alternatives would return over time as island elevations subside naturally and are altered via coastal processes. Additional analysis of the impacts on EFH is included in the Project-specific EFH assessment provided in Appendix F of Joint RP/EA #1.

Overall, the Preferred Alternative would incorporate all the potential Project features described for the action alternatives, resulting in the greatest associated construction impacts on aquatic fauna and EFH, as well as the most extensive long-term habitat modifications. However, the Preferred

Alternative would also result in the creation of the most habitat acreage compared to the other action alternatives, providing the greatest long-term benefits to aquatic fauna and EFH through increased habitat creation and increased island longevity that would similarly increase the longevity of associated high-quality aquatic habitats. Overall, while construction impacts are expected to be short-term to long-term, minor to moderate, and adverse, impacts following Project implementation are expected to be long-term and beneficial.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

The impacts from construction activities would be similar for all action alternatives, including Alternative 2, and would require a similar type and quantity of construction equipment, resulting in disturbance to marine and estuarine aquatic fauna (including managed species) and EFH in the Project area. With the exception of the Preferred Alternative, construction of Alternative 2 would have the greatest total impacts on intertidal vegetation and mangroves (see Table D-2) and would include four placement areas (sand reservoirs) along the western side of North Chandeleur Island within aquatic habitat. Less mobile species present within the intertidal and mangrove habitat at the time of sediment placement may be smothered. Of the habitat created, Alternative 2 would result in approximately 189 fewer acres of higher elevation land present to protect high-quality aquatic habitats at TY-20 than the Preferred Alternative (see Table D-4). Overall, impacts from construction are expected to be short-term to long-term, minor to moderate, and adverse; impacts following Project implementation are expected to be long-term and beneficial. The general impacts described above for Alternative 5 capture the impacts anticipated for implementation of Alternative 2.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

The impacts from construction activities would be similar for all action alternatives, including Alternative 3, and would require a similar type and quantity of construction equipment, resulting in disturbance to aquatic fauna, managed species, and EFH in the Project area. However, Alternative 3 would have four placement areas (pocket marshes) along the western side of North Chandeleur Island, which are smaller and would have a lesser impact on mSAV and mangrove habitat than the sand reservoirs proposed for Alternative 2. Less mobile species present within the pocket marsh placement areas may be smothered. Of the habitat created, Alternative 3 would result in the fewest acres of higher elevation land present to protect high-quality aquatic habitats at TY-20 than the remaining alternatives, and about 425 fewer acres than the Preferred Alternative (see Table D-4). Overall, impacts from construction are expected to be short-term to long-term, minor to moderate, and adverse; impacts following Project implementation are expected to be long-term and beneficial. The general impacts described above for Alternative 5 capture the impacts anticipated for implementation of Alternative 3.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

The impacts from construction activities would be similar for all action alternatives, including Alternative 4, and would require a similar type and quantity of construction equipment, resulting in disturbance to aquatic fauna in the Project area. However, in Alternative 4, the placement area would be a feeder beach feature, near the nodal zone identified along the Gulf shoreline of North Chandeleur Island. The feeder beach placement area would result in the least overall impacts on mangrove and seagrass habitat when compared with the other action alternatives (see Table D-2), and the second highest acreage of higher elevation land present to protect high-quality aquatic habitats at TY-20 (83 acres fewer than the Preferred Alternative; see Table D-4). Overall, impacts from construction are expected to be short-term to long-term, minor to moderate, and adverse; impacts following Project implementation are expected to be long-term and beneficial. The general impacts described above capture the impacts anticipated for implementation of Alternative 4.

D.1.2.4 Protected Species

Protected species can include any species that is covered by additional regulation, such as the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and MBTA. Species protected by the ESA and MMPA are discussed below. Species covered by the MBTA are discussed in Section D.1.2.2.

Affected Environment

Threatened and Endangered Species

The ESA of 1973 (16 U.S.C. § 1531 et seq.) protects all federally listed threatened and endangered species, as well as their designated critical habitat. Section 7 of the ESA requires that federal agencies ensure that any action authorized, funded, or carried out by an agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat. To comply with the ESA, consultation with the USFWS and NMFS is required for the Project. A list of federally threatened and endangered species with the potential to occur within the Project area was developed based on a review of the USFWS Information for Planning and Consultation System (IPaC) and NMFS' ESA Section 7 Mapper. Although the smalltooth sawfish (*Pristis pectinata*) is a federally listed species, it was not identified in the NMFS Section 7 mapper and NMFS does not consult on it outside of Florida; therefore, it is not considered further in this section and any impacts on the species would be similar to those discussed above in Sections D.1.2.1 and D.1.2.3. In total, 20 species are potentially present within the Project area (see Table D-7). In addition, the Project area contains designated critical habitat for the Piping Plover (*Charadrius melodus*) and proposed critical habitat for the Rice's whale *(Balaenoptera ricei)*, *Rufa* Red Knot *(Calidris canutus rufa)*, and green sea turtle, North Atlantic Distinct Population Segment (DPS) *(Chelonia mydas)*. Additional information regarding species that are listed under the ESA is provided in Appendix F of Joint RP/EA #1.

Table D-7. ESA Federally Listed or Proposed Species Potentially Occurring in the Project Area

Common Name	Scientific Name	Jurisdiction	Current Status
Mammals			
Tricolored bat	*Perimyotis subflavus*	USFWS	Proposed Endangered
West Indian manatee	*Trichechus manatus*	USFWS	Threatened
Rice's whale[a]	*Balaenoptera ricei*	NMFS	Endangered
Birds			
Black-capped Petrel	*Pterodroma hasitata*	USFWS	Endangered
Eastern Black Rail	*Laterallus jamaicensis ssp. jamaicensis*	USFWS	Threatened
Piping Plover[a]	*Charadrius melodus*	USFWS	Threatened
***Rufa* Red Knot[a]**	*Calidris canutus rufa*	USFWS	Threatened
Reptiles			
Alligator snapping turtle	*Macrochelys temminckii*	USFWS	Proposed Threatened
Gopher tortoise	*Gopherus polyphemus*	USFWS	Threatened
Green sea turtle, North Atlantic DPS[a]	*Chelonia mydas*	USFWS (nesting beaches)/NMFS (marine environment)	Threatened
Hawksbill sea turtle	*Eretmochelys imbricata*	USFWS (nesting beaches)/NMFS (marine environment)	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	USFWS (nesting beaches)/NMFS (marine environment)	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	USFWS (nesting beaches)/NMFS (marine environment)	Endangered
Loggerhead sea turtle, Northwest Atlantic DPS	*Caretta caretta*	USFWS (nesting beaches)/NMFS (marine environment)	Threatened

Common Name	Scientific Name	Jurisdiction	Current Status
Insects			
Monarch butterfly	*Danaus plexippus*	USFWS (nesting beaches)/NMFS (marine environment)	Proposed Threatened
Fish			
Giant manta ray	*Manta birostris*	NMFS	Threatened
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	USFWS (riverine environment)/NMFS (estuarine/marine environment)	Threatened
Pallid sturgeon	*Scaphirhynchus albus*	USFWS	Endangered
Oceanic whitetip shark	*Carcharhinus longimanus*	NMFS	Threatened
Ferns and Allies			
Louisiana quillwort	*Isoetes louisianensis*	USFWS	Endangered

[a] These species have designated or proposed critical habitat in the Project area.

A review of IPaC and NMFS data identified the tricolored bat (*Perimyotis subflavus*), pallid sturgeon (*Scaphirhynchus albus*), Black-capped Petrel (*Pterodroma hasitata*), alligator snapping turtle (*Macrochelys temminckii*), gopher tortoise (*Gopherus polyphemus*), Louisiana quillwort (*Isoetes louisianensis*), and oceanic whitetip shark (*Carcharhinus longimanus*) only along the potential transit paths of Project-related vessels, rather than in the restoration area. As none of these species are subject to potential impacts from vessel strikes where vessels operate along existing shipping fairways, and no terrestrial work or modification of terrestrial or marine habitat is proposed along vessel access routes, they are not addressed further. Additionally, the proposed threatened monarch butterfly is listed as potentially occurring on North Chandeleur or New Harbor Island; however, no suitable habitat is present for the species and it is not discussed further. The remaining species are discussed below.

West Indian Manatee

The West Indian manatee (*Trichechus manatus*) (manatee) was listed as an endangered species in 1967 and later reclassified as threatened under the ESA in 2017 (82 Federal Register [Fed. Reg.] 16668). The manatee is also federally protected under the MMPA of 1972. This species is a large marine mammal occurring in the southeastern region of the United States, eastern Mexico, and in patchy distribution throughout the Caribbean, but predominantly occurring in Florida. The total range-wide population of manatees is estimated at 13,000. Manatees inhabit marine, brackish, and freshwater systems such as estuaries, saltwater bays, slow moving rivers and river mouths, canals, and coastal areas alike. The manatee is herbivorous and prefers nearshore habitats containing SAV

(USFWS, 2024a). Manatees are opportunistic feeders and feed on a wide variety of marine, estuarine, and freshwater plants some including cord grass (*Sporobolus* spp.), algae, turtle grass, shoal grass, manatee grass, and eel grass (*Zostera marina*) (USFWS, 2024b).

Very limited reports of manatee occurrence at the Chandeleur Islands have been recorded (Slone et al., 2022). However, a 2005 study on manatee occurrence in the northern Gulf, west of Florida, recorded various manatee sightings in the waters of Louisiana from 1943 to 2004, one of which was reported in the Chandeleur Islands. This sighting occurred in 2003, where a single manatee was observed feeding on a weed line at the water's surface, in open water at the southwestern tip of the Chandeleur Islands (Fertl et al., 2005). However, an incidental sighting in the seagrass meadows of North Chandeleur Island was reported in July of 2024; this sighting will undergo verification from the LDWF (Weigel, 2024).

Rice's Whale

Rice's whale was acknowledged and listed as a subspecies of the Bryde's whale under the ESA in 2021 (86 Fed. Reg. 47022). Rice's whales, unlike most baleen whale species, do not migrate long distances and are the only species of the baleen whale family that resides in the Gulf year-round (NOAA NMFS, 2023a; 2024a). This species is consistently located along the continental shelf in the northeastern Gulf, in water depths ranging from approximately 328 to 1,312 feet, an area designated by NMFS as their core distribution zone. However, acoustic surveys conducted between 2016 and 2017 recorded multiple calls of Rice's whales in the western Gulf, suggesting persistent occurrence of the species over a broader range than the previously identified northeastern Gulf shelf (Soldevilla et al., 2022).

Critical habitat for the Rice's whale is proposed to include all waters between the 100- and 400-meter isobaths (328-foot to 1,312-foot depths) within the Gulf (88 Fed. Reg. 47453). North Chandeleur and New Harbor Islands are not located within the area proposed as critical habitat for the species; however, Rice's whale could potentially occur within the portions of the Project area that may be traversed by Project-related vessels, particularly those waters adjacent to the Mississippi River Delta, where designated fairways overlap with critical habitat for the species.

Avian Species

The Eastern Black Rail, Piping Plover, and Red Knot, each of which are federally listed as threatened, were identified as potentially present within the Project area. The Project site has undergone numerous surveys to characterize the flora and fauna within the Project area. These surveys included winter bird surveys once per month for 8 months (September 2023 through April 2024), during which an estimated 141 Piping Plovers and 1,176 Red Knots were identified. Additional surveys included solitary breeding, colonial waterbird, and waterfowl surveys; however, no other observations of Piping Plover or Red Knot (or any observations of Black Rail) were recorded (CEC et al., 2024).

The Eastern Black Rail was federally listed as a threatened species on November 9, 2020 (85 Fed. Reg. 63764). No critical habitat has been proposed for this species. One of five subspecies of Black Rail, the Eastern Black Rail is a secretive marsh bird that occurs in emergent wetland habitat and contiguous uplands (USFWS, 2019). Wetlands dominated by mangroves, such as those predominant on North Chandeleur and New Harbor Islands, are not suitable habitat for the species (USFWS, 2019). The range of this species extends across the Gulf Coast and it has been documented in western coastal Louisiana; however, Louisiana is not currently known to support a breeding population of Eastern Black Rail (Watts, 2016; USFWS, 2019). Further, Louisiana is considered to be on the periphery of known breeding areas for the species (Watts, 2016 and noted in the final rule listing the species under 85 Fed. Reg. 63764). Given the Chandeleur Islands are outside areas of documented occurrences, and the island chain's location offshore, it is unlikely that the Eastern Black Rail occurs in the Project area.

The Piping Plover and Red Knot are both small, migratory shorebirds that winter along the Gulf Coast, including coastal Louisiana and the Chandeleur Islands. Both species nest outside the Project area. The Atlantic Coast and Northern Great Plains populations of Piping Plover were federally listed as threatened in January 1986 (50 Fed. Reg. 50626); critical habitat for wintering Piping Plovers was designated in 2001 (66 Fed. Reg. 36038). Designated critical habitat includes North Chandeleur and New Harbor Islands. Piping Plovers spend up to 10 months annually on their wintering grounds and are typically present between mid-July and mid-May (USFWS, 2015). Preferred wintering habitats include coastal sand spits, tidal flats, shoals, sandbars, and small islands; foraging habitats include sand and mud flats, ephemeral pools, overwash areas, and emergent seagrass beds where plovers feed on macroinvertebrates (USFWS, 2015).

The Red Knot was federally listed as threatened in January 2015 (79 Fed. Reg. 73705); critical habitat is currently proposed for the species, including on North Chandeleur and New Harbor Islands (88 Fed. Reg. 22530). Similar to the Piping Plover, wintering habitat for the Red Knot is within coastal marine and estuarine habitats with exposed, intertidal sediments to support foraging for invertebrates. Habitats include sand spits, shoals, and sandbars (USFWS, 2020). Red Knots that winter in Louisiana typically migrate along the Mississippi River Basin. Studies in Texas show that birds that winter on the Gulf Coast spend most of their time in wintering habitat, leaving breeding habitat beginning in July and staying in Texas until mid-May; juveniles may remain in non-breeding habitat in June and July (USFWS, 2020). The seasonal use of wintering habitat in Louisiana is expected to be similar.

Sea Turtles

Five federally listed sea turtles, including the endangered hawksbill (*Eretmochelys imbricata*), Kemp's Ridley (*Lepidochelys kempii*), and leatherback (*Dermochelys coriacea)*, and the threatened loggerhead, North Atlantic DPS (*Caretta caretta*) and green, North Atlantic DPS (*Chelonia mydas*) sea turtles occur or potentially occur within the Project area. Each species is under the shared jurisdiction of the USFWS and NMFS (USFWS and NOAA NMFS, 1977), where the USFWS has responsibility for sea turtles on nesting beaches and NMFS has jurisdiction in the marine environment and all waters adjacent to the terrestrial environment. Proposed critical habitat for the green sea turtle overlaps with the easternmost open water portion of the Project area (beginning in water depths of 33 feet and extending out towards the U.S. EEZ). Although critical habitat has been designated or proposed for each of the four remaining species, those critical habitats do not overlap the Project area.

Sea turtles are found throughout the tropical and subtropical seas of the world, where they occur at or near the surface of the water. Female sea turtles nest on land and lay eggs. After 2 to 3 months, hatchlings emerge from nests and return to the ocean where they have a prolonged pelagic stage. Juveniles and adults use varying habitats, depending on the species, and adult females generally return to their natal coastal sand beaches to nest and lay their eggs. The Kemp's ridley sea turtle is considered the most critically endangered species of sea turtles and is primarily found within nearshore coastal habitats with muddy or sandy sea bottoms (NOAA NMFS, 2024b). The loggerhead inhabits oceanic waters, as well as shallow water areas containing seagrass beds, salt marshes, bays, and tidal inlets (LDWF, N.d.). The green sea turtle is primarily herbivorous, spending most of its life in shallow coastal habitats where it feeds on seagrasses (NOAA NMFS, 2024c). The hawksbill is a circumtropical species, commonly found in coral reefs, rocky areas, lagoons, shallow coastal areas, mangrove-fringed bays, and estuaries (NOAA NMFS, 2024d). The leatherback sea turtle is the largest in size and has the widest range of all sea turtle species, primarily occupying oceanic waters (NOAA NMFS, 2024e). Threats to sea turtles include interactions with fishing gear; military operations; dredging operations; habitat alterations (including channel construction); vessel operations; marine debris and pollution; poaching; global environmental changes; cold-stunning; and predation (NOAA NMFS, 2024b; c; d; and e).

The Project site has undergone numerous surveys to characterize the flora and fauna within the Project area, including weekly aerial sea turtle crawl surveys, from the 2022, 2023, and 2024 nesting seasons (May – August), during which 53, 54, and 28 crawls were documented respectively, for a total of 135 crawls. Genetic analysis of select nests indicated that most nests were from Kemp's ridley sea turtles, with a smaller number belonging to loggerhead and green sea turtles. Within the United States, hawksbill nesting is rare and restricted primarily to the southeast coast of Florida and the Florida Keys. Leatherback sea turtles primarily nest in Florida, Puerto Rico, and the U.S. Virgin Islands (NOAA NMFS, 2024d; e); however, they could potentially occur in the marine waters of the Project area.

Giant Manta Ray

The giant manta ray (*Manta birostris*) was listed as a threatened species under the ESA in 2018 (83 Fed. Reg. 2916). This species inhabits tropical, subtropical, and temperate waters and can be found offshore, in oceanic waters and productive coastal areas. Giant manta rays have also been observed in estuarine waters, oceanic inlets, intercoastal waterways, and bays. The global population size of this species is unknown and small, highly fragmented populations are sparsely distributed around the world. The few regional population estimates range from 600 to 2,000 individuals (NOAA NMFS, 2024f). The giant manta ray is an HMS, and their movements correspond with current circulation, seasonal upwelling, water temperatures, and location of food source. The primary diet of this species consists of planktonic organisms or zooplankton (NOAA NMFS, 2024f). Several inshore sightings have been documented off the coast of Louisiana, including within the Chandeleur Sound (NOAA NMFS, 2024g).

Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is federally listed as threatened wherever found with designated critical habitat in coastal inshore waters of Louisiana and Mississippi. The species historically occurred from the Mississippi River to Tampa Bay, Florida, with sporadic records across the northern Gulf. The present range includes Lake Pontchartrain, Louisiana and nine river systems between Mississippi and Florida. The species is anadromous, spawning in rivers during the spring, and migrating into the estuaries and bays in the fall (NOAA NMFS, 2024h). In the winter, adults may move further into marine waters, whereas younger fish (ages 2 to 3 years) would remain in estuarine and freshwater habitats. Estuarine and marine habitat includes shallow water habitats and shoals (5 to 7 feet deep), deeper waters near passes, unvegetated soft bottoms, and intertidal zones (NOAA NMFS, 2024h). The species can live up to 50 years (up to 25 years on average) and grow up to 8 feet long (NOAA NMFS, 2024h; 68 Fed. Reg. 13370). Threats include contaminant runoff, dredging, river dams, and environmental changes. Acoustic monitoring near the Chandeleur Island chain indicates that adult Gulf sturgeon from the Pearl and Pascagoula River breeding stocks winter at the Chandeleur Islands, with 14 individuals identified along North Chandeleur Island between December 2021 and March 2023 (Dance, N.d.; Constant, N.d.).

Marine Mammals

In addition to the listed species discussed above, all marine mammals are protected under the MMPA of 1972, including the bottlenose dolphin. Under Section 3 of the MMPA, all marine mammals are protected from “take” which is defined as to “harass, hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal.” NMFS has authority over the marine mammals potentially occurring within the Project area, with the exception of the West Indian manatee, which is under USFWS jurisdiction and protected under both the ESA and the MMPA.

Bottlenose dolphins are one of the most common marine mammal species in the northern Gulf, occurring widely throughout waters surrounding the Project area (Vollmer and Rosel, 2013). This species can thrive on a wide variety of prey, some of which include fish, crustaceans (for example, shrimp and crab), and squid. The primary threats to bottlenose dolphins include interactions with fishing gear, habitat destruction and degradation, biotoxins (harmful algal blooms), and illegal human harassment and feeding activities (NOAA NMFS, 2024i).

Dolphin aerial surveys were conducted over the general Project area (Biloxi Marsh, Chandeleur Sound, and the Chandeleur Islands) from May 2022 through June 2023. Surveys were conducted by scanning the open water for signs of marine life, including bottlenose dolphins, and other marine animals. All marine animal sightings were recorded in a survey log and compared between the three survey areas. Analysis of the aerial survey data was conducted to discern whether bottlenose dolphins exhibited a preference for the Chandeleur Islands over the nearby Chandeleur Sound or Biloxi Marsh.

Survey efforts recorded a combined total of 255 dolphin sightings. Analysis of the aerial survey data indicated a notably higher frequency of dolphin sightings around North Chandeleur Island when compared to the nearby Chandeleur Sound or Biloxi Marsh survey areas. Additionally, analysis of the overall dolphin observations around North Chandeleur Island (n = 184) from the aerial surveys recorded the highest number of dolphin observations in the central/seagrass area of North Chandeleur Island (n = 91), followed by the east side/open water (n = 74), and the west side open water having the smallest (n = 19) number of observations.

Seagrass beds within the Project area provide habitat for a diverse assemblage of invertebrate and fish species, likely attracting the large number of dolphins. Based on the Project-specific aerial surveys and review of publicly available data, it is likely that dolphins from both the Mississippi River Delta and the Mississippi Sound/Lake Borgne/Bay Boudreau Stocks utilize the Chandeleur Islands and seagrass meadows as foraging grounds year-round, although dolphins from the northern coastal stock are also likely to occur (NOAA NMFS, 2023a).

Environmental Consequences

Threatened and Endangered Species

For actions involving major construction activities with the potential to affect ESA-listed species or designated critical habitat, such as the proposed Project, a Biological Assessment (BA) must be submitted to the USFWS and/or NMFS. Based on anticipated Project impacts, the LA and Open Ocean TIGs are entering formal consultation with the USFWS and NMFS in accordance with Section 7 of the ESA, and the BA is included as Appendix G of Joint RP/EA #1. All consultation would be completed prior to Project construction, and any avoidance and mitigation measures developed in coordination with the USFWS and NMFS during the formal consultation process would be implemented for the Project.

The species discussions in this section incorporate and rely on assessments in the BA. Although the BA includes the information that was necessary for formal consultation under the ESA, the below analysis also includes the information to comply with NEPA, including an assessment of alternatives.

The determinations from the BA are included in Table D-8 and include:

- No effect: the proposed Project would not affect a listed species;
- May affect, not likely to adversely affect: effects on a listed species are expected to be discountable (extremely unlikely to occur), insignificant (the impact would never reach the scale where take occurs), or completely beneficial; and
- May affect, likely to adversely affect: adverse effects on a listed species may occur as a direct or indirect result of the proposed Project and the effect is not discountable, insignificant, or beneficial.

Table D-8. Summary of Impacts on Listed Species and critical habitats from the Action Alternatives

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Species Under U.S. Fish & Wildlife Service Jurisdiction				
Birds				
Black-capped Petrel	*Pterodroma hasitata*	Endangered	NE/NI	The species range overlaps within only the vessel transit pathways. It is not subject to potential impacts from vessel strikes, and no modification of marine habitat is proposed along vessel access routes.
Eastern Black Rail	*Laterallus jamaicensis ssp. jamaicensis*	Threatened	NE/NI	The Chandeleur Islands are outside areas of documented species occurrences, and, given the islands' location offshore, the species is not expected to occur in the Project area.
Piping Plover	*Charadrius melodus*	Threatened	LAA/short-term to long-term, moderate, adverse; long-term, beneficial	The species is known to occur in the Project area. Construction would cause temporary short-term disturbance and displacement from the localized foraging and resting areas within the footprint of active construction. Available, undisturbed habitat would be present elsewhere on North Chandeleur Island during construction and, following restoration, the Project would benefit the species due to an increase in available wintering habitat.

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Piping Plover critical habitat	--	Unit LA-7	NLAA/short-term to long-term, minor, adverse; long-term, beneficial	While the Project would involve the placement of fill on some areas of critical habitat, overall, the Project would expand the area of available critical habitat, as well as barrier island longevity. Newly restored habitats are expected to present the essential physical and biological features needed to support Piping Plover.
***Rufa* Red Knot**	*Calidris canutus rufa*	Threatened	LAA/short-term to long-term, moderate, adverse; long-term, beneficial	The species is known to occur in the Project area. Construction would cause temporary short-term disturbance and displacement from the localized foraging and resting areas within the footprint of active construction. Available, undisturbed habitat would be present elsewhere on North Chandeleur Island during construction and, following restoration, the Project would benefit the species due to an increase in available wintering habitat.
***Rufa* Red Knot critical habitat**	--	Proposed, Unit LA-1	NLAA/short-term to long-term, minor, adverse; long-term, beneficial	While the Project would involve the placement of fill on some areas of proposed critical habitat, overall, the Project would expand the area of available habitat, as well as barrier island longevity. Newly restored habitats are expected to present the essential physical and biological features needed to support *Rufa* Red Knots.

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Mammals				
Tricolored bat	*Perimyotis subflavus*	Proposed Endangered	NE/NI	The species range overlaps within only the vessel transit pathways. It is not subject to potential impacts from vessel strikes, and no terrestrial work or modification of terrestrial habitat is proposed along vessel access routes.
West Indian manatee	*Trichechus manatus latirostris*	Threatened	NLAA/short-term to long-term, minor, adverse; long-term, beneficial	The species has been documented in the mSAV beds around North Chandeleur Island (sighting currently unverified), and is an occasional or seasonal visitor to the Project area. Construction activities would temporarily disturb or displace individuals, if present, but agency-recommended BMPs (such as the USFWS' Standard Manatee Conditions for In-water Work [USFWS, 2011]) would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, the Louisiana Coastal Protection and Restoration Authority (CPRA) would implement mitigation measures per NMFS Protected Species Construction Conditions (NOAA NMFS, 2021a).
Reptiles–terrestrial environment				
Alligator snapping turtle	*Macrochelys temminckii*	Proposed Threatened	NE/NI	The species range overlaps within only the vessel transit pathways. It is not subject to potential impacts from vessel strikes, and no terrestrial work or modification of terrestrial or riverine habitat is proposed along vessel access routes.

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Gopher tortoise	*Gopherus polyphemus*	Threatened	NE/NI	The species range overlaps within only the vessel transit pathways. It is not subject to potential impacts from vessel strikes, and no terrestrial work or modification of terrestrial habitat is proposed along vessel access routes.
Green sea turtle, North Atlantic DPS	*Chelonia mydas*	Threatened	LAA/short-term to long-term, moderate, adverse; long-term, beneficial	The species is known to nest on North Chandeleur Island. Nests present would be marked and avoided, or relocated prior to construction, but any nest not discovered and relocated could be lost. Impacts would also occur from the temporary disruption/reduction of nesting habitat. Long-term benefits due to increased nesting habitat would occur following implementation of the Project.
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered	NE/NI	The species does not nest in the Project area.
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	LAA/short-term to long-term, moderate, adverse; long-term, beneficial	The species is known to nest on North Chandeleur Island. Nests present would be marked and avoided, or relocated prior to construction, but any nest not discovered and relocated could be lost. Impacts would also occur from the temporary disruption/reduction of nesting habitat. Long-term benefits due to increased nesting habitat would occur following implementation of the Project.
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	NE/NI	The species does not nest in the Project area.

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Loggerhead sea turtle, Northwest Atlantic DPS	*Caretta caretta*	Threatened	LAA/short-term to long-term, moderate, adverse; long-term, beneficial	The species is known to nest on North Chandeleur Island. Nests present would be marked and avoided, or relocated prior to construction, but any nest not discovered and relocated could be lost. Impacts would also occur from the temporary disruption/reduction of nesting habitat. Long-term benefits due to increased nesting habitat would occur following implementation of the Project.
Fish				
Gulf sturgeon	*Acipenser oxyrinchus*	Threatened	NE/NI	The species range overlaps within only the vessel transit pathways. No modification of riverine or estuarine habitat is proposed along vessel access routes.
Gulf sturgeon critical habitat	--	CHU8	NE/NI	Critical habitat is only present within the vessel transit pathways; no dredging or other habitat modification is proposed within this zone of influence (ZOI).
Pallid sturgeon	*Scaphirhynchus albus*	Endangered	NE/NI	The species range overlaps within only the vessel transit pathways. No modification of riverine or estuarine habitat is proposed along vessel access routes.
Insects				
Monarch butterfly	*Danaus plexippus*	Proposed Threatened	NE/NI	While pollinator plant species may be present in terrestrial habitat in the Project area, milkweed was not documented in vegetation assessments conducted in 2023, and suitable monarch butterfly or caterpillar habitat would not be directly affected by beach, dune, or marsh fill for the Project.

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Ferns and Allies				
Louisiana Quillwort	*Isoetes louisianensis*	Endangered	NE/NI	The species range overlaps within only the vessel transit pathways. No terrestrial work or modification of terrestrial habitat is proposed along vessel access routes.
Species under NOAA NMFS Jurisdiction				
Reptiles—marine environment				
Green sea turtle, North Atlantic DPS	*Chelonia mydas*	Threatened	LAA/short-term to long-term, minor, adverse; long-term, beneficial	Take of individuals could occur due to entrainment or impingement during use of hopper dredges. Construction activities would temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (NOAA NMFS, 2021a).
Green sea turtle critical habitat	--	Proposed, North Atlantic DPS	NE/NI	The Project itself would not be within the proposed critical habitat and overlap with the Project area would be restricted to the outer extent of the Project area and within the vessel transit pathways. The only effects of the action within those overlapping areas would be limited to vessel transit, which would be similar to the existing uses.

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered	NLAA/short-term to long-term, minor, adverse; long-term, beneficial	The species is not anticipated to be in the Project area with any regularity, particularly in proximity to restoration activities. Agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (NOAA NMFS, 2021a).
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	LAA/short-term to long-term, minor, adverse; long-term, beneficial	Take of individuals could occur due to entrainment or impingement during use of hopper dredges. Construction activities would temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (NOAA NMFS, 2021a).
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	NLAA/short-term to long-term, minor, adverse; long-term, beneficial	The species is not anticipated to be in the Project area with any regularity, particularly in proximity to restoration activities. Agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (NOAA NMFS, 2021a).

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Loggerhead sea turtle, Northwest Atlantic DPS	*Caretta caretta*	Threatened	LAA/short-term to long-term, minor, adverse; long-term, beneficial	Take of individuals could occur due to entrainment or impingement during use of hopper dredges. Construction activities would temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (NOAA NMFS, 2021a).
Loggerhead sea turtle critical habitat	--	Northwest Atlantic DPS	NE/NI	The Project itself would not be within the critical habitat, and overlap with the Project area would be restricted to vessel transit pathways. The only effects of the action within those overlapping areas would be limited to vessel transit, which would be similar to the existing uses.
Fish				
Giant manta ray	*Mobula birostris*	Threatened	NLAA/short-term to long-term, minor, adverse; long-term, beneficial	Construction activities would temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or other construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (NOAA NMFS, 2021a).

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	Threatened	LAA/short-term to long-term, minor, adverse; long-term, beneficial	Take of individuals could occur due to entrainment or impingement during use of hopper dredges, although the more susceptible juveniles are not anticipated in the Project area or dredging locations. Other construction activities would temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or other construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (NOAA NMFS, 2021a).
Gulf sturgeon critical habitat	---	CHU 8	NE/NI	Critical habitat is only present within the vessel transit pathways; no dredging or other habitat modification is proposed within this ZOI.
Oceanic whitetip shark	*Carcharhinus longimanus*	Threatened	NE/NI	The species range overlaps within only the vessel transit pathways. It is not subject to potential impacts from vessel strikes, and no modification of marine habitat is proposed along vessel access routes.
Marine Mammals				
Rice's whale	*Balaenoptera ricei*	Endangered (vessel access only)	NLAA/short-term to long-term, minor, adverse; long-term, beneficial	Potential occurrence is limited to the vessel transit pathways, where potential impacts would be limited to vessel impact. Typical BMPs would be implemented to minimize the potential for impact due to vessel strikes.

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	ESA/NEPA Effect Determination	Justification
Rice's whale critical habitat	---	Proposed	No effect	Critical habitat is only present within the vessel transit pathways; no dredging or other habitat modification is proposed within this ZOI.

NE = no effect; NI = no impact; LAA = likely to adversely affect; NLAA = not likely to adversely affect. Information presented is summarized from the Project BA.

In addition to summarizing the ESA determinations made in the BA, a corresponding NEPA determination of impact is also provided, based on the definitions provided in the DWH Final PDARP/PEIS. They include the following threatened and endangered species indicators for the following impacts, along with major impacts (which are not described here, as major, adverse impacts are not applicable to the Project):

- No impact: there is no discernible or measurable impact. This would generally correlate with an ESA Section 7 no effect determination.
- Minor impact: impacts on threatened or endangered species, their habitats, or the natural processes sustaining them could be detectable, but small and localized, and could not measurably alter natural conditions. This impact would generally correlate with an ESA Section 7 may affect, not likely to adversely affect determination.
- Moderate impact: impacts on threatened or endangered species, their habitats, or the natural processes sustaining them could be detectable and some alteration in the numbers of species or occasional responses to disturbance by some individuals could be expected, with some negative impacts on feeding, reproduction, resting, migrating, or other factors affecting local and adjacent population levels. Impacts could occur in key habitats, but sufficient population numbers or habitat could remain functional to maintain the viability of the species both locally and throughout their range. Some disturbance to individuals or impacts on potential or designated critical habitat could occur. This impact would generally correlate with an ESA Section 7 may affect, likely to adversely affect determination for at least one listed species. No adverse modification of critical habitat could be expected.

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term to long-term adverse impacts on ESA-listed species and critical habitat associated with the action alternatives would not occur. However, long-term benefits from habitat creation and increased barrier island longevity would also not occur. Over time, coastal processes, shoreline change, overwash, and erosion would contribute to the loss of habitat utilized by ESA-listed species. While the No Action Alternative would provide the greatest area of subtidal habitat, the potential to support mSAV would be reduced over time, as sediment is expected to migrate away from the Project area and result in long-term conversion to open water and the associated losses of habitat for wintering shorebirds and nesting sea turtles protected under the ESA. The loss of these habitats would result in (up to) major, long-term, adverse impacts on threatened and endangered species (particularly shorebirds and sea turtles) as the species would lose essential habitat.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Potential short-term to long-term, minor to moderate, adverse effects on threatened and endangered species and their habitats could occur as a result of Project construction activities; however, there would be long-term benefits to protected species (particularly sea turtles, shorebirds, and estuarine-dependent species), and their habitat once construction is complete. By restoring North Chandeleur and New Harbor Islands, and providing shoreline protection and sediment-holding features, the Project is expected to prolong the existence of barrier island habitat, which is essential for the restoration of protected shorebird population levels, the continued provision of sea turtle nesting habitat, and the continued presence of mSAV for foraging marine species.

Table D-8, summarizes the potential impacts on threatened and endangered species for the Preferred Alternative. As further described in the BA (see Appendix G of Joint RP/EA #1), BMPs would be implemented during construction to minimize the potential for impacts on protected species, including measures from the *Protected Species Construction Conditions* (NOAA NMFS, 2021a), *Measures for Reducing Entrapment Risk to Protected Species* (NOAA NMFS, 2012), *Vessel Strike Avoidance Measures and Reporting for Mariners* (NOAA NMFS, 2021b), and *Standard Manatee Conditions for In-water Work* (USFWS, 2011).

In summary, potential short-term to long-term, minor, adverse effects on protected species such as West Indian manatee, dolphins, sea turtle species that do not nest in or frequent the Project area (that is, leatherback and hawksbill sea turtle), Rice's whale, and giant manta ray may include temporary, localized, noise impacts, entrapment, and collisions with vessels and/or dredging equipment. For each of these species, impacts would be avoided and minimized to the extent practicable through the implementation of the BMPs and protected measures described above.

Potential short-term to long-term, minor to moderate, adverse effects would occur where the Project would affect shorebirds and their associated designated or proposed critical habitat (Piping Plover and Red Knot); sea turtles that nest in and/or frequent open water areas in the Project area (that is, green, Kemp's ridley, and loggerhead sea turtles), and Gulf sturgeon. Each of these species is vulnerable to Project impacts resulting from displacement or disturbance in critical wintering habitat (shorebirds) or injury or mortality due to disturbance of nesting beaches or operation of hopper dredges. However, following construction, long-term benefits to habitat quality and longevity are expected to provide long-term benefits to species that occur in the Project area. Specifically, the Project would construct about 179 acres of sea turtle nesting habitat (between elevations of +4 and +5.5 feet NAVD88) that would be available at TY-0 and maintained for the life of the Project. By comparison, 48 acres of sea turtle nesting habitat are projected to be available at TY-0 if the Project is not implemented, with 0 acres remaining by TY-5 (see Table D-9).

Table D-9. Sea Turtle Nesting Habitat Sustainability on North Chandeleur Island

Alternative	TY-0	TY-5	TY-10	TY-15	TY-20
Alternative 1 (No Action)	48	0	0	0	0
Alternative 5 (Preferred Alternative)	179	205	273	307	234
Alternative 2	200	200	310	305	50
Alternative 3	205	205	336	335	52
Alternative 4	164	190	247	282	230

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

The duration of construction for Alternative 2 would be similar to, although shorter than, Alternative 5 (752 compared to 868 days), and the alternative would require a similar type and quantity of construction equipment, which is expected to disturb protected species present in the Project area. The largest difference between the alternatives is the amount of habitat affected and created/restored, which results in the same effective impact determinations for each species, as listed in Table D-8, but with incrementally higher or lower impact or benefit. For example, while Alternative 2 would have fewer restoration features and therefore slightly less impacts during construction, it would also provide the smallest area of total habitat (including critical habitat) for protected shorebirds on North Chandeleur Island when compared with the other action alternatives at TY-20 (2,391 acres of intertidal and supratidal habitat, as compared with 2,865 acres under Alternative 5; see Table D-4). The smaller restoration footprint and reduced island longevity would also provide less protection for adjacent mSAV than Alternative 5. Similarly, Alternative 2 would provide the least sea turtle nesting habitat acres (50 acres) by TY-20 when compared with the other action alternatives (see Table D-9).

Overall, protected species such as West Indian manatee, sea turtle species that do not nest in or frequent the Project area (that is, leatherback and hawksbill sea turtle), Rice's whale, and giant manta ray would be subject to potential short-term to long-term, minor, adverse effects from Project construction. Potential short-term to long-term, minor to moderate, adverse effects would affect protected shorebirds and associated designated or proposed critical habitat (Piping Plover and Red Knot); sea turtles that nest in and/or frequent open water areas in the Project area (that is, the green, Kemp's ridley, and loggerhead sea turtles), and Gulf sturgeon. However, following construction, long-term benefits to habitat quality and longevity (see Section D.1.2.1) are expected to provide long-term benefits to listed species that occur in the Project area (see Table D-8). The general impacts described above for Alternative 5 capture the impacts anticipated for implementation of Alternative 2.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

The duration of construction for Alternative 3 (749 days) would be similar to, although shorter than, each of the other action alternatives, and would require a similar type and quantity of construction equipment, which is anticipated to disturb protected species present in the Project area. The largest difference between the alternatives is the amount of habitat affected and created/restored, which results in the same effective impact determinations for each species, as listed in Table D-9, but with incrementally higher or lower impact or benefit. This alternative would provide approximately 5,000 more linear feet of restored beach and dune habitat on North Chandeleur Island when compared with Alternatives 2 and 4 and would provide more sustainable habitat (including critical habitat) for protected shorebirds on North Chandeleur Island throughout the 20-year analysis period (2,440 acres of intertidal and supratidal; see Table D-4) when compared with Alternative 2. The smaller restoration footprint and reduced island longevity would also provide less protection for adjacent mSAV than Alternative 5. Alternative 3 would also provide an estimated 52 acres of sea turtle nesting habitat by TY-20, which is much smaller than the area expected for Alternatives 4 and 5 (see Table D-9). Overall, protected species such as West Indian manatee, sea turtle species that do not nest in or frequent the Project area (that is, leatherback and hawksbill sea turtle), Rice's whale, and giant manta ray would be subject to potential short-term to long-term, minor, adverse effects from Project construction. Potential short-term to long-term, minor to moderate, adverse effects would occur where the Project would affect protected shorebirds and associated designated or proposed critical habitat (Piping Plover and Red Knot); sea turtles that nest in and/or frequent open water areas in the Project area (green, Kemp's ridley, and loggerhead sea turtles); and Gulf sturgeon. However, following construction, long-term benefits to habitat quality and longevity (see Section D.1.2.1) are expected to provide long-term benefits to listed species that occur in the Project area (see Table D-8). The general impacts described above for Alternative 5 capture the impacts anticipated for implementation of Alternative 3.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

The duration of construction for Alternative 4 (754 days) would be similar to each of the other action alternatives, although shorter than Alternative 5 (868 days), requiring comparable types and quantities of construction equipment, which are expected to disturb wildlife present in the Project area. The largest difference between the alternatives is the amount of habitat affected and created/restored, which results in the same effective impact determinations for each species, as listed in Table D-8, but with incrementally higher or lower impact or benefit. The number of borrow areas would be the same across all alternatives; however, in Alternative 4, the placement area would be a feeder beach, near the nodal zone along the Gulf shoreline of North Chandeleur Island, allowing natural processes to nourish the beach over time, thus slowing the shoreline erosion rate. By TY-20, only Alternative 5 would create greater long-term benefits to intertidal and supratidal dune habitat supporting shorebirds when compared with Alternative 4 (2,782 acres on North Chandeleur Island under Alternative 4, when compared with 2,865 acres under Alternative 5; see Table D-4). Similarly, following implementation, and except when compared with Alternative 5, Alternative 4 would provide the greatest total area of sea turtle nesting habitat (230 acres) by TY-20 due to inclusion of the feeder beach in the Alternative 4 design (see Table D-9).

Overall, protected species such as the West Indian manatee, sea turtle species that do not nest in or frequent the Project area (that is, the leatherback and hawksbill sea turtle), Rice's whale, and giant manta ray would be subject to potential short-term to long-term, minor, adverse effects from Project construction. Potential short-term to long-term, minor to moderate, adverse effects would affect protected shorebirds and associated designated or proposed critical habitat (the Piping Plover and Red Knot); sea turtles that nest in and/or frequent open water areas in the Project area (that is, green, Kemp's ridley, and loggerhead sea turtles); and Gulf sturgeon. However, following construction, long-term benefits to habitat quality and longevity (see Section D.1.2.1) are expected to provide long-term benefits to listed species that occur in the Project area (see Table D-8). The general impacts described above for Alternative 5 capture the impacts anticipated for implementation of Alternative 4.

Marine Mammals

Marine mammals potentially occurring in the Project area include both listed and non-listed species under the ESA. West Indian manatee and Rice's whale are protected by both the MMPA and ESA and are therefore included in the above section. This section focuses on bottlenose dolphins, which are protected only by the MMPA.

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term to long-term adverse impacts on dolphins associated with the action alternatives would not occur. However, the long-term benefits from habitat creation and longevity would also not occur. Over time, coastal processes, shoreline change, overwash, and erosion would contribute to habitat loss in areas currently supporting seagrass beds. While the No Action Alternative would provide the greatest area of subtidal habitat, its potential to support mSAV would be significantly reduced. Over time, sediment is expected to migrate away from the Project area and result in long-term conversion to open water, resulting in less high-quality foraging habitat for the dolphins that were observed to use the North Chandeleur Island seagrass beds. Overall, the No Action Alternative would have a long-term, minor to moderate, adverse impact on dolphins.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Potential short-term to long-term, minor, adverse effects on bottlenose dolphins and their habitats could occur as a result of Project construction activities; however, there would be long-term benefits to available foraging habitat once construction is complete, which would benefit dolphins using the waters and habitats in the Project area. By restoring North Chandeleur and New Harbor Islands, the Project is expected to prolong the existence of barrier island habitat which would maintain high-quality seagrass foraging areas for local dolphin populations. Habitat restoration is further discussed in Section D.1.2.1.

Dolphins in the Project area could be affected by temporary disturbance due to the presence of vessels, equipment, and personnel; vessel strikes; entrapment (including in enclosures, such as the shoreline protection features). In general, the measures to protect listed species from entrapment and vessel strikes (identified in the Threatened and Endangered Species Section, above) would protect dolphins.

The greatest potential for impacts from underwater noise would occur during impact pile-driving to install an estimated 30 timber piles for rock breakwaters and rock revetment warning signs near New Harbor Island; these impacts would be temporary and limited to the duration of pile installation (conservatively assumed to take about 30 days if driving one pile per day). A detailed assessment of pile-driving noise that may result from the Project is included in the BA (see Appendix G of Joint RP/EA #1); the assessment below summarizes the impacts for dolphins. NMFS has developed guidelines for noise thresholds likely to either cause behavioral effects via disturbance or injury via hearing loss to marine mammals, fish, and sea turtles (NOAA NMFS, 2023b; 2024j). Because pile-driving for the Project could exceed applicable thresholds for dolphins, the potential for impacts from impulsive sound due to pile-driving are presented in Table D-10 as the distances to injury and behavioral response thresholds for listed species based on the available multi-species and marine mammal acoustic tools (NOAA NMFS, 2024k; l). While the specific details of pile-driving are not known, a conservative scenario based on driving 15, 12-inch-diameter timber piles per day using 360 strikes per pile was used to assess potential impacts. As noted above, pile-driving is likely to extend over a longer period (approximately 30 days), resulting in fewer strikes per day and a smaller region of influence.

Table D-10. Isopleth Distances to Dolphin Injury and Behavioral Disturbance from Impulsive Noise

Species / Hearing Group	Permanent Injury Criteria, Peak SPL meters (ft)	Permanent Injury Criteria, SELcum meters (ft)	Behavioral Response, RMS SPL meters (ft)
Marine Mammals			
High-frequency cetaceans[a]	0.0 (0.0)	7.2 (23.7)	29.3 (96.1)

Source: NOAA NMFS, 2023b; 2024j-m

peak = peak sound pressure, RMS = root mean square; SELcum = cumulative sound exposure level; SPL = sound pressure level.

[a] Also referenced as mid-frequency cetaceans in NOAA NMFS, 2024l. This includes bottlenose dolphins in the Project area.

The isopleth distances for injury and behavioral effects for all species assessed is less than 200 feet. The Louisiana Coastal Protection and Restoration Authority (CPRA) would instruct personnel to assess the areas within 50 feet of pile-driving locations prior to beginning pile-driving and, if a protected species (such as a dolphin) is observed, avoid commencing pile-driving activities until it has left the area of its own accord. CPRA would further instruct personnel to be alert for protected species in the vicinity of pile-diving. Therefore, the potential for injury due to pile-driving noise is low. Impacts on ESA-listed species are described in further detail in the BA (see Appendix G of Joint RP/EA #1) and above.

Overall, potential short-term to long-term, minor, adverse effects on dolphins may include temporary, localized, noise impacts, entrapment, and collisions with vessels; however, these impacts would be avoided and minimized to the extent practicable though the implementation of the BMPs. Following construction, long-term benefits to habitat quality and longevity (see Section D.1.2.1) are expected to provide long-term benefits to the species that occur in the Project area, including bottlenose dolphins.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

The duration of construction for Alternative 2 would be similar to, although shorter than, Alternative 5 (752 compared to 868 days), and the alternative would require a similar type and quantity of construction equipment, which is expected to disturb dolphins present in the Project area through vessel traffic and noise. However, following construction, long-term benefits to habitat quality and longevity are expected. Overall, impacts on dolphins from construction are expected to be short-term to long-term, minor, and adverse; however, impacts following Project implementation are expected to be long-term and beneficial as habitat is created, restored, and/or protected, but with approximately 405 fewer acres of habitat (with elevations above -1.5 feet) present on North Chandeleur Island and available to protect seagrass foraging habitat behind the island at TY-20 when compared to the Preferred Alternative. The general impacts described for the Preferred Alternative, above, capture the impacts anticipated for implementation of Alternative 2.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

The duration of construction for Alternative 3 (749 days) would be similar to, although shorter than, each of the other action alternatives, and would require a similar type and quantity of construction equipment. As discussed for Alternative 2, overall impacts on dolphins from construction are expected to be short-term to long-term, minor, and adverse; however, impacts following Project implementation are expected to be long-term and beneficial as habitat is created, restored, and/or protected. Approximately 404 fewer acres of habitat (with elevations above -1.5 feet) would be present on or around North Chandeleur Island and available to protect seagrass foraging habitat behind the island at TY-20 when compared to the Preferred Alternative. The general impacts described for the Preferred Alternative, above, capture the impacts anticipated for implementation of Alternative 2.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

The duration of construction for Alternative 4 (754 days) would be similar to each of the other action alternatives, requiring comparable types and quantities of construction equipment. As discussed for Alternative 2, overall impacts on dolphins from construction are expected to be short-term to long-term, minor, and adverse; however, impacts following Project implementation are expected to be long-term and beneficial as habitat is created, restored, and/or protected. By TY-20, only the Preferred Alternative would create greater long-term habitat benefits when compared with Alternative 4 (and only by about 7 acres); although those habitats described in Table D-4 would not be directly used by dolphins, their presence would allow for the continued protection of seagrass beds and other higher quality fish habitat over time. The general impacts described for the Preferred Alternative, above, capture the impacts anticipated for implementation of Alternative 2.

D.1.3 Socioeconomic Resources

This section discusses relevant human resources including socioeconomics, cultural resources, infrastructure, land and marine management, tourism and recreation, aesthetics and visual resources, public health and safety, fisheries and aquaculture, and marine transportation.

D.1.3.1 Socioeconomics

Affected Environment

The Chandeleur Islands have no structures and no permanent or temporary populations. However, communities along the Louisiana and Mississippi coast use the islands and the surrounding area for various recreational and commercial activities. The closest populated towns near the Chandeleur Islands are in Plaquemines and St. Bernard Parishes, about 50 miles to the west of the Project, and several coastal communities about 25 miles north in Mississippi.

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term beneficial impacts associated with construction of the action alternatives would not occur. Implementation of the Project is anticipated to benefit natural resources and therefore benefit local socioeconomic conditions over the long term. Under the No Action Alternative, these benefits would not be realized, resulting in a long-term, minor, adverse impact on socioeconomic factors over time, from the continued degradation and loss of natural resources.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

The Project area is uninhabited by people and would remain so under the Preferred Alternative (and all alternatives). However, construction of the Preferred Alternative would likely result in short-term to long-term beneficial impacts on the local economy, particularly in local coastal areas. Short-term, beneficial impacts would be realized through the purchase of construction materials and equipment from local businesses, hiring a portion of the workforce from the local labor force, and spending in the nearby areas by Project construction personnel.

Once the Project is implemented, the Project could provide direct and indirect long-term benefits to commercial and recreational fishing industries through increased fish populations and improved wildlife habitat. In addition, the restored areas of the islands would aid in buffering coastal communities from the effects of coastal storms, such as flooding. Finally, the improved habitat may induce increased recreational and commercial activity in the area, which could also benefit area economies.

The local coastal communities are located 25 miles or more north of the Project and would not experience direct adverse impacts from construction traffic, noise, or related emissions. Further, visual receptors in these communities are sufficiently removed such that Project construction would not be visible.

Overall, Alternative 5 would have short-term, beneficial impacts during Project construction and long-term, beneficial impacts after construction is complete. Construction of the Preferred Alternative is anticipated to take about 868 days to complete, compared to between 749 and 754 days for the other three action alternatives. The longer construction period may result in additional economic benefits through local spending by the Project workforce. Although all action alternatives would provide long-term, direct and indirect benefits to commercial and recreational fishing industries through increased fish populations and improved wildlife habitat, as well as indirect benefits from increased storm protection for coastal communities, the increased benefits would be higher for the Preferred Alternative compared to the other action alternatives given that it has the largest projected habitat creation (see Table D-3).

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Alternative 2 would have short-term, beneficial impacts during Project construction and long-term, beneficial impacts after construction is complete. Impacts on socioeconomics from Alternative 2 would be similar to those described above under the Preferred Alternative; however, it would result in somewhat fewer short-term and long-term benefits than the Preferred Alternative, given the decreased construction timeframe (752 days versus 868 days) and reduced habitat creation on North Chandeleur Island (see Table D-3).

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Overall, Alternative 3 would have short-term, beneficial impacts during Project construction and long-term, beneficial impacts after construction is complete. Impacts on socioeconomics from Alternative 3 would be similar to those described above under the Preferred Alternative; however, it would result in somewhat fewer benefits than the Preferred Alternative, given the decreased construction timeframe (749 days versus 868 days) and reduced habitat creation on North Chandeleur Island (see Table D-3).

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Overall, Alternative 4 would have short-term, beneficial impacts during Project construction and long-term beneficial impacts after construction is complete. Impacts on socioeconomics from Alternative 4 would be similar to those described above under the Preferred Alternative; however, it would result in somewhat fewer benefits than the Preferred Alternative, given the decreased construction timeframe (754 days versus 868 days) and reduced habitat creation on North Chandeleur Island (see Table D-3).

D.1.3.2 Cultural Resources

Affected Environment

Cultural resources are evidence of past human activity. In marine settings, these may include historic shipwrecks and associated debris such as armaments, ammunitions, barrels, furnishings, as well as historic lighthouses, and prehistoric and historic archaeological sites.

In 2023, Goodwin & Associates, Inc. (Goodwin) conducted Phase I submerged cultural resources investigations for the Project, including analyses of high-resolution geophysical survey data collected by Ocean Surveys, Inc. (Schmidt et al., 2025). The marine Area of Potential Effects (APE) is the proposed “geographic area or areas within which an undertaking may directly or indirectly cause changes in the character of or use of historic properties, if any such properties exist” (36 CFR § 800.16(d)). The marine APE for archaeological resources includes all areas where the seabed may be disturbed, including the HPBA, pump-out areas, conveyance corridors, and access channels. The central and southern offshore pump-out area (Rehandling Areas 1 and 2 respectively) were previously surveyed by Tidewater Atlantic Research in 2010 as part of the Emergency Berm to Barrier Project and reported no potentially significant cultural resources in those areas (Watts, 2011) The geophysical survey of the APE was designed to locate and potentially identify specific magnetometer anomalies, side scan sonar images, and subbottom profiler anomalies that represent significant submerged cultural resources. The identification of potentially significant submerged cultural resources involves correlation of data from the entire remote sensing array; as a result, accurate recording of anomaly locations is essential.

A desktop review of the Project area, which included a 1-mile radius around the APE, was conducted and focused on available previous cultural resources reports, inventories of identified historic properties, and submerged cultural resources (pre- and post-contact period). That research included a review of readily available historical maps, and other relevant public records, as well as an examination of the site files and records sourced from the Louisiana Cultural Resource Viewer maintained by the Louisiana Division of Archaeology in Baton Rouge. Additionally, this research included reviewing the National Oceanic and Atmospheric Administration (NOAA), Office of Coast Survey's Wrecks and Obstructions database (NOAA, 2023), the Office of Coast Survey's Historical Map & Chart Collection, and the hydrographic survey data and products. The literature search and records review were used to determine the location of all previously recorded archaeological sites, shipwrecks, historic standing structures, historic cemeteries, and National Register of Historic Places (NRHP) properties within or adjacent to the Project. No historic properties or previously identified cultural resources were identified within the Project APE.

During the research, lists of reported vessel losses in the 1-mile radius around the Project area were created using online and published compendia of such data, including the NOAA Office of Coast Survey's Wrecks and Obstructions database (NOAA, 2023). No reported vessel losses were identified as within the Project APE.

Understanding the natural environment is paramount in predicting how and where humans interacted with a landscape across time. Determining the preservation potential of cultural materials within the Project area requires consideration of both the landscapes and environments that have existed in the area throughout time, and the likelihood that cultural materials deposited in those landscapes have been preserved and remain undisturbed. The development in this area is closely tied to regional sea-level changes, subsidence, and delta switching cycles.

There is some evidence of human activity on the St. Bernard delta between 1,800 to 300 years before present as progressive stages of delta abandonment expanded brackish wetlands, which supported native food supplies (Otvos and Giardino, 2004). Though humans likely interacted with this landscape during this period, archaeological habitation sites in areas that are flooded for extended periods of time are rare. In these areas, it is more likely that smaller ephemeral archaeological deposits may be identified that are associated with the nomadic collection of food and its processing. The Project area was likely submerged and uninhabitable prior to the development of the St. Bernard delta complex and was likely also unsuitable during and after its initial development, being primarily composed of saturated mud, which would have presented as an unsuitable/unfavorable surface for human habitation.

Once deposited, the preservation potential of cultural materials in subaqueous conditions is significantly affected by both physical and geological processes, which are primarily driven by delta formation and reworked sediments caused by sea-level rise, erosional shoreface retreat, and episodes of severe storms. As a result, over time, the preservation of cultural materials within these sedimentary matrices is reworked and often greatly reduced or destroyed. Although, the discovery of archaeological deposits within the natural landscapes of the Project area is possible, the normal setting is not conducive to their preservation. Therefore, even in normal conditions, the potential for encountering preserved cultural materials with the existing environment within the Project area is categorized as low.

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, none of the proposed restoration activities would occur and the Project would not be implemented. There are no previously reported cultural resources in the proposed APE. A Phase I submerged cultural resources investigation was conducted in support of this proposed Project and found no cultural resources within the Project area (Schmidt et al., 2024). Although the discovery of archaeological deposits within the natural landscapes of the Project area is possible, the normal setting is not conducive to their preservation. Therefore, even in normal conditions, the potential for encountering preserved cultural materials with the existing environment within the Project area is categorized as low. Under the No Action Alternative there would be no short-term or long-term impacts on cultural resources.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

The Phase I submerged cultural resources investigation conducted in support of this proposed Project found no cultural resources within the Project area. As a result, although construction of the Preferred Alternative would cause the greatest amount of sediment and ground disturbance, there would be no anticipated short-term or long-term impacts on cultural resources from implementation of the Preferred Alternative, as none are located in the area. A complete review under Section 106 of the National Historic Preservation Act would be completed before construction activities begin. If any culturally or historically significant resources are identified during Project preparations or predevelopment surveys, such areas would be avoided during construction.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

The Phase I submerged cultural resources investigation conducted in support of this proposed Project found no cultural resources within the Project area. Similar to the Preferred Alternative, there would be no anticipated short-term or long-term impacts on cultural resources from implementation of the Alternative 2.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

The Phase I submerged cultural resources investigation conducted in support of this proposed Project found no cultural resources within the Project area. Similar to the Preferred Alternative, there would be no anticipated short-term or long-term impacts on cultural resources from implementation of the Alternative 3.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

The Phase I submerged cultural resources investigation conducted in support of this proposed Project found no cultural resources within the Project area. Similar to the Preferred Alternative, there would be no anticipated short-term or long-term impacts on cultural resources from implementation of the Alternative 4.

D.1.3.3 Infrastructure

Affected Environment

The Chandeleur Islands are uninhabited and only accessible by water or air. The islands are dominated by sandy beaches, submerged vegetation areas, and open water. There are no buildings or development directly on the islands and no roadway or recreational trail system exists on the islands.

Based on a review of recreational activities in the area, several floating mobile offshore vessels were identified near the Chandeleur Islands for commercial fishing charters (Chandeleur Pelican, 2024; Chandeleur Islander, 2024). The Chandeleur Pelican is located within Schooner Cove, an area on the west side of North Chandeleur Island. The Chandeleur Islander is located offshore between New Harbor Island and North Chandeleur Island. These vessels or lodges offer onsite, overnight accommodations and home base for recreational fishing and tourist excursions in Chandeleur Sound.

There are no active oil or gas wells within the Project area based on a review of the Louisiana Department of Energy and Natural Resources (LDENR) Strategic Online Natural Resources Information System (SONRIS) Mapper (LDENR, 2024). A review of publicly available pipeline databases identified two pipelines within the Project area. Both of the pipelines are active natural gas pipelines (12 and 16 inches in diameter). The pipelines are collocated and cross the Project area immediately south of North Chandeleur Island through the Katrina Cut where they are crossed by the nearshore conveyance and the offshore south conveyance corridors. Based on the geophysical and cultural resources survey conducted for the Project through this area, the pipelines are 8 feet and 11 feet below the seabed in the area where they would be crossed by the Project.

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the long-term beneficial impacts associated with implementation of the action alternatives would not occur. Impacts on infrastructure are not anticipated under the No Action Alternative.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

No impacts on infrastructure would occur during or after construction of the Preferred Alternative. There are no roads, utilities, or vessels on North Chandeleur Island or New Harbor Island. There are several existing offshore structures identified as overnight accommodations (lodges) for recreational fishermen and tourists. These structures are located within various coves along the west side of North Chandeleur Island and would not be directly affected by construction of the Project (see above), as they would be outside of the active construction footprint. Once the Project is completed, stabilization and restoration of the island would provide increased protection of these structures from erosion, resulting in a long-term, beneficial impact. Two pipelines were identified within the Project area on the south side of North Chandeleur Island, near the Katrina Cut. The pipelines would be crossed by the nearshore and offshore conveyance corridors where a sediment pipeline would be installed along the seabed within the corridors, over the existing gas pipelines. Since the sediment pipeline would not be buried and, therefore, would not affect the existing buried pipelines, the Project would have no impact on the existing infrastructure.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Infrastructure in the Project area is identical to that described for the Preferred Alternative; therefore, no impacts on infrastructure would occur during construction of Alternative 2. During implementation of Alternative 2, increased protection of offshore structures would result in a long-term beneficial impact.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Infrastructure in the Project area is identical to that described for the Preferred Alternative; therefore, no impacts on infrastructure would occur during construction of Alternative 3. During implementation of Alternative 3, increased protection of offshore structures would result in a long-term beneficial impact.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Infrastructure in the Project area is identical to that described for the Preferred Alternative; therefore, no impacts on infrastructure would occur during construction of Alternative 4. During implementation of Alternative 4, increased protection of offshore structures would result in a long-term beneficial impact.

D.1.3.4 Land and Marine Management

<u>Affected Environment</u>

The Federal Coastal Zone Management Act (CZMA) encourages states to develop coastal management programs for preserving statewide coastal resources. Once a state develops an approved coastal management program, "federal consistency" requires that any federal actions affecting coastal land or water resources (the Coastal Zone) be consistent with the state's program. The LDENR Office of Coastal Management (OCM) oversees the state's Coastal Zone Management Program (CZMP). The Project is located within the Louisiana Coastal Zone established by the State and Local Coastal Resources Management Act of 1978, modified in 2012 (LDENR, 2024).

St. Bernard Parish has a Local CZMP that was developed in 1982 and approved in 1987, with the most recent update to the program occurring in 2012 (Coastal Environments, Inc., 2012). The St. Bernard CZMP divided the parish into 15 environmental management units (EMU) (Coastal Environments, Inc., 2012) with each EMU assigned customized management goals based on environmental characteristics, existing uses, and existing resources. The Project (including the HPBA) is located within EMU 14 (Chandeleur Sound & Islands) and is recognized in the St. Bernard CZMP for potential coastal protection measures, as oyster growing areas, and for potential future use as a source of dredged material for marsh restoration (Coastal Environments, Inc., 2012).

The Chandeleur Islands are part of the Breton NWR, managed by the USFWS. Portions of the Project are located within the NWR, including the North Chandeleur Island, New Harbor Island, access channels, and a portion of the nearshore conveyance corridor. The NWR management objectives are outlined in the Delta and Breton National Wildlife Refuge Comprehensive Conservation Plan (CCP) (USFWS, 2008) and the Habitat Management Plan (HMP) for Delta and Breton National Wildlife Refuges (USFWS, 2013). Per the CCP, the goals and management objectives for the Breton NWR includes the conservation and restoration of the barrier island habitats for fish and wildlife resources, conservation and protection of coastal fish and wildlife species (emphasis on migratory birds, colonial nesting waterbirds, and threatened and endangered species), providing the public with recreational activities, environmental education, and outreach.

The HMP provides refuge managers with the guidance and tools for consistent habitat management. Under the HMP, the management objectives include island and dune restoration. The HMP includes potential restoration strategies to meet these objectives, including deposition of dredge spoil for island restoration and revegetation and/or construction of sand fences or similar devices to restore dunes on the NWR. Additionally, most of the Breton NWR is designated as a federal wilderness area, Breton Wilderness, and protected under the 1964 Wilderness Act. The HMP also outlines objectives and the strategies to meet the provisions required for wilderness areas.

The Chandeleur Islands are within the Coastal Barrier Resources System (CBRS) unit LA-03P. The Coastal Barrier Resource Act (CBRA; Public Law 97-348), passed by Congress in 1982, designated undeveloped coastal barriers along the U.S. coast as part of the CBRS. The CBRA encourages the protection and conservation of hurricane prone coastal barriers by restricting federal funding that spurs development (for example, federal flood insurance) in these areas. The USFWS is the primary authority responsible for implementing the CBRA and monitoring the CBRS (USFWS, 2024c).

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term adverse impacts associated with implementation of the action alternatives would not occur. However, any long-term benefits, as discussed below, would also not occur. Overall, the No Action Alternative would have no measurable effect on land and marine management.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

As discussed above, the Chandeleur Islands are part of the Breton NWR, managed by the USFWS. Portions of the Project are located within the NWR, including North Chandeleur Island, New Harbor Island, the temporary access channels, and a portion of the nearshore conveyance corridor. The Chandeleur Islands are also designated as a federal wilderness area.

Construction of the Preferred Alternative would result in temporary access restrictions to land and marine management areas. Restricted access to areas of active construction (both on land and water) would be short term and minor. Once completed, the Project would result in direct, long-term, beneficial impacts on land and marine management in the Project area by meeting the objectives of the CCP and HMP, which include island restoration, habitat restoration and conservation, and protection of fish and wildlife species. Similarly, the Project would be consistent with the CBRA, which encourages the protection and conservation of hurricane prone coastal barriers. The Project would comply with all applicable guidance and restrictions associated with the Special Use Permit required for construction within the Breton NWR and Breton Wilderness Area.

Overall, the Preferred Alternative would result in direct, short-term, minor, adverse, but direct long-term, beneficial impacts on land and marine management in the Project area. Although all action alternatives would provide long-term, direct benefits on land and marine management, the benefits would be greater for the Preferred Alternative compared to the other action alternatives given the size of the Project and the overall larger area to be restored (see Table D-3).

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Overall, Alternative 2 would result in direct, short-term, minor, adverse impacts from restricted access during construction and direct, long-term, beneficial impacts on land and marine management in the Project area. Impacts on land and marine management for Alternative 2 would be the same as those described above under Alternative 5; however, it would result in somewhat fewer short-term impacts than Alternative 5, given the decreased construction timeframe (752 days versus 868 days), and slightly reduced long-term benefits from habitat creation on North Chandeleur Island (see Table D-3).

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Overall, Alternative 3 would result in direct, short-term, minor, adverse impacts from restricted access during construction and direct, long-term, beneficial impacts on land and marine management in the Project area. Impacts on land and marine management for Alternative 3 would be the same as those described above under Alternative 5; however, it would result in somewhat fewer short-term impacts than Alternative 5, given the decreased construction timeframe (749 days versus 868 days) and slightly reduced long-term benefits from habitat creation on North Chandeleur Island (see Table D-3).

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Overall, Alternative 4 would result in direct, short-term, minor, adverse impacts from restricted access during construction and direct, long-term, beneficial impacts on land and marine management in the Project area. Impacts on land and marine management for Alternative 4 would be the same as those described above under Alternative 5; however, it would result in somewhat fewer short-term impacts than Alternative 5, given the decreased construction timeframe (754 days versus 868 days) and slightly reduced long-term benefits from habitat creation on North Chandeleur Island (see Table D-3).

D.1.3.5 Tourism and Recreational Use

<u>Affected Environment</u>

The waters around the Chandeleur Islands, as well as the islands themselves, are a popular destination for boating, fishing, bird watching, and photography. While the islands and the surrounding areas are uninhabited, tourism to and around the island is frequent. As previously discussed, the Chandeleur Islands are part of the Breton NWR and the USFWS estimates that there are 3,000 visitors per year to the Breton NWR (USFWS, 2024d).

The Project area is accessible by air or by boat. Since most of the Project area is within the Breton NWR, activities permitted on the islands are managed by the USFWS. The USFWS does not allow planes or helicopters to land on refuge land or waters; however, planes can land outside of the refuge and passengers can boat or walk onto NWR lands (USFWS, 2024d). Sport finfishing (rod and reel or pole and line, only) and shellfishing are permitted on designated areas of the NWR (USFWS, 2024e). Various charter vessels are available originating from coastal areas in Louisiana and Mississippi. There are also several floating mobile offshore vessels that are moored off of North Chandeleur Island providing overnight accommodation and homebase for recreational fishing and tourist excursion and are available for rent (Chandeleur Pelican, 2024; Chandeleur Islander, 2024; see Section D.1.3.3). No camping, hunting, or motorized vehicles are permitted within the refuge. Commercial fishing is prohibited within the refuge or within 800 feet of the low water mark (USFWS, 2024e).

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term adverse impacts associated with implementation of the action alternatives would not occur. However, any long-term benefits, including enhanced experiences due to improved habitat for fish and wildlife species and larger usable beach areas, would also not be realized, resulting in a long-term, minor, adverse impact on tourism and recreational use associated with continued habitat degradation and loss.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Short-term, minor, adverse impacts on tourism and recreational use may occur during construction of any of the Project due to the presence of construction equipment and personnel, temporary disturbance of fish and wildlife habitat from construction activities, and the increase in boat traffic within the Project area. As discussed above, a variety of recreational activities occur on and around the Breton NWR, including sport finfishing and shellfishing, visits by charter vessels and planes, and offshore lodging vessels moored around North Chandeleur Island. During construction of the Project, portions of North Chandeleur Island and New Harbor Island would be inaccessible to the public where active construction is occurring. Fishing would still be permitted in areas around the island that are not actively under construction. CPRA has conducted outreach to local charter companies, as well as the owners of the existing offshore lodges, and are continuing to work with those individuals to address any concerns regarding the Project.

After construction is complete, there would likely be long-term beneficial impacts on tourism and recreation as a result of the restoration activities. Improved habitat for fish and wildlife species would result in an increase in these populations, providing a better recreational experience for tourists who visit the area. The restoration activities could also provide a socioeconomic benefit to charter companies and businesses specializing in tourism to the Chandeleur Islands. Restoration and stabilization of North Chandeleur Island would provide increased protection of the moored lodging facilities and fishing locations on the west side of the island, providing a long-term beneficial impact.

Overall, short-term, minor, adverse impacts on tourism and recreational use would occur during construction of Alternative 5 due to the presence of construction equipment and personnel, with long-term beneficial impacts occurring due to improved habitats and larger usable beach areas. The construction period for Alternative 5 would be longer than the other alternatives, which would result in impacts on tourism and recreational use over a longer period of time; however, the amount of improved habitat would be greater than the other action alternatives, resulting in slightly higher beneficial impacts following construction of the Project.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Short-term, minor, adverse impacts on tourism and recreational use may occur during construction due to the presence of construction equipment and personnel, with long-term beneficial impacts due to improved habitats and larger usable beach areas. Impacts on tourism and recreational use from Alternative 2 would be similar to those described above under Alternative 5, although the long-term benefits would be slightly less given the decrease in habitat created by Alternative 2.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Short-term, minor, adverse impacts on tourism and recreational use may occur during construction due to the presence of construction equipment and personnel, with long-term beneficial impacts due to improved habitats and larger usable beach areas. Impacts on tourism and recreational use from Alternative 3 would be similar to those described above under Alternative 5, although the long-term benefits would be slightly less given the decrease in habitat created by Alternative 3.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Short-term, minor, adverse impacts on tourism and recreational use may occur during construction due to the presence of construction equipment and personnel, with long-term beneficial impacts due to improved habitats and larger usable beach areas. Impacts on tourism and recreational use from Alternative 4 would be similar to those described above under Alternative 5, although the long-term benefits would be slightly less given the decrease in habitat created by Alternative 4.

D.1.3.6 Aesthetics and Visual Resources

Affected Environment

Visual resources include natural and manmade components of the environment perceived by human receptors. “Aesthetics” refers to beauty in both form and appearance. Perceptions and aesthetic values may vary among individuals depending upon personal preferences.

The Project area (including the Chandeleur Islands and New Harbor Island) is located within the Breton NWR. The Breton NWR is an uninhabited area with no permanent structures or surface infrastructure. The area remains relatively natural, dominated by sand beaches, coves, and open waters. As stated in Section D.1.3.4, the Chandeleur Islands are federally designated as a wilderness area. Wilderness areas are federal lands that are managed to protect their natural characteristics.

Viewsheds to the Project site are offered only from aircraft and boat. Additionally, there are several offshore, moored fishing vessels providing overnight accommodations that are available for rent and have direct views of the islands and the surrounding area (see Section D.1.3.5).

The closest onshore areas to the Project are coastal communities to the north in Harrison County, Mississippi and communities along the Mississippi River in St. Bernard and Plaquemines Parishes, Louisiana to the west. Neither the island, nor activities associated with the Project, would be visible from these onshore locations.

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term adverse impacts associated with changes in the viewshed from the action alternatives would not occur. However, any long-term benefits from the Project (including any wildlife viewing opportunities associated with habitat creation) would also not be realized, resulting in a long-term, minor, adverse impact on local aesthetics and visual resources associated with continued habitat degradation and loss.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Given its offshore location, the Project area would generally only be visible by air or boat, particularly by individuals who are visiting the Breton NWR and surrounding areas for recreational activities. Construction equipment, personnel, and vessel traffic would be visible to nearby visual receptors during active construction periods; although these impacts would be adverse, they would be short term and minor.

Implementation of the Project would restore beach, dune, and marsh habitat, which would enhance habitat for birds and sea turtle species, thereby enhancing the natural aesthetic of the islands. This would result in a long-term, beneficial impact on aesthetic and visual resources. The magnitude of these beneficial impacts would vary depending on an individual visual receptor’s perceptions and preferences.

Overall, the Preferred Alternative would have minor, short-term, adverse impacts on aesthetics and visual resources during Project construction and long-term, beneficial impacts after construction is complete. Whether the individual features of this alternative, or the resulting beach/dune and marsh areas created, would be discernable to viewers would depend on an individual visual receptor’s familiarity with the current viewshed and knowledge of such features. While the magnitude of these beneficial impacts would vary depending on an individual visual receptor’s perceptions and preferences, the larger restoration area associated with the Preferred Alternative would result in a larger change in the viewshed compared to the other alternatives discussed below.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Overall, the construction of Alternative 2 would result in short-term, minor, adverse impacts on aesthetic and visual resources, and long-term, beneficial impacts once construction is complete. Impacts on visual receptors in the Project area from Alternative 2 would be similar to those described above under Alternative 5, but would result in somewhat less of a change to the visual properties of North Chandeleur Island.

Once construction is complete, whether the individual features of this alternative (for example, sand reservoirs) would be discernible from different features for other action alternatives (for example, pocket marshes) or the resulting beach/dune and marsh areas created would depend on an individual visual receptor's familiarity with the current viewshed and knowledge of such features.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Overall, the construction of Alternative 3 would have short-term, minor, adverse impacts on aesthetic and visual resources and long-term, beneficial impacts after construction is complete. Impacts on visual receptors in the Project area from Alternative 3 would be similar to those described above under Alternative 5, but would result in somewhat less of a change to the visual properties of North Chandeleur Island.

Once construction is complete, whether the individual features of this alternative (for example, pocket marshes) would be discernible from different features for other action alternatives (for example, sand reservoirs) or the resulting beach/dune and marsh areas created (would depend on an individual visual receptor's familiarity with the current viewshed and knowledge of such features.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Overall, the construction of Alternative 4 would have minor, short-term, adverse impacts and long-term, beneficial impacts on aesthetics and visual resources after construction is complete. Whether the individual features of this alternative (for example, feeder beach) would be discernible from different features for other action alternatives (for example, sand reservoirs) or the resulting beach/dune and marsh areas created would depend on an individual visual receptor's familiarity with the current viewshed and knowledge of such features.

D.1.3.7 Public Health and Safety

Affected Environment

Public health and safety considerations include the health and safety of the general public, including boaters and that of the personnel involved in activities related to the construction of the proposed Project. Additionally, coastal islands act as a buffer to reduce the effects of flooding, wave action, saltwater intrusion, storm surge, and tidal current.

Executive Order (EO) 13045, Protection of Children from Environmental Health Risks and Safety Risks (1997), requires that Project-related environmental health and safety risks to children are identified and assessed and disproportionate risks to children are addressed.

The Project would be constructed on uninhabited land within the Breton NWR. Open water adjacent to the Project area is open to the public for recreational and commercial activities. Public access to the Project area is limited to boat and air traffic. The area is remote and uninhabited with the closest access points from Gulfport or Biloxi, Mississippi to the north and from St Bernard Parish, Louisiana to the west. The closest populated towns near the Chandeleur Islands are in St. Bernard Parish, about 50 miles to the west of the Project, and several coastal communities about 25 miles north in Mississippi.

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the long-term, beneficial impacts associated with restoration activities from the action alternatives would not occur. The No Action Alternative would result in long-term, minor, adverse impacts on public health and safety caused by continued coastal erosion and land loss which increases the risk of flooding, wave action, saltwater intrusion, storm surge, and tidal current further inland.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

Construction of the Project would not adversely impact public health and safety. Although heavy construction equipment and marine vessels would be used during construction, navigational safety measures would be followed to ensure the public safety of the general public including boaters and construction personnel. BMPs such as developing a Stormwater Pollution Prevention Plan and implementing warning signs would minimize the possibility of impacts on public health and safety. All United States Coast Guard rules and state/federal laws would be followed during construction, and construction activities would be conducted to avoid, to the greatest extent feasible, any unreasonable interference with public health and safety.

Implementation of the Project would result in long-term, beneficial effects on public health and safety through the restoration of the Chandeleur Islands. The restoration activities would increase the longevity of the barrier island chain, which acts as a buffer to reduce the effects of wave action, storm surge, and tidal currents, providing the benefit of increased storm risk reduction for coastal communities.

Additionally, the Project would comply with EO 13045, Protection of Children from Environmental Health Risks and Safety Risks and does not represent disproportionately high and adverse environmental health or safety risks to children. Implementation of the Project would not create other public health and safety concerns.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Impacts on public health and safety for Alternative 2 would be similar to the Preferred Alternative including long-term, beneficial impacts.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Impacts on public health and safety for Alternative 3 would be similar to the Preferred Alternative including long-term, beneficial impacts.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Impacts on public health and safety for Alternative 4 would be similar to the Preferred Alternative including long-term, beneficial impacts.

D.1.3.8 Fisheries and Aquaculture

Affected Environment

The area surrounding the Chandeleur Islands is available for both commercial and recreational fishing. Commercial fishery landings in 2022 in Louisiana were about 912 million pounds and resulted in a total commercial revenue of 416 million dollars. The dominant fishery in Louisiana (by monetary value) is shellfish, which accounted for over 70 percent of the total commercial revenue in the state (NOAA NMFS, 2022).

Recreational fishing is also an important activity in the state. The LDWF collects yearly data on recreational fishing efforts and catches to provide key data to guide them in fisheries management practices. According to the LDWF LA Creel Recreational Survey, in 2023 there were a total of 1,757,820 angler trips within Louisiana (LDWF, 2023). Of these, 424,628 trips were within the Pontchartrain Basin, which includes an area from the northern border of Louisiana down through the Chandeleur Islands. These trips resulted in a total of 1.2 million fish landings, with more than 65 percent of all landings dominated by seatrout species.

A review of the LDWF Oyster Map (LDWF, 2024) shows that there are POSGs within the Project area. The POSG overlaps about 2.5 miles of the northern most tip of North Chandeleur Island. No other portions of the Project area would be located within the oyster seed grounds.

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term adverse impacts associated with implementation of the action alternatives would not occur. However, any long-term benefits (including enhanced fisheries in the action area) would also not be realized, resulting in a long-term, minor, adverse impact on fisheries from the continued degradation and loss of high-quality fish habitat.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

A temporary decline in fish and mobile aquatic species near active construction, including within the borrow area, offshore pump-out areas, conveyance corridors, and temporary access channels, would likely occur due to relocation away from construction activities and would result in diminished commercial and recreational fishing experiences or relocation to another area.

However, these species are expected to return once the Project's construction activities have concluded, resulting in a short-term, minor, adverse impact on commercial and recreational fishing experiences in the action area.

There is a POSG located along the north end of North Chandeleur Island. Project features located within this area include the HPBA, alternative access channel north, marsh fill, and beach/dune fill; however, no oysters were observed during Project-specific seagrass surveys (see Appendix E of Joint RP/EA #1) and they are unlikely to occur within the HPBA because of the soft-bottom substrate. In the unlikely event that oysters are present in adjacent areas, or if areas suitable for oysters are present, turbidity and sedimentation from construction could result in short-term, minor, and adverse effects on the habitat and present individuals. These short-term impacts, if applicable, would be offset by the long-term, beneficial impacts on both terrestrial and aquatic habitats within the Project area by increasing the total quantity of available barrier island habitat available to shelter the POSG. As discussed further in Sections D.1.2.1 and D.1.2.3, impacts following Project implementation are generally expected to be long-term and beneficial. While the shoreline protection features along New Harbor Island would result in a permanent loss of soft-bottom habitat, they would provide hard substrate that would act as fish habitat and would provide long-term benefits by protecting mangrove habitat on New Harbor Island from erosion and loss.

Overall, the Project would have minor, short-term, adverse impacts during Project construction and long-term, beneficial impacts after construction is complete. However, as discussed in Section D.1.2.3, the combined material volumes from the restoration features would create and sustain the most habitat acreage compared to the other action alternatives, proving the greatest long-term benefits, including for EFH.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

Alternative 2 would have minor, short-term, adverse impacts during Project construction and long-term, beneficial impacts after construction is complete. Impacts on fisheries and aquatic species from Alternative 2 would be similar to those described above under the Preferred Alternative, but would create slightly less habitat for increased fish use along North Chandeleur Island.

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

Alternative 3 would have minor, short-term, adverse impacts during Project construction and long-term, beneficial impacts after construction is complete. Impacts on fisheries and aquatic species from Alternative 3 would be similar to those described above under the Preferred Alternative, but would create slightly less habitat for increased fish use along North Chandeleur Island.

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

Alternative 4 would have minor, short-term adverse impacts during Project construction and long-term, beneficial impacts after construction is complete. Impacts on fisheries and aquatic species from Alternative 4 would be similar to those described above under the Preferred Alternative, but would create slightly less habitat for increased fish use along North Chandeleur Island.

D.1.3.9 Marine Transportation

Affected Environment

The Project area is located within state waters about 25 miles south of the Mississippi shoreline and about 45 miles east of the St. Bernard Parish mainland, Louisiana. The closest shipping fairways near the Project provide access to the Mississippi River and the Mississippi Sound. The shipping fairway that provides access to the Mississippi River (and subsequently to Port Venice and the Port of New Orleans), is located more than 12 miles south of the pump-out areas. The shipping fairway that provides access to the Mississippi Sound (and subsequently to the ports along the Mississippi coast such as Gulfport and Biloxi), is located about 3 miles from the northern tip of North Chandeleur Island and the HPBA (NOAA, 2024). No major shipping fairways are located within the Chandeleur Sound and the majority of marine traffic near the Project area would be from recreational and commercial fishing vessels.

Environmental Consequences

Alternative 1 – No Action

Under the No Action Alternative, the Project would not be implemented and the short-term adverse impacts associated with marine traffic from the action alternatives would not occur. Overall, the No Action Alternative would have no measurable effect on marine transportation.

Alternative 5 (Preferred Alternative) – Beach, Dune, and Marsh Fill + Sand Reservoirs + Pocket Marshes + Feeder Beach + New Harbor Island Fill

No major shipping fairways are located within the Chandeleur Sound and the majority of marine traffic near the Project area would be from recreational and commercial fishing vessels. During construction, various construction vessels may be present in and around North Chandeleur Island, These vessels could readily divert around the Project area during active construction periods, resulting in short-term, minor, adverse impacts. The United States Coast Guard posts a weekly Local Notice to Mariners (LNM), which provides information on any navigation hazards or marine information of interest (USCG, 2025). Any potential hazards or closings around the Chandeleur Islands that would impede traffic navigation would be posted in the weekly LNM. Following completion of construction activities, associated vessel traffic would cease and there would be no long-term, adverse impacts from the Project on marine transportation.

Alternative 2 – Beach, Dune, and Marsh Fill + Sand Reservoirs + New Harbor Island Fill

The Project would have short-term, minor, adverse impacts on marine traffic (generally restricted to visiting recreational or commercial vessels) during Project construction, which would cease after construction is complete. Impacts on marine transportation from Alternative 2 would be similar to those described above under the Preferred Alternative, but would occur over a slightly shorter period of time (approximately 116 days less).

Alternative 3 – Beach, Dune, and Marsh Fill + Pocket Marshes + New Harbor Island Fill

The Project would have short-term, minor, adverse impacts on marine traffic (generally restricted to visiting recreational or commercial vessels) during Project construction, which would cease after construction is complete. Impacts on marine transportation from Alternative 3 would be similar to those described above under the Preferred Alternative, but would occur over a slightly shorter period of time (approximately 119 days less).

Alternative 4 – Beach, Dune, and Marsh Fill + Feeder Beach + New Harbor Island Fill

The Project would have short-term, minor, adverse impacts on marine traffic (generally restricted to visiting recreational or commercial vessels) during Project construction, which would cease after construction is complete. Impacts on marine transportation from Alternative 4 would be similar to those described above under the Preferred Alternative, but would occur over a slightly shorter period of time (approximately 114 days less).

D.2 Summary of Environmental Consequences for Habitat Restoration Alternatives

The NEPA analysis found that the Habitat Restoration alternatives would result in some short-term to long-term, minor to moderate, adverse impacts on certain resources. The adverse impacts would be offset by the long-term, beneficial impacts that the alternative would generate. The No Action Alternative would result in long-term, minor to major, adverse impacts with no beneficial impacts.

A summary of impacts for the No Action Alternative, the Preferred Alternative, and the other action alternatives for the Habitat Restoration Project is provided in Table D-11. For each alternative and resource category, beneficial or no effects are noted, as is the longest duration and most severe adverse effect level, as applicable.

Table D-11. Summary of Environmental Consequences for Habitat Restoration Alternatives

Resource	Alt. 1 (No Action)	Alt. 5 (Preferred Alternative)	Alt. 2	Alt. 3	Alt. 4
Geology and Substrates	L Maj -	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +
Hydrology and Water Quality	L Mod -	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +
Air Quality	NE	S Min - / L+	S Min - / L+	S Min - / L+	S Min - /L+
Noise	NE	S Min - / NE	S Min - / NE	S Min - / NE	S Min - / NE
Habitats	L Maj -	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +
Terrestrial Wildlife Species	L Mod to Maj -	S Mod - / L +	S Mod - / L +	S Mod - / L +	S Mod - / L +
Marine and Estuarine Fauna	L Maj -	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +
Protected Species	L Maj – (T&E)/ L Min to Mod – (MM)	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +	S, L Min to Mod - / L +
Socioeconomics	L Min -	S + / L +	S + / L +	S + / L +	S + / L +
Cultural Resources	NE	NE	NE	NE	NE
Infrastructure	NE	NE / L+	NE / L+	NE / L+	NE / L+
Land and Marine Management	NE	S Min - /L +	S Min - /L +	S Min - /L +	S Min - /L +
Tourism and Recreational Use	L Min -	S Min - / L +	S Min - / L +	S Min - / L +	S Min - / L +
Aesthetics and Visual Resources	L Min -	S Min - / L +	S Min - / L +	S Min - / L +	S Min - / L +
Public Health and Safety	L Min -	NE / L +	NE / L +	NE / L +	NE / L +
Fisheries and Aquaculture	L Min -	S Min - / L +	S Min - / L +	S Min - / L +	S Min - / L +
Marine Transportation	NE	S Min - / NE	S Min - / NE	S Min - / NE	S Min - / NE

NE = No effect, S = Short-term, L = Long-term, Min = Minor, Mod = Moderate, Maj = Major

+ = Beneficial effect, - = Adverse effect

D.3 NEPA Consideration of Additional Reasonably Foreseeable Environmental Effects

The Final PDARP/PEIS (Section 6.17.2) stated that consideration of environmental effects of proposed alternatives in RP/EAs should build on the programmatic analyses and focus on site-specific issues. Section 6.6 and Appendix 6.B of the Final PDARP/PEIS are incorporated by reference herein, including the methodologies for assessing additional reasonably foreseeable environmental impacts, identification of affected resources, and the reasonably foreseeable environmental effects scenario. The Final PDARP/PEIS found that implementation of restoration projects under the restoration types in this Joint RP/EA #1 would be consistent with the Final PDARP/PEIS Restoration Goals and would not be expected to contribute substantially to short-term and long-term adverse reasonably foreseeable environmental effects on physical, biological, or socioeconomic resources when analyzed in combination with other past, present, and reasonably foreseeable future actions.

Reasonably foreseeable environmental effects include each of the resources identified in the Physical Environment, Biological Environment, and Socioeconomics Resources sections discussed previously in this Joint RP/EA #1. It was determined that several of these resources would have no effects or only short-term, minor effects and, based on their magnitude with respect to context and intensity, would not contribute to adverse reasonably foreseeable environmental effects, and are noted as “resources not analyzed further.” Environmental impacts that were found to have adverse and long-term impacts are noted as “resources analyzed further.”

Resources not analyzed further in the reasonably foreseeable environmental effects analysis include: Air Quality; Noise; Socioeconomics; Cultural Resources; Infrastructure; Land and Marine Management; Tourism and Recreational Use; Aesthetics and Visual Resources; Public Health and Safety; Fisheries and Aquaculture; and Marine Transportation. Resources analyzed further include: Geology and Substrates; Hydrology and Water Quality; Habitats; Wildlife Species; Marine and Estuarine Fauna (including managed fish species) and EFH; and Protected Species.

Past, present, and reasonably foreseeable future actions near the Chandeleur Island Restoration Project were identified to effectively consider the potential reasonably foreseeable environmental effects. The spatial boundary used to identify these actions includes a 6-mile buffer around North Chandeleur Island, which includes New Harbor Island, the HPBA, conveyance corridors, pump-out areas, and access channels. The temporal boundaries include the Project construction duration which is anticipated to occur over 2.5 years and the 20-year analysis period. The list of past, present, and future projects was compiled using LDENR, U.S. Army Corps of Engineers, USEPA, National Fish and Wildlife Foundation (NFWF), USFWS, U.S. Department of Agriculture (USDA), NOAA, and Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE) Council websites, reports, and databases. The past and potential future activities near the Chandeleur Island Restoration Project area include maintenance dredging, marsh restoration, and emergency work as described in Table D-12.

Table D-12. Projects Considered in the Reasonably Foreseeable Environmental Effects Analysis

Category	Project Name	Applicant/ Proponent	Summary	Estimated Timeframe
Future	Maintenance Dredging and Activities for the Gulfport Harbor Federal Navigation Channel	U.S. Army Corps of Engineers, Mobile District	Continued maintenance dredging and placement for 5 years. Approximately 1.5 to 2.0 MCY of dredged material may be placed at a littoral zone site east of Chandeleur Island a maximum of every 6-10 years.	2024-2029
Past	Chandeleur Islands Marsh Restoration	Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA)	Provide stabilization to 364 acres of unvegetated overwash deposits on 22 overwash fan sites through smooth cordgrass (*Sporobolus alterniflorus*) plantings.	2001
Past	Emergency Berms	CPRA	Emergency berm constructed to 6 feet NAVD88 after DWH.	2010

As described above, the resource areas with potential for reasonably foreseeable environmental effects and therefore analyzed further include geology and substrates; hydrology and water quality; habitats; wildlife species; marine and estuarine fauna (including managed fish species) and EFH; and protected species. Since the Project is a restoration project, it would create long-term benefits to these resources but would also have some short-term and/or long-term, adverse impacts. The anticipated short-term, adverse impacts on hydrology and water quality, habitats, and wildlife could be minimized with the development and implementation of BMPs.

Since the past, present, and reasonably foreseeable future actions identified above are similar in nature or compatible with the alternatives in this Joint RP/EA #1, the effects from the alternatives and the identified actions are expected to result in net beneficial impacts on the resources listed above. The previously constructed Chandeleur Islands Marsh Restoration project contributed to habitat benefits through vegetation plantings on North Chandeleur Island, which provided secondary benefits to wildlife species and estuarine fauna. The Emergency Berm project on North Chandeleur Island increased the available sediment supply on the island, benefiting the island's geology and substrates, increasing overall island and habitat longevity. The proposed dredging of the Gulfport Harbor Federal Navigation Channel includes the possible placement of dredged material off the northeast corner of North Chandeleur Island. Depending upon the properties and exact placement of this dredged material, such placement could contribute new sediment for island nourishment through littoral transport. Thus, the TIGs conclude that the alternatives in this Joint RP/EA #1 would not contribute substantially to reasonably foreseeable adverse environmental effects when added to other past, present, or reasonably foreseeable future actions.

Under the No Action Alternative described in Section 1.7, the Chandeleur Island Restoration Project would not be implemented. Under the No Action Alternative, the existing habitats would continue to degrade due to erosion, local subsidence, and sea-level rise, which could result in the decrease of habitat and the species which utilize that habitat. The No Action Alternative would likely result in adverse impacts on resources including geology and substrates, hydrology and water quality, habitats, wildlife species, marine and estuarine fauna, protected species, socioeconomics, tourism and recreational use, aesthetics and visual resources, public health and safety, and fisheries and aquaculture. When the No Action Alternative is analyzed in combination with other past, present, and reasonably foreseeable future actions, short-term and long-term, adverse, impacts on the resources identified would likely occur. Despite the beneficial impacts of the past and reasonably foreseeable future projects, there would be continued degradation of habitats and species that utilize the habitat under the No Action Alternative. Continued coastal erosion and land loss would increase the risk of flooding, wave action, saltwater intrusion, storm surge, and tidal current further inland. Therefore, the No Action Alternative for the Project would be expected to contribute to adverse, impacts on environmental resources.

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Appendix E:

Chandeleur Island Restoration PO-0199 Phase 2 Seagrass Survey

COASTAL PROTECTION AND RESTORATION AUTHORITY

CHANDELEUR ISLAND RESTORATION (PO-0199)

PHASE 2 - SEAGRASS SURVEY REPORT

PREPARED FOR

Coastal Engineering Consultants, Inc.

December 2023

PREPARED BY

SWCA Environmental Consultants

DRAFT COASTAL PROTECTION AND RESTORATION AUTHORITY CHANDELEUR ISLAND RESTORATION PROJECT (PO-0199) – SEAGRASS SURVEY REPORT

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SWCA Project No. 00081792-001

December 2023

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CONTENTS

Appendices

Figures

Tables

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1 INTRODUCTION

1.1 Project Overview

The Chandeleur Island Restoration (PO-0199) Project (Project) is located on the Chandeleur Islands in St. Bernard Parish, Louisiana (Figure 1). The Chandeleur Island system includes those lands between Chandeleur Sound and the Gulf of Mexico, consisting of Chandeleur Island, Gosier Islands, Grand Gosier Islands, Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands forming the Breton National Wildlife Refuge (Figure 2). This report's Study Area includes Chandeleur and New Harbor Islands and the seagrass beds and water bottoms surrounding them (Figure 3).

The purpose of the Project is to engineer and design a restoration project benefitting the Chandeleur Islands and the many species that use them as defined in the Restoration Plan and Environmental Assessment Plan #1 of the Region-wide Trustee Implementation Group (2021). Phase 1 of the Project focuses on plan formulation for restoration of the main Chandeleur Island and New Harbor Island. The Coastal Protection and Restoration Authority (CPRA) serves as the designated State agency for the Project.

The purpose of this report is to provide methodology used to identify the seagrass community composition and map the extent of the seagrass beds at the main Chandeleur Island and New Harbor Island during late summer/early fall 2022 and present the results of the survey. The approach and methods are described in the SWCA 2022 Chandeleur Island Restoration Project (PO-0199) Seagrass Survey Plan (Appendix A).

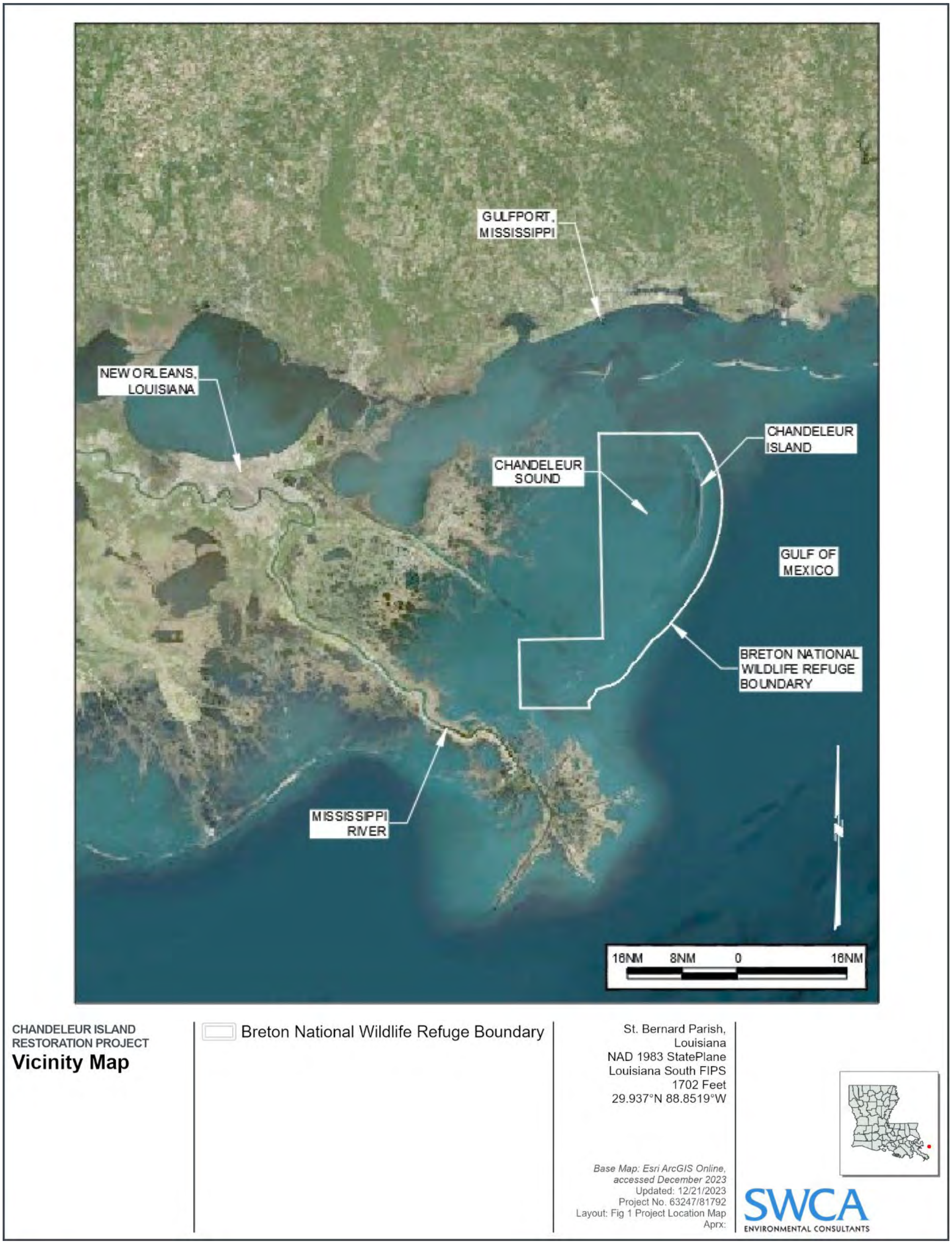


Figure 1. Project vicinity map.

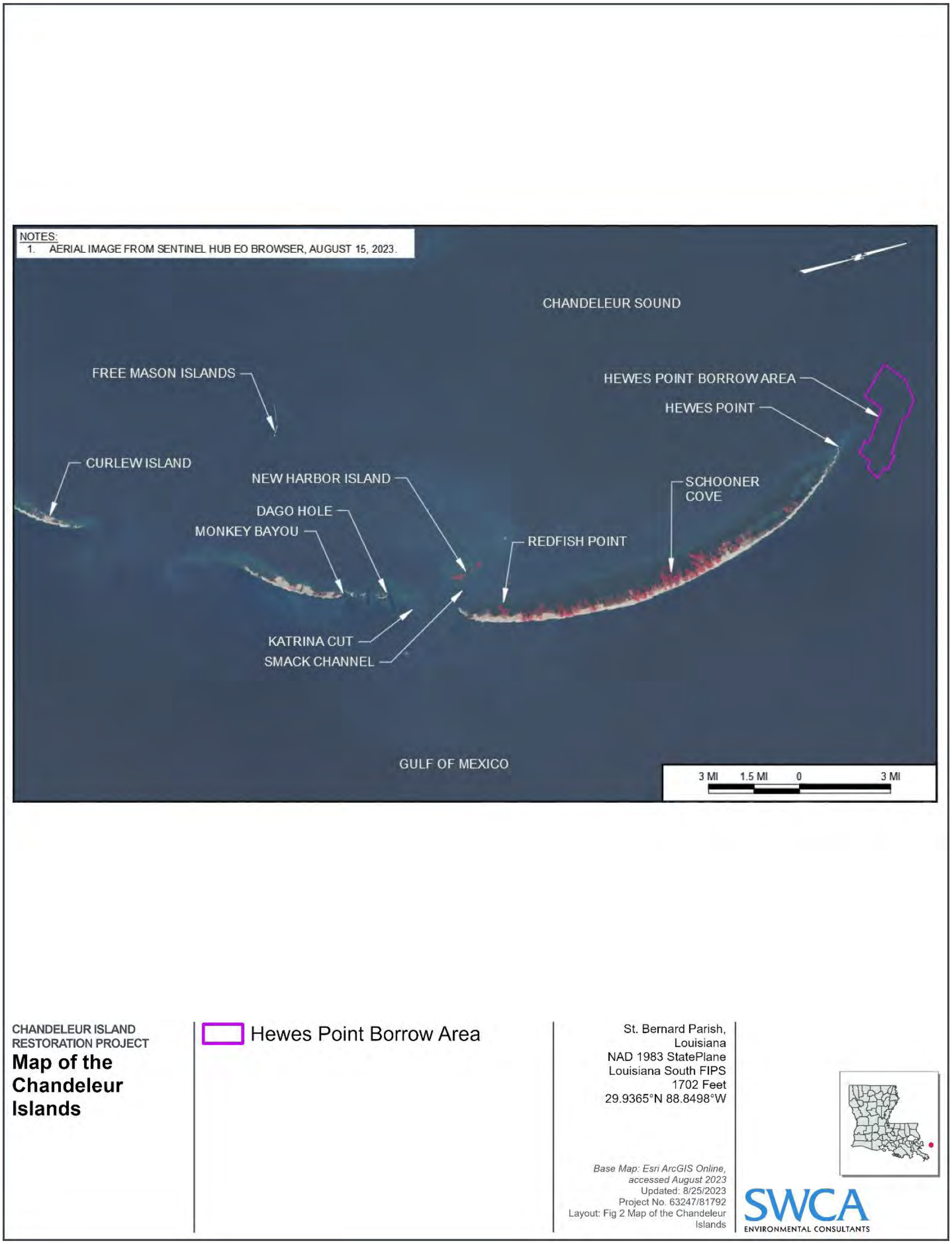
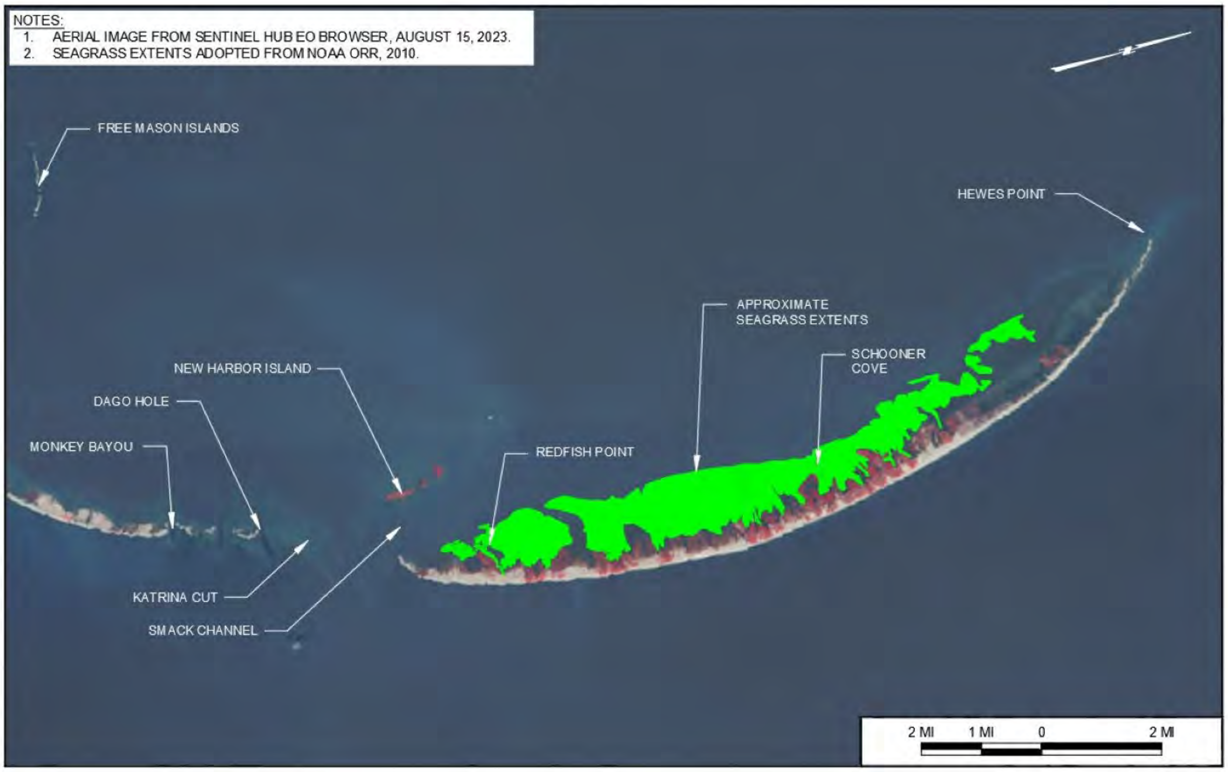


Figure 2. Map of the Chandeleur Islands and potential borrow area location.



CHANDELEUR ISLAND RESTORATION PROJECT

2010-2011 Seagrass Bed Mapping by NOAA (NOAA 2015)

2010-2011 Mapped Seagrass Extent

St. Bernard Parish, Louisiana
NAD 1983 StatePlane
Louisiana South FIPS
1702 Feet
29.9365°N 88.8498°W

Base Map: Esri ArcGIS Online, accessed August 2023
Updated: 8/25/2023
Project No. 63247/81792
Layout: Fig 3 2011 Seagrass bed mapping

SWCA ENVIRONMENTAL CONSULTANTS

Figure 3. 2010-2011 Seagrass bed extent mapped by NOAA (NOAA 2015)

1.2 Project Area Description

The Chandeleur Islands can be subdivided into two subsets, which are affected by different hydrologic inputs, energy regimes, barrier island dynamics, and environmental stressors. The northern islands include the main Chandeleur Island, New Harbor Island, and Freemason Island. The southern islands include Curlew Island, Grand Gosier Islands and Breton Island. The primary ecological drivers in the Chandeleur Islands system are attributed to natural coastal processes such as barrier island dynamics, disintegration of abandoned river deltas, and impacts from tropical storms and hurricanes. The southern islands are proximal to major outlets of the Mississippi River where they receive significant seasonal freshwater inputs and attendant high nutrient and turbidity levels. The northern islands experience only limited influence from riverine inputs as they are located farther from freshwater sources such as coastal Mississippi waters and inputs from the Pearl River and passes of Lake Pontchartrain. Importantly, the northern islands are far more stable due to higher sand content and robust backbarrier marshes compared to the southern islands that are sand-starved and lack significant backbarrier marshes. As a result, the northern islands respond differently to storm impacts than southern parts of the chain. Storm response in the north is characterized by barrier breaching and overwash processes that transfer the beach and dune system landward with backbarrier marshes providing a platform for sand deposition, maintaining subaerial exposure and healing of breaches during post storm recovery. In the south, major storms can result in complete island submergence with recovery and emergence significantly delayed and only after extended periods (years to decades) of minimal storm impacts. These contrasting barrier island storm responses are important to consider with respect to stability of seagrasses because of the protection afforded to the backbarrier seagrass communities by the more robust northern islands both during storms and the recovery period as breaches heal. The ephemeral island/shoal behavior that characterizes the southern islands does not provide for long term protection to the backbarrier from open Gulf conditions. As a result, seagrass meadows have persisted in the shelter of the northern islands at least for the historical record. However, as the northern island chain has undergone rapid land loss by thinning and shortening over the past three decades, the backbarrier area with sufficient protection to host resilient seagrass communities has also decreased (Miner et al. 2021). Along with protection from high-energy conditions, seagrass growth and persistence requires good overall water quality and clarity, habitats along the southern islands are not conducive to seagrass growth, whereas seagrass has developed and thrived in environment of the northern islands (Handley et al. 2007).

Studies throughout the past five decades have reported varying coverage of seagrasses along the Chandeleur Islands, however, as summarized in Poirrier and Handley (2007), and identified during species composition investigations after the Deepwater Horizon oil spill (Kenworth et al. 2017) the species composition has remained fairly consistent and includes turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*). Frequent damage due to passing hurricanes influences the species composition and abundance in certain areas. Areas that experience higher levels of damaging forces, such as locations where the protecting barrier island was breached during a storm and sediment overwash features with significant sediment deposition, and exposure to higher wave action, were found to have some turtle grass, but also manatee grass and shoal grass. Those areas that are sheltered from storm damage are dominated by dense turtle grass meadows (Franze 2002; Poirrier and Handley 2007). Star grass was found to be present in these disturbed areas but was quite rare (Handley et al. 2007). In a 20-year study of the region, using information on leaf tissue nutrient levels, specifically in *T. testudinum*, Darnell et al. (2017) concluded that high nutrient levels and eutrification, noted as the primary driver in seagrass loss along more coastal environments, there does not appear to be strong evidence that this is the case at the Chandeleurs. Furthermore, the 2014 study by Pham et al. provided a comparison of aerial mapping efforts at the Chandeleurs from 1992 to 2005, documenting an evolution of the Chandeleur Islands, documenting rapid rates of land loss and declining seagrass coverage, therefore supporting the causation between land loss and declining seagrass coverage.

The last comprehensive investigation for seagrass bed extent, viability, and species composition within the Chandeleur Islands was conducted by the NOAA and the United States Geological Survey (USGS) in 2010 and 2011. The investigation was conducted as part of the post-incident exposure of the Deepwater Horizon Oil Spill on seagrass vegetation throughout the northern Gulf of Mexico (NOAA 2015). The 2010 and 2011 seagrass coverage totaled approximately 2,385 acres, and 2,614 acres, respectively (NOAA 2015). The National Aeronautics and Space Administration (NASA) Tool CREOL (NASA 2021) also provided supporting aerial imagery of the Project Area to illustrate changes in seagrass extent. In addition to the summary of studies provided above, investigations are ongoing through the University of Mississippi.

2 METHODOLOGY

2.1 Defining the Survey Area

The limits of the 2010 and 2011 NOAA and USGS aerial data, as well as project-specific high resolution aerial photography collected in May 2022 were georeferenced to establish the preliminary Survey Area and allow for reproducibility in the 2022 survey efforts in order to: 1) verify the identification of the entire seagrass habitat or potential habitat, and 2) enable comparisons of species, community compositions, and densities over time.

To define the Survey Area (Figure 4), a single polygon was created, identifying the maximum bounds of the 2010/2011 seagrass extent (NOAA 2015) and the results of the photogrammetric interpretation of the aerial imagery acquired in May 2022. As the aerial photographs collected in May 2022 occurred prior to the start of the peak growing season in the Chandeleurs (mid-September to early October) (*pers. comm.* Darnell 2022)), additional satellite data was collected in September 2022 to confirm the current extent at the time of the seagrass field survey. The 50-cm resolution satellite data was obtained from Planet Labs SkySat for an approximately 105-sq km area encapsulating the known 2010 and 2011 seagrass and Survey Area extent. Considering the size of Survey Area, the use of aerial imagery is a cost-effective and more precise method for delineating seagrass fringe habitat than diver delineated methods. Obtaining the aerial imagery prior to field survey allowed for spot checking in the field rather than swimming the full edge of the Survey Area. Additional data to be collected under separate tasks, including the collection of topographic and bathymetric data during the Summer of 2023, and identification or collection of new aerial imagery, will provide further insights to characterize the area and refine the initial seagrass community discussion.

2.2 Fixed Station Location

The field survey plan utilized the methods outlined in Dunton et al. (2010) which allows for robust data collection and reproducibility over a large Survey Area. The recommended practice utilizes a grid of tessellated hexagons (500 meters per side) to identify sampling locations for all levels of seagrass monitoring. This hexagonal grid was overlaid onto the Survey Area to establish the sampling locations (Figure 4). One fixed sample location was randomly selected within each hexagon, for a total of 143 sample locations. The USM, by Principal Investigator, Kelly Darnell (*personal communication*, August 2022), is conducting ongoing research at the Chandeleur Islands. In order to contribute spatially consistent data, SWCA compared hexagonal grids and fixed locations, and in instances where a USM location was in an SWCA hexagon, the USM location was used and SWCA adopted the nomenclature. Locations belonging to USM are identified by C-###, whereas the SWCA location are identified by S-###.

For survey planning purposes beginning in March 2022, the hexagonal grid was overlaid on the most current publicly available, high resolution aerial data (Google Earth 2019). Due to the dynamic nature of the barrier islands and presumed migration of the island from the last large scale seagrass mapping effort (2011) to its current position, some survey grid locations containing historical seagrass data extensively overlap with the island and extend into the Gulf. Figure 4 illustrates how some survey hexagons were truncated to account for island overlap.

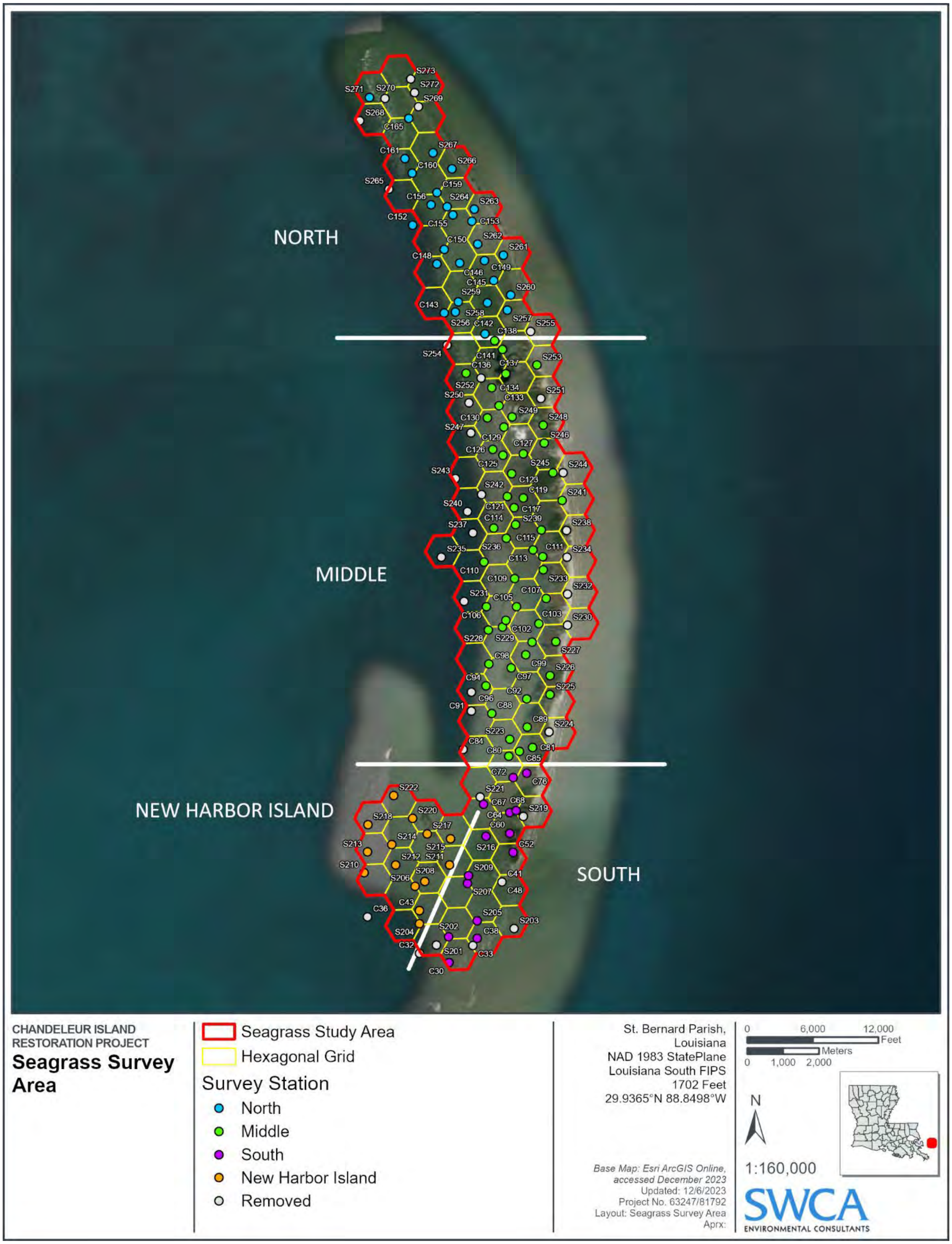


Figure 4. Seagrass Study area.

2.3 Field Data Collection

The field study was conducted from September 15 through September 25, 2022, known to be within the peak seagrass growing season at the Chandeleur Islands. While Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Environmental Quality do not stipulate a seagrass growing season, especially as it pertains to environmental surveys, initial guidance on timing for surveys utilized the Florida Department of Environmental Protection (FDEP 2020) regulatory season as June 1 and Sept. 30 for the Florida and the northern Gulf of Mexico coastal regions. However, personal communication with Kelly Darnell (USM) provided further detail that that the peak growing season at the Chandeleurs occurs from early to mid-September and can extend as late as early October.

The primary objective of the survey was to collect data metrics that would characterize the seagrass community, including species composition, percent cover, seagrass bed configuration (patchiness), and preliminary water quality information to establish a baseline condition at the peak of the 2022 growing season. The fixed location is to be navigated to with GPS accuracy of 4 meters or better. All location information was documented in ArcGIS Field Maps, and all water quality and seagrass metrics were recorded on hard copy datasheets for transcription into a database. The location was identified as having a 10-meter radius, and the four stations were sampled within this circle. In situ water quality parameters, water transparency, and photosynthetically active radiation (PAR) were collected prior to deployment of any benthic sampling equipment to minimize disturbance to the water column or sediment.

Species community composition and areal coverage were documented at each randomly selected, fixed location. Four replicate stations were sampled in set directions oriented around each location: forward starboard, aft starboard, aft port, forward port, (Figure 5). Direct observations were evaluated in the field within a 0.25 m^2 PVC quadrat frame with 100 subdivided cells. An underwater camera was used to document each quadrat. A summary of primary data metrics collected is described in Table 1.

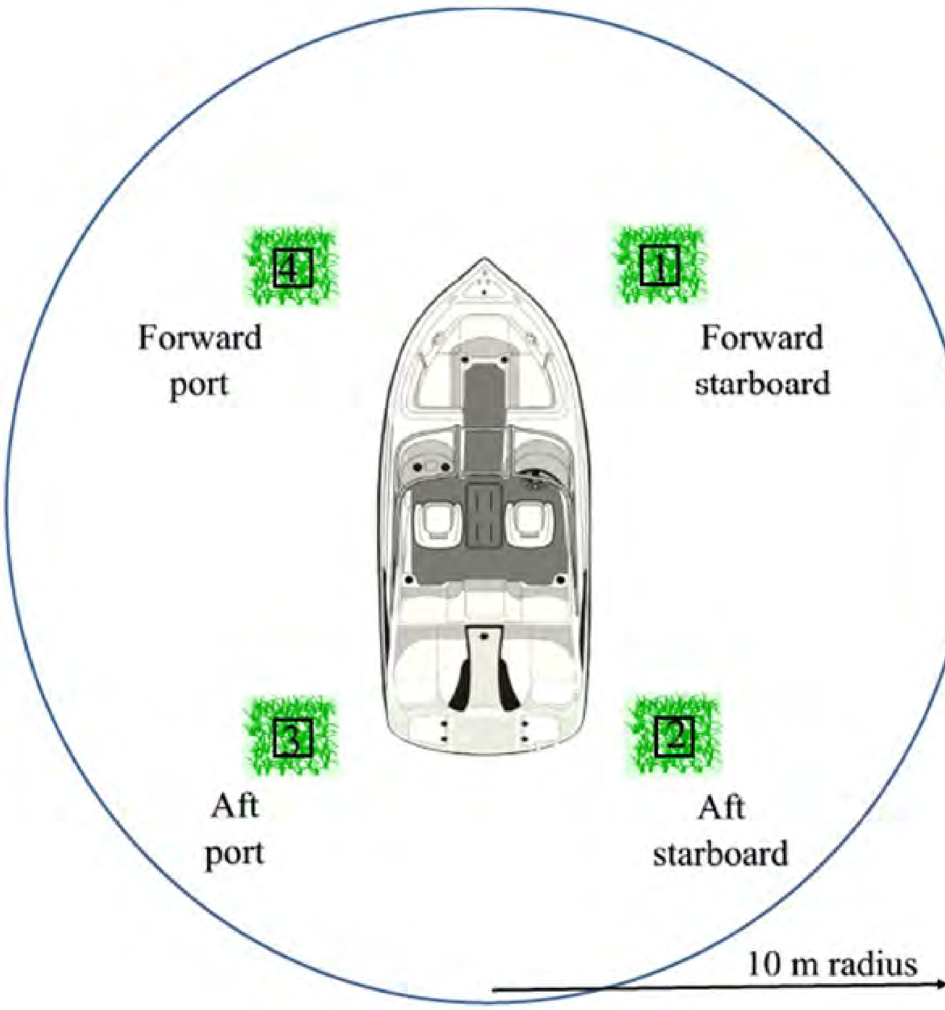


Figure 5. Sampling stations oriented around each randomly selected fixed location.

Table 1. Survey metrics for locations and stations.

Data Collection Location	Metrics	Equipment
Vessel Location	Date/Time	
	GPS location	GPS unit (submeter accuracy)
	Relative Water depth	Sounding rod
	Water temperature, salinity, conductivity, pH, dissolved oxygen	YSI Pro Series, multi-probe sonde
	Light attenuation	LI-COR (Li-192) Underwater PAR sensor
	Transparency	Secchi disk
Stations	Sediment type	Direct Observation using .25 m^2 PVC quadrat. (with underwater camera)
	Species composition	
	Total percent cover	
	Percent cover by species	
	Representative canopy height	Ruler

2.4 Data Validation

2.4.1 Water Quality

The United States Environmental Protection Agency (USEPA) in its *National Coastal Condition Assessment (NCCA) 2020 Quality Assurance Project Plan (QAPP)* (USEPA 2020) provides appropriate data reporting unit criteria for in situ measurements:

Table 2. Data report unit criteria for in situ measurements (USEPA 2020).

Measurement	Units	No. Significant Figures	Maximum No. Decimal Places
Temperature	ºC	2	1
Salinity	ppt	2	1
Conductivity	µS/cm at 25ºC	3	1
Dissolved Oxygen	mg/L	2	1
pH	pH units	3	Not reported
PAR	µE/m^2/s	2	1
Secchi Depth	Meters	3	1
Depth	Meters	3	1

As the Chandeleur Islands are a fairly unique environment removed from typical anthropogenic influence in Louisiana's coastal waters, and not considered an open ocean environment, SWCA used the range of values for the above water quality parameters as guidance for site specific values based previous research at the Chandeleur Islands. Table 3 presents the reported water quality values from previous studies conducted at the Chandeleur Islands.

Table 3. Summary of in situ water quality measurements from past research at the Chandeleur Islands.

Source	Sampling Timeframe	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	PAR (µE/m^2/s)	Secchi (m)
Darnell, *per. comm*. 2022 (range of values)	September and October 2018	25.2 to 35.4	21.8 to 30.1	4.8 to 13.8	53 to 1603	0 to Depth
Darnell et al. 2017 (average values)	October 2014, and April 2015	27.3 +/- 0.9	30.7 +/- 0.3	6.8 +/- 0.5	Not reported	Not reported
Robertson and Baltzer 2017 (range of values)	September and July of 2015 and 2016	23.8 to 31.1	23.0 to 30.8	2.6 to 10.5	Not reported	Not reported

2.4.2 Species Descriptions

The following species are known to occur within the northern Gulf of Mexico and documented during this survey at the Chandeleur Islands.

2.4.2.1 *HALODULE WRIGHTII* (SHOAL GRASS)

Halodule wrightii (shoal grass), a fairly ubiquitous species, plentiful along the Atlantic Coast from North Carolina, and into the Caribbean, is tolerant of low light, can tolerate a range of temperatures and salinities, and can survive in high wave energy and turbid environments (Gutierrez et al., 2010, Ray et al. 2014, and Florida Museum of Natural History 2018). *H. wrightii* is easily distinguished by its flat narrow blades that grow to a length of 10-15 cm and a width of 2-3 mm. These blades grow from a single node and are notched at the tip (Florida Museum of Natural History 2018). Reference photographs and illustrations are presented in Figure 7 (Meiman 2019).

Figure 6. Reference photographs and illustrations of *H. wrightii*.

2.4.2.2 *THALASSIA TESTUDINUM* (TURTLE GRASS)

Thalassia testudinum (turtle grass) is a subtropical and tropical marine seagrass, common in the Gulf of Mexico and Caribbean, typically found in waters with salinity between 24 and 35 parts per thousand (ppt), and temperatures ranging between 27 and 30ºC. The species occurs in narrow depth ranges, typically between 0.5 and 2 m, and within areas that are protected from wave energy and other factors causing high turbidity and poor water quality (TPWD 2012, McDonald et al. 2016, LDWF 2023). *T testudinum* is identified by flat, ribbon-like blades, with rounded tips, growing in small clusters up to 35 cm long or longer. During the flowering season, pale green to pink, fruit-producing flowers can be observed (LDWF 2023). Reference photographs and illustrations are presented in Figure 7 (Meiman 2019).

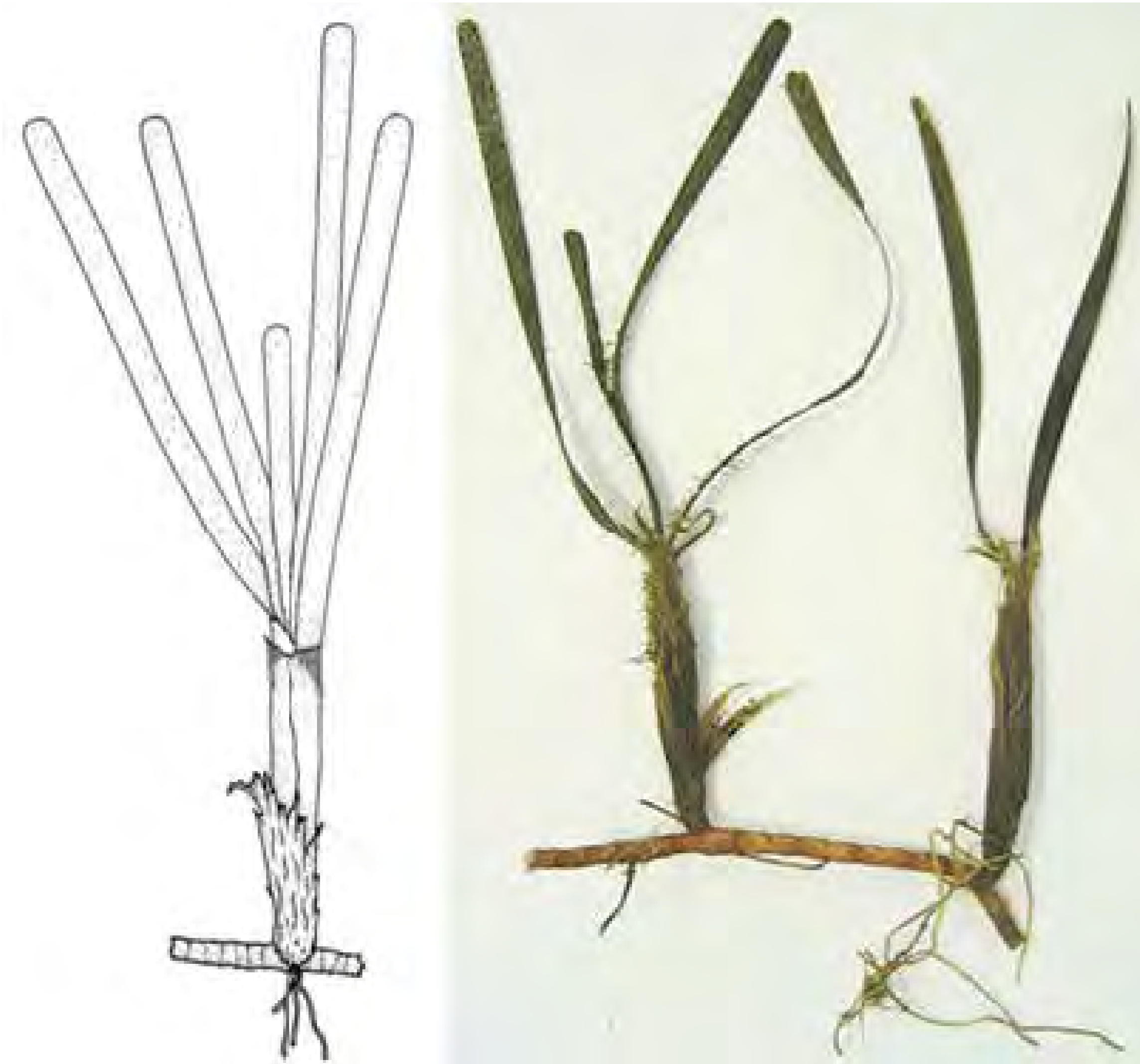


Figure 7. Reference photos and illustrations of *T. testudinum*.

2.4.2.3 *RUPPIA MARITIMA* (WIDGEON GRASS)

Ruppia maritima (widgeon grass) is a wide distributed seagrass, tolerating a broad range of salinity, temperature, light, and nutrient conditions, and can be found in waters as shallow as a few centimeters, and up to 4.5 m, depending on light penetration and wave disturbance. *R. maritima* occupies a wide range of habitats including tidally influenced rivers, bays, estuaries, and along barrier islands. *R. maritima* can colonize an area quickly due to a high shoot turnover and its ability to reproduce sexually and asexually and can be perennial or annual depending on temperature and salinity ranges, acting as a perennial species in areas of higher temperature and salinity maxima. R. maritima produces a large number of underwater flowers about 5 to 6 weeks after the onset of spring growth and within 1 to 2 weeks the flower spike develops, releasing pollen into the water column (Byrnes et al., 2022, Kantrud 1991, NatureServe 2023). *R. maritima* can be identified by shoots reaching lengths up to 2.5 m with leaves ranging between 5 and 20 cm, however when not reproducing, leaves only grow to a length of 1-2 mm. Leaf blades are wider at the base of the stem and slowly taper into long pointed tips (Byrnes et al. 2022). At the time of survey, *R. maritima* was not flowering, therefore requiring a further examination of the roots and rhizomes to

distinguish from shoal grass. Reference photographs and illustrations are presented in Figure 8 (iNaturalist 2023, Native Plant Trust 2023).

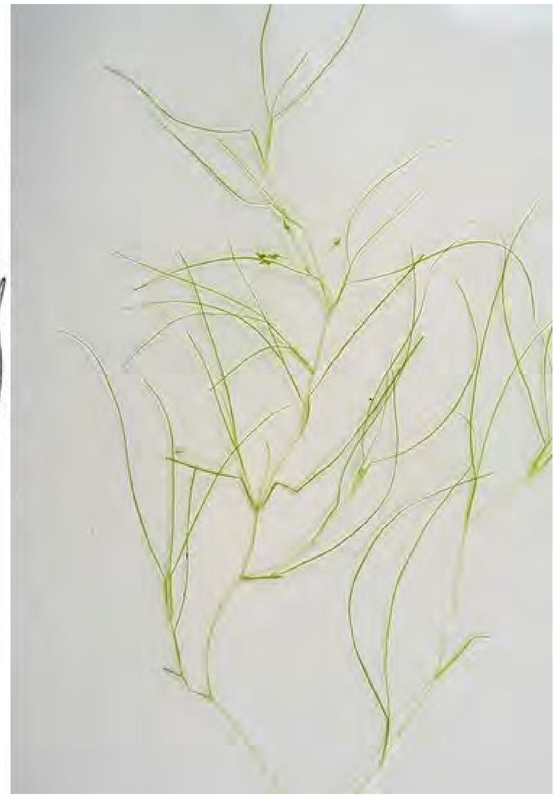


Figure 8. Reference photos and illustrations of *R. maritima*.

2.4.2.4 *HALOPHILA ENGELMANNII* (STAR GRASS)

H. engelmannii is known to thrive on sandy or muddy bottoms in depths ranging from near surface to 20 meters, in areas with low wave energy (NatureServe 2022). Unlike most seagrass species *H. engelmannii* can tolerate lower light levels, caused by depth or high turbidity, and found in typical marine environments which makes it more common in deeper waters of the Gulf of Mexico than other species (NatureServe 2022). *H. engelmannii* has 4 to 8 oblong leaves in a whorl at the end of each stem. These leaves are around 2.5 cm long and 0.6 cm wide. Stems do not usually exceed 10 cm in length (TPWD 2012). Reference photographs and illustrations are presented in Figure 9 (Meiman 2019).

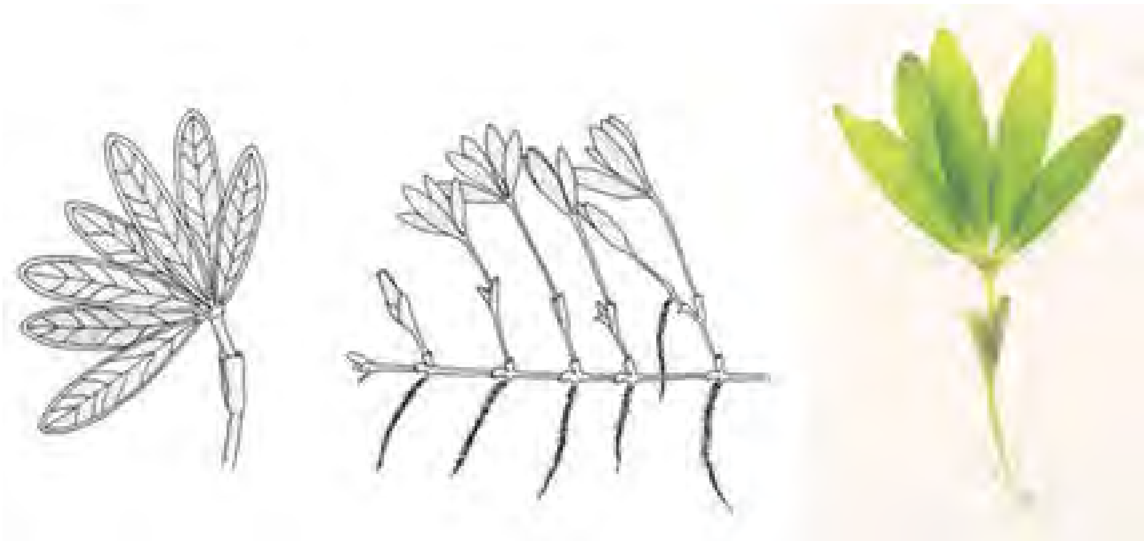


Figure 9. Reference photos and illustrations of *H. engelmannii*.

2.4.2.5 *SYRINGODIUM FILIFORME* (MANATEE GRASS)

S. filiforme is common along the Gulf Coast and the Caribbean in bays and shallow waters, ranging from 0.75 to 2.0 m in depth (TPWD 2012). Its cylindrical leaves help distinguish it from other species. *S. filiforme* has leaves that can reach 50 cm in length that often cluster in numbers of 2 to 4 with roots growing just below the surface (Florida Museum of Natural History 2018). *S. filiforme* is found in coastal waters with salinities of 20-36 ppt. This species often grows in small patches or in areas with other species of seagrass.

S. filiforme reproduces through sexual reproduction of seeds and vegetatively by rhizome elongation (Samper-Villarreal et al., 2020). Reproductive cymes (flat-topped cluster of flowers on a branch or a system of branches in which the central flowers open first, followed by the peripheral flowers) can be observed when the seagrass is reproducing. They usually only appear during the warmer months, however in the northern Gulf of Mexico this occurs in shorter intervals versus more tropical to subtropical locations (Samper-Villarreal et al., 2020). Reference photographs and illustrations are presented in Figure 10 (Meiman 2019).

Figure 10. Reference photos and illustrations of *S. filiforme*.

2.5 Data Analysis

2.5.1 Aerial Photogrammetric Interpretation

Seagrass was digitized using a mixture of photointerpretation and image analysis according to methodology described in *Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach* (NOAA Coastal Services Center 2001). Satellite imagery of study area was captured on September 14, 2022, by Planet Labs PBC through their Planet Tasking service. Planet Labs technology has 20 of its SkySat satellites in orbit, capable of high frequency fly over of a given area 5-7 times a day. SkySat produces 3 band natural color imagery at a resolution of 50cm, capable of download within a few hours of acquisition. The overflight photomosaics collected in May 2022 were not used during this analysis as those images were not collected during the peak growing season, and therefore would not provide the

maximum extent of seagrass coverage. Satellite imagery was acquired just days before the field survey, providing near real-time imagery for comparison and analysis.

The satellite imagery was first processed using the ArcGIS Pro 2.9 Image Analyst extension, using the Image Classification and Classification tools to digitize areas of contrast within the seagrass study area. This classification consisted of a machine learning model created from small areas of trained data input from geospatial scientists which focused on contrast changes within the imagery that specifically identified the difference between potential seagrass and open water. From there the delineation of seagrass was visually confirmed and revised to include all areas of seagrass discernable from the satellite imagery. This method included “heads-up digitization,” defined as manual digitization by tracing a mouse over features displayed on a computer monitor, used as a method of vectorizing raster data, focusing on outer boundaries and using a minimum mapping unit of 0.03 hectares (0.25 acres) to differentiate patchy seagrass as described in the reference methodology. The analog digitization and revisions of modeled seagrass boundaries were also completed in ArcGIS Pro 2.9. Focus was applied to determine the outer boundaries of the seagrass with the goal of capturing any areas above 10 percent cover as described in *Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach* (NOAA Coastal Services Center 2001).

2.5.2 In situ Measurements and Observational Data

Water quality and seagrass coverage were examined as a function of relative water depth at the time of survey, and “zones” based on barrier island morphology within the Survey Area. For locations found in depths between 0 and 1.0 m, only one measurement was recorded at 0.3 m below the water line. Locations in depths > 1.0 m were recorded both at 0.3 m and at 1.0 m. For measurements in depths at or just over 1.0 m, readings were taken approximately 0.3 m from the bottom to avoid disturbing the bottom sediments. In this survey report, SWCA calculated the average water quality measurements within each zone at the surface and at 1.0 m, as applicable. All depth measurements discussed in the body of this report are relative depths. Tidally corrected depths are presented in Appendix B.

As the secchi reading is relative to the depth of the water column at each location, measured as the depth at which the Secchi disk is no longer visible when lowered into water from the shaded side of a boat, and the point at which it reappears after raising it.

As the Li-Cor sensor is highly sensitive, five replicate PAR readings were recorded at each depth (0.3 m, and as appropriate at 1.0 m or 0.3 m off the bottom) for each location, and the five readings were then averaged for each depth zone. The diffuse attenuation coefficient (K_d) for downward irradiance was calculated using the following equation: $K_d = [-\ln(l_o/L_z)]$.

General notes taken at each location also included substrate, which was categorized as sand (coarse, medium, fine grain), a combination of silt and sand, and silt. These notes were based on visual observation and did not include a detailed assessment or laboratory analysis for grain size.

2.5.3 Defining Island Zonation

Based on visual observation in the field, primarily related to the above sea level island land mass and vegetative properties, SWCA defined the following “Zones” within the Survey Area. The locations are color coded by zone in Figure 4, above.

North Zone: In general, there is minimal to no discernable land mass above sea level to provide protection to the backside of the island. There is no supporting backmarsh vegetation between the island

and the seagrass beds. There is evidence that sand bars separate the more inland areas from Chandeleur Sound. Twenty-seven of the 108 locations are found within the North Zone.

Middle Zone: These stations are in areas found behind the island with elevation above sea level, providing protection to the seagrasses from wind and wave action. Large tracts of marsh grasses further protect the shallow water seagrass. The most landward areas are characterized by slower moving, and protected waters. The middle zone is characterized by cuts between the marsh, draining of the island. As distance from the island increases, the water movement is influenced by the Chandeleur Sound, increasing in velocity. Fifty-two of the 108 locations are found within the Middle Zone.

South Zone: These locations are found in areas behind the island with above sea level land mass, however exhibit evidence of erosion. The lack of supporting back marsh systems indicates this area is fairly dynamic. At the southernmost point, locations are found in open water on the Gulf side, with no evidence of seagrass. Historic aerials indicate the point was more prominent and likely though wind and wave action, has eroded backwards. Fifteen of the 108 locations are found within the South Zone.

New Harbor Island (NHI Zone): The locations in this area border smaller mangrove islands and are separated from the main island by a deep and wide channel. Fourteen of the 108 locations are found within the NHI Zone.

2.5.4 Seagrass Distribution and Community Composition

The seagrass community composition was assessed similarly to the in-situ water quality data, where coverage was examined based on island zones and relative depth. The measured relative depth was refined into categories to identify trends in species distribution and coverage, defined as follows:

- Shallow: 0 to 0.6 m
- Mid: >0.6 m to 1.2 m
- Deep: >1.2 m to >2.0

Results below present species community composition and occurrence, coverage, and canopy height as a function of location, zone within the study area, relative depth zone, and general substrate observations.

To estimate the spatial pattern of seagrass community composition, SWCA estimated individual species percent cover within a quadrat based on standardized guidance on cover classifications, provided in Figure 11, as presented in Meiman (2019). This allowed for a rapid, visual, and repeatable classification product.

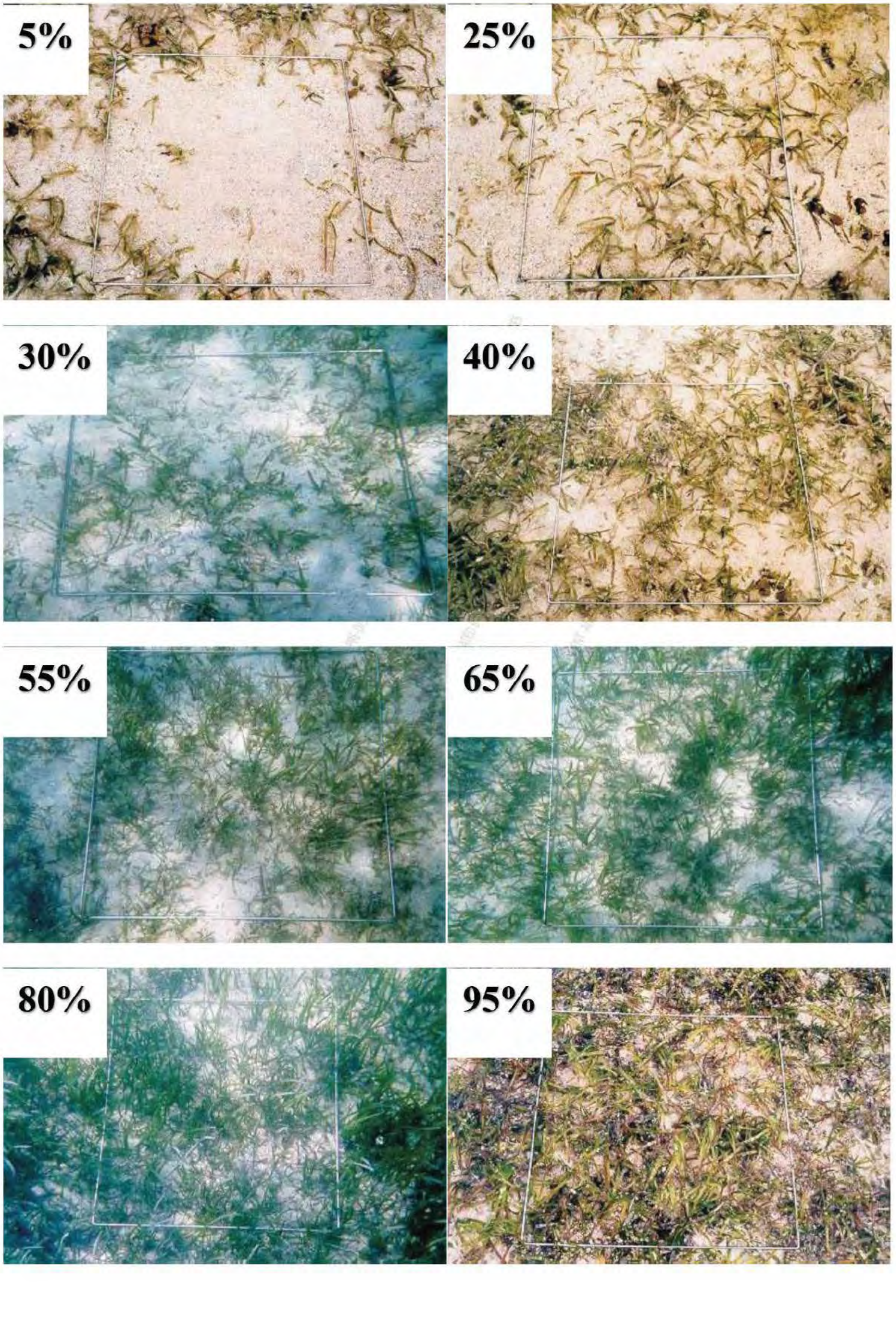


Figure 11. Standardization guidance for estimating percent seagrass cover.

The seagrass density analysis and modeling were completed using the ArcGIS suite of software and tools. The seagrass data and observations for each station were assessed using the percent cover values observed in the field. Each observation was recorded in the field and digitized into a geospatial database that tied the values of each species observation to the point at which it was recorded. Using this digitized field data, the density of seagrass was run through an ArcGIS Average Nearest Neighbor tool, to calculate seagrass coverage across the Study Area. The Average Nearest Neighbor returns the observed mean distance, expected mean distance, nearest neighbor index, z-score, and p-value for measures of statistical significance.

3 FIELD RESULTS

3.1 Water Quality Measurements

Of the 143 locations identified for survey, 108 locations fell within the sea grass coverage area identified and mapped using the September 2022 satellite imagery. Within each zone, the average relative depth of the randomly sampled locations was 1.0 m (SD ±0.8m) in the North Zone, 1.3 m (SD ±0.7m) in the Middle Zone, 1.4 m (SD ±0.7m) in the South Zone, and 1.7 m (SD ±0.6m) in the NHI Zone. A summary of the average water quality measurements are presented in Table 5, and described below.

For water temperature, pH, and PAR, measurements were fairly consistent between the zones. Surface temperature was characteristic for the time of year and exhibited only minor decrease between the surface measurement and the measurement at depth. Average surface temperature was fairly consistent between zones with averages between 30.0^{o}C and 29.1^{o}C, and measurements at 1.0 m averaged between 28.4^{o}C and 29.5^{o}C. pH measurements were consistent between zones and depths, ranging from 8.18 to 9.06. The average diffuse attenuation coefficient (K_d) ranged from 0.38 to 0.46, with the lowest occurring at NHI.

Salinity at the surface and at depth was lowest in the North Zone (26.3 ppt at surface; 28.5 ppt at depth), and gradually increased moving south through the Survey Area. The NHI Zone recorded 34.1 ppt at the surface and 35.2 ppt at depth. Similar trends are seen in the conductivity measurements.

Average dissolved oxygen was highest in the North Zone (8.4 mg/L at the surface [128.0%]; 7.6 mg/L [115.8%] at depth), and lowest in the NHI Zone (7.1 mg/L[110.0%] the surface;7.1 mg/L [117.6%] at depth). There were five locations where the dissolved oxygen was higher than 11 mg/L. A review of other environmental conditions indicate that these high dissolved oxygen values were at locations where the total water depth was less than 0.3 m. Due to the shallow water allowing for rapid exchange with the air, based on SWCA's professional opinion, these values were left in the data set. These values were primarily in the North Zone, and one in the Middle Zone, However, removal of these values would bring the average dissolved oxygen down to 7.4 mg/L, which is consistent with the other zones on the main Chandeleur Island.

Appendix B provides a complete summary of water quality data by station.

Table 4. Average water quality measurements per zone.

Average Measurements at Surface (0.3m)

Zone	Temp		Salinity		Conductivity		DO		pH	Secchi		PAR	
	°C	SD	ppt	SD	µS/cm	SD	mg/L	SD	range	Depth (m)	SD	K_d	SD
North Zone	30.0	2.5	26.3	3.0	48.1	4.8	8.4	2.2	8.17 - 8.73	1.0	0.8	0.46	0.15
Middle Zone	29.4	1.2	28.8	5.4	58.2	3.4	7.4	2.1	8.06 - 9.09	1.2	0.7	0.46	0.24
South Zone	29.1	0.4	24.6	0.5	64.5	2.2	7.7	1.4	8.36 - 8.90	1.1	0.5	0.45	0.13
NHI Zone	29.7	0.5	23.9	0.2	64.5	1.6	7.1	2.2	8.24 - 8.59	1.5	0.4	0.38	0.05

Average Measurements at Depth (1.0m)

Zone	Temp		Salinity		Conductivity		DO		pH	Secchi		PAR	
	°C	SD	ppt	SD	µS/cm	SD	mg/L	SD	range	Depth (m)	SD	K_d	SD
North Zone	28.4	*0.8*	28.5	*4.7*	50.2	6.9	7.6	1.7	8.18 - 8.71	--	--	--	--
Middle Zone	28.8	*0.6*	28.7	*6.7*	59.5	2.8	7.5	1.6	8.29 - 8.71	--	--	--	--
South Zone	28.9	*0.6*	24.9	*0.5*	64.6	2.0	7.5	0.9	8.36 - 8.60	--	--	--	--
NHI Zone	29.5	*0.6*	24.2	*0.4*	64.8	1.5	7.1	2.1	8.47 - 8.60	--	--	--	--

3.2 Direct Observation Occurrence and Coverage

Of the 108 locations surveyed for seagrass, 40 were bare, 46 were dominated (greater than 50% cover) by *H. wrightii*, 10 dominated by *T. testudinum*, 6 dominated by *R. maritima*, 3 had relatively even coverage of *H. wrightii* and *R. maritima*, 2 dominated by *H. engelmannii*, and 1 was evenly dominated by *H. wrightii* and *T. testudinum*. One location, C142, had a species richness of 4 species, and was the only location with documented *S. filiforme*. *T. testudinum* was not present at this location. This location was on the boundary between the North Zone and the Middle Zone. The Middle Zone supported the next highest species richness, with 3 species at C129: *H. wrightii*, *T. testudinum*, and *R. maritima*. Only one location in the NHI Zone contained seagrass: S217 supported *H. wrightii*. Table 5 presents the dominant species and distribution of those dominance classes within each zone.

Table 5. Dominant seagrass species by zone presented as count of locations.

	Bare	*H. wrightii*	*T. testudinum*	*R. maritima*	*H. wrightii/ R. maritima*	*H. engelmannii*	*H. wrightii/ T. testudinum*
North Zone	6	15	--	5	1	--	--
Middle Zone	11	27	10	1	2	2	
South Zone	10	3	--	--	--	--	1
NHI Zone	13	1	--	--	--	--	
Total	40	46	10	6	3	2	1

In the North Zone, the greatest percent cover of *H. wrightii* was found at the mid depth locations, while *R. maritima* had evenly distributed covers between shallow and deep locations.

In the Middle Zone, *H. wrightii* cover was greatest at shallow locations, and decreased in coverage into the mid and deep locations. *T. testudinum* showed similar trends, decreasing in coverage from shallow to deep locations. *H. engelmannii* was not present in shallow locations and had the highest coverage at locations at mid-depth locations. *R. maritima* had lower coverage than the other species present and had highest coverage at shallow locations.

In the South Zone, *H. wrightii* had the highest coverage at the shallow and mid depth locations, with minimal coverage at the deep locations. Only minimal coverage of *T. testudinum* was found at the deep locations, and the highest coverage of *R. maritima* was found at shallow locations.

In the NHI Zone, only minimal *H. wrightii* coverage was observed at a shallow location. Table 6 presents the average coverage by species in each zone and at relative depths.

Appendix C provides a complete summary of seagrass percent coverage data and canopy height by location.

Table 6. Average seagrass species percent cover per zone and depth

Zone	Depth	*H. wrightii*	*T. testudinum*	*S. filiforme*	*H. engelmannii*	*R. maritima*
	Shallow	5.2%	--	--	--	24.1%
North	Mid	74.3%	--	--	--	1.5%
	Deep	20.1%		3.8%	6.3%	28.8%
Middle	Shallow	44.9%	53.8%	--	--	4.7%

	Mid	39.1%	47.2%	--	21.0%	1.8%
	Deep	28.7%	48.8%	--	8.4%	--
South	Shallow	99.8%	--	--	--	45.5%
	Mid	89.9%	--	--	--	0.3%
	Deep	6.3%	4.0%	--	--	--
NHI	Shallow	16.8%	--	--	--	--
	Deep	--	--	--	--	--

3.3 Seagrass Data Interpolation and Cover Modeling

Through image processing of the September 2022 satellite imagery for total coverage as described above, maximum extent of acreage that supports seagrass growth within the Study Area is 2,102 hectares. 1,711 hectares of this area was classified as dense (51-100%) seagrass with the remaining 391 hectares considered patchy (50% or less). Results of the coverage mapping showing the maximum extent are presented in Figure 12. Appendix D presents the detailed results to depict the areas of dense cover and the areas of patchy cover. Cover classification mapping using the percent cover from the September 2022 field studies, and data interpolation for percent cover as described above, are provided for total seagrass coverage (Figure 13), and for each species identified during the field survey: *H. wrightii* (Figure 14), *T. testudinum* (Figure 15), *R. maritima* (Figure 16), *H. engelmannii* (Figure 17), and *S. filiforme* (Figure 18). Coverage classification mapping was completed using the nearest neighbor interpolation method within ArcGIS using coverage values per sampling station location. The maximum seagrass extent from aerial image processing (orange boundary in Figure 12), was overlaid on the data interpolation models, to provide context to the modeled high cover and low cover areas. The maximum 2022 extent from the imagery is seen as a black polygon layer over the modeled results in Figure 13 through Figure 18.

Figure 12. Total seagrass cover through satellite imagery interpretation, and direct observation for species counts.

Figure 13. Total seagrass coverage modeling results.

Figure 14. ***H. wrightii*** **coverage modeling results.**

Figure 15. *T. testudinum* coverage modeling results.

Figure 16. *R. maritima* coverage modeling results.

Figure 17. ***H. engelmannii*** **coverage modeling results**

Figure 18. *S. filiforme* coverage modeling results.

4 DISCUSSION

4.1 Seagrass Distribution Observations

In general, the in-situ water quality measurements were within similar ranges between zones and locations indicating that these parameters are likely not a limiting factor for the growth and coverage of the seagrasses at the Chandeleur Islands. Values were typical of a shallow, coastal environment with limited anthropogenic influence, and indicated overall good water quality.

Based on the defined zonation of the Northern Chandeleur Island, the North and South Zones supported higher coverage of *H. wrightii*, and also a relatively high coverage of *R. maritima* but in large, isolated patches, not interspersed with *H. wrightii*. The North and South Zones experience higher overall entropy from wave and tidal currents at the most extreme points. Additionally, in these Zones the more dominant substrate type was sand, with fewer sites documenting finer silt material. As these Zones experience the highest levels of periodic disturbance from large storm events, the recovery species *H. wrightii* and *R. maritima* will grow and thrive, as they can quickly grow during periods of calm, but are also quickly removed during storm and disturbance events with the ability to recover quickly after disturbance, acting as both perennial and annual species. *T. testudinum* was not dominant in these zones, as this species requires more stable conditions for growth as an annual species. In general, the lack of *T. testudinum* was consistent with previous studies, however the distribution of *H. wrightii* and *R. maritima* should be examined further. Previous studies indicate a larger distribution of specifically *R. maritima*, rather than isolated patches, as identified here. At the time of the study, flowering *R. maritima* was not observed, and required examination of roots and rhizomes for differences in identification between that and *H. wrightii*. With both *R. maritima* and *H. wrightii* considered weedy species, influenced by disturbance, the dominance of these species can change over time. Furthermore, one station documented *S. filiforme*. This is consistent with observations of rare coverage documented by Kenworthy et al. 2017, who notes that as this species flowers and produces seeds that remains buried in sediment seed banks for more than 12 months before germinating. Kenworthy et al. 2017 concluded that it is possible that seed banks were chronically exposed to contamination from *Deepwater Horizon*, with population level effects on this, and other seed producing species.

The Middle Zone supported the highest coverage of *T. testudinum*, with moderate coverage of *H. wrightii* and *H. engelmannii*. In this area, silt and sand combination, and silt were the dominant substrate. As the Middle Zone is more protected from wave energy from an observed higher land mass and supporting back marsh system, and lower water velocity based on distance from the Chandeleur Sound, the finer grain sediments have the opportunity to settle out. In areas of high *T. testudinum* coverage, these sediments are trapped within the dense foliage and thick root structure. In this area of good water quality, and minimal evidence of wash over and breeches in the island morphology, *T. testudinum* is the climax species thriving in the stable environment, and within its acceptable depth requirements. As the area becomes more unstable due to water velocity, depth limitations, and water quality, the more tolerant species, the *H. wrightii* and *H. engelmannii* succeed. At the shallow extent of *T. testudinum distribution*, there is an increase in *H. engelmannii* and *R. maritima.*

The NHI Zone is separated from the main Chandeleur Island by a deep channel. The buildup of the land mass and the establishment of the mangrove forest provides habitat for seagrass; however, the current dynamics and wave energy appears to be different. The overall water clarity was lower at the NHI Zone than the other zones. At the time of survey, the tide was slack, and water was calm, indicating this area may not receive adequate water movement, allowing for particulates in the water to remain suspended. Only one location in this Zone supported seagrass growth, with a relative low coverage of *H. wrightii*.

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Appendix A

Chandeleur Island Restoration Project (PO-0199) Seagrass Survey Plan

Chandeleur Island Restoration Project (PO-0199)

Seagrass Survey Plan

MAY 2022

PREPARED FOR

Coastal Engineering Consultants, Inc.

PREPARED BY

SWCA Environmental Consultants

CHANDELEUR ISLAND RESTORATION PROJECT (PO-)0199)
SEAGRASS SURVEY PLAN

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CONTENTS

Figures

Tables

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1 INTRODUCTION

1.1 Project Overview

The Chandeleur Island Restoration (PO-0199) Project (Project) is located on the Chandeleur Islands in St. Bernard Parish, Louisiana (Figure 1). The Chandeleur Islands include those lands between Chandeleur Sound and the Gulf of Mexico to include Chandeleur Island, Gosier Islands, Grand Gosier Islands, Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands (Figure 2). This Project Area includes the Chandeleur Islands and the seagrass beds and water bottoms within the Breton National Wildlife Refuge (Figure 3).

The purpose of the Project is to engineer and design a restoration project benefitting the Chandeleur Islands and the many species that use them with a particular focus on birds as defined in the Restoration Plan and Environmental Assessment Plan #1 of the Region-wide Trustee Implementation Group. Phase 1 of the Project focuses on plan formulation for restoration of the main Chandeleur Island and New Harbor Island. The Coastal Protection and Restoration Authority (CPRA) serves as the designated State agency for the Project.

The purpose of this document it to define the Survey Area and present the Survey Plan to map the current extent and document the species composition and relative density of the seagrass beds in conjunction with the Project data collection efforts; and describe the changes to the seagrass beds over time.

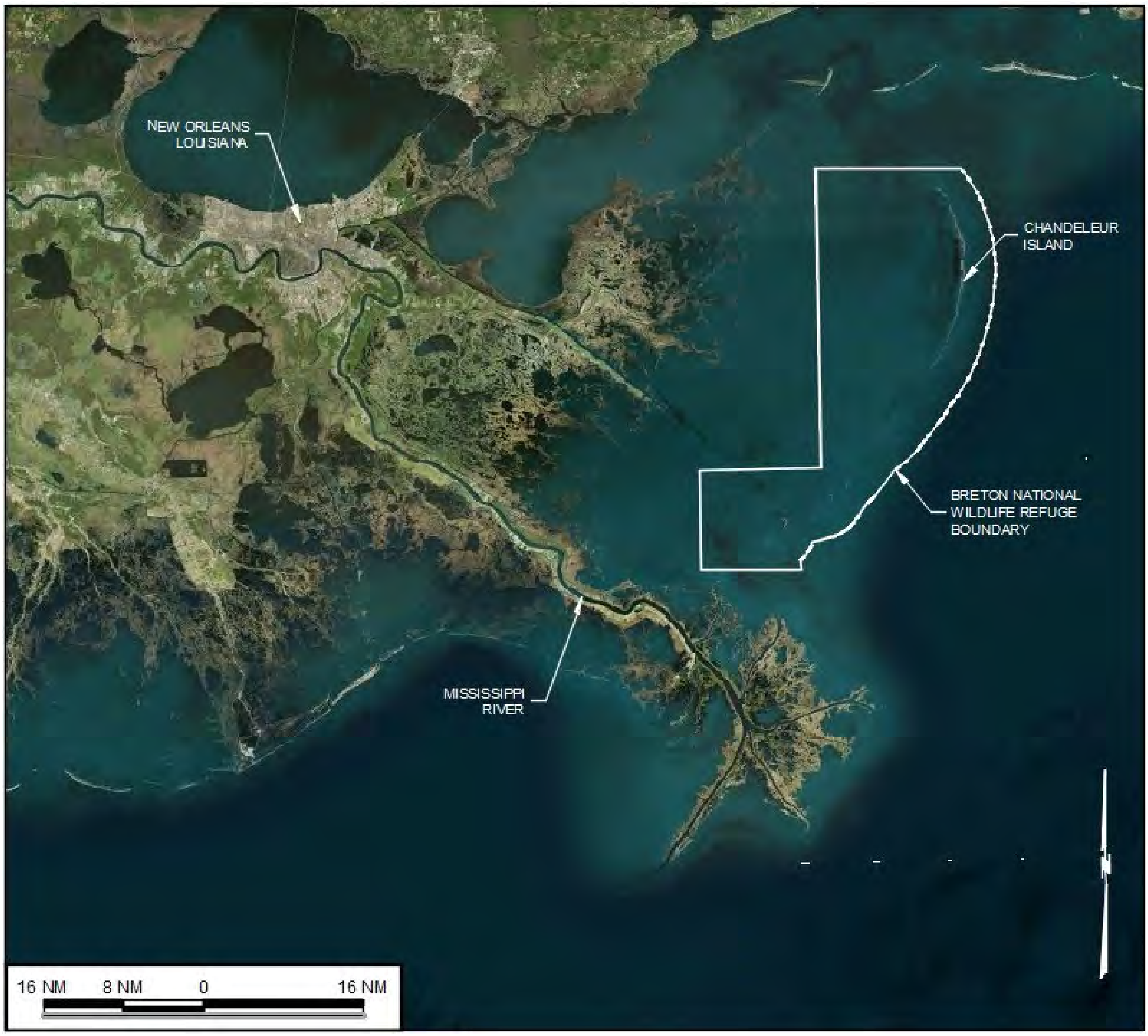

Figure 1. Project Location Map

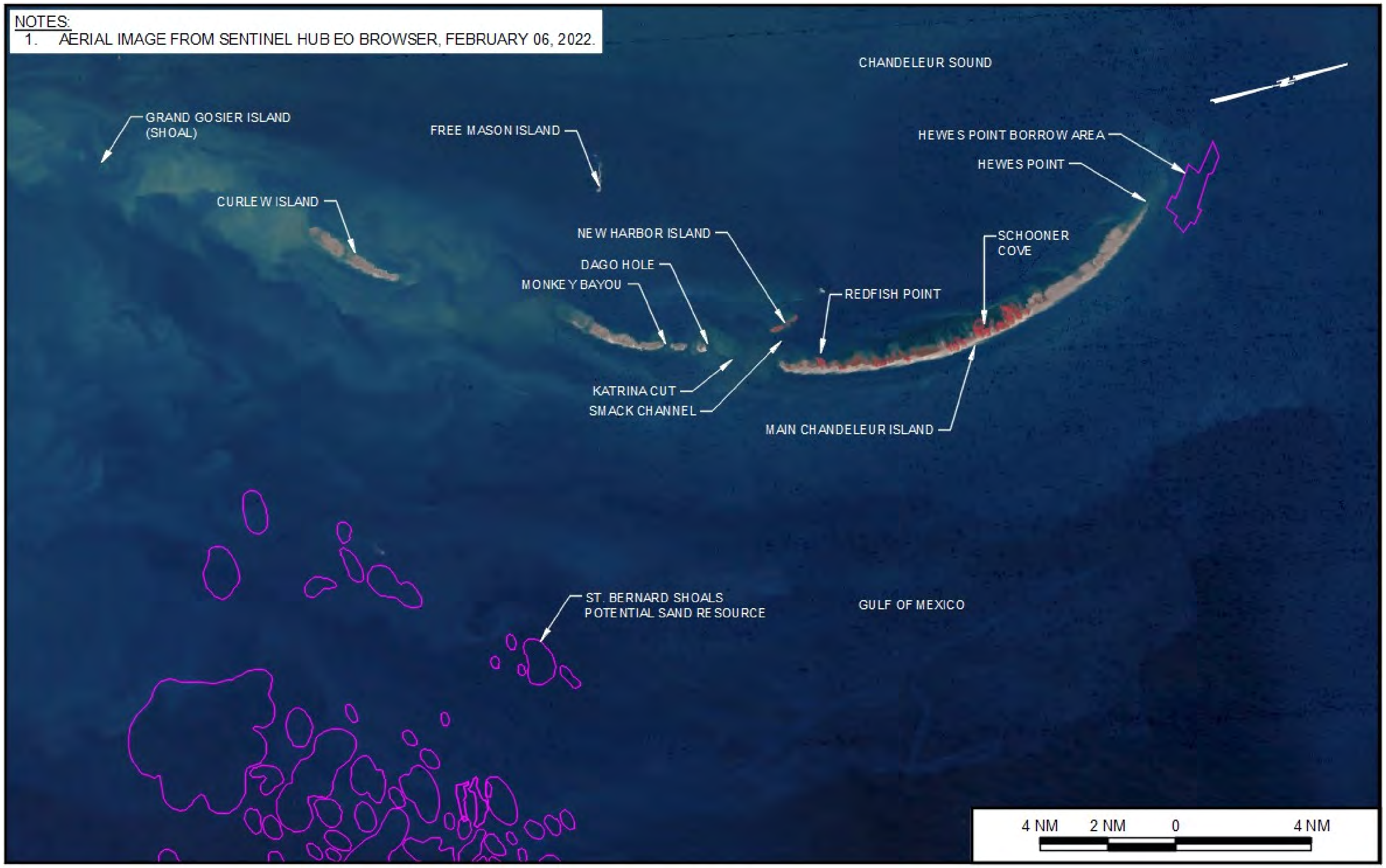

Figure 2. Chandeleur Islands

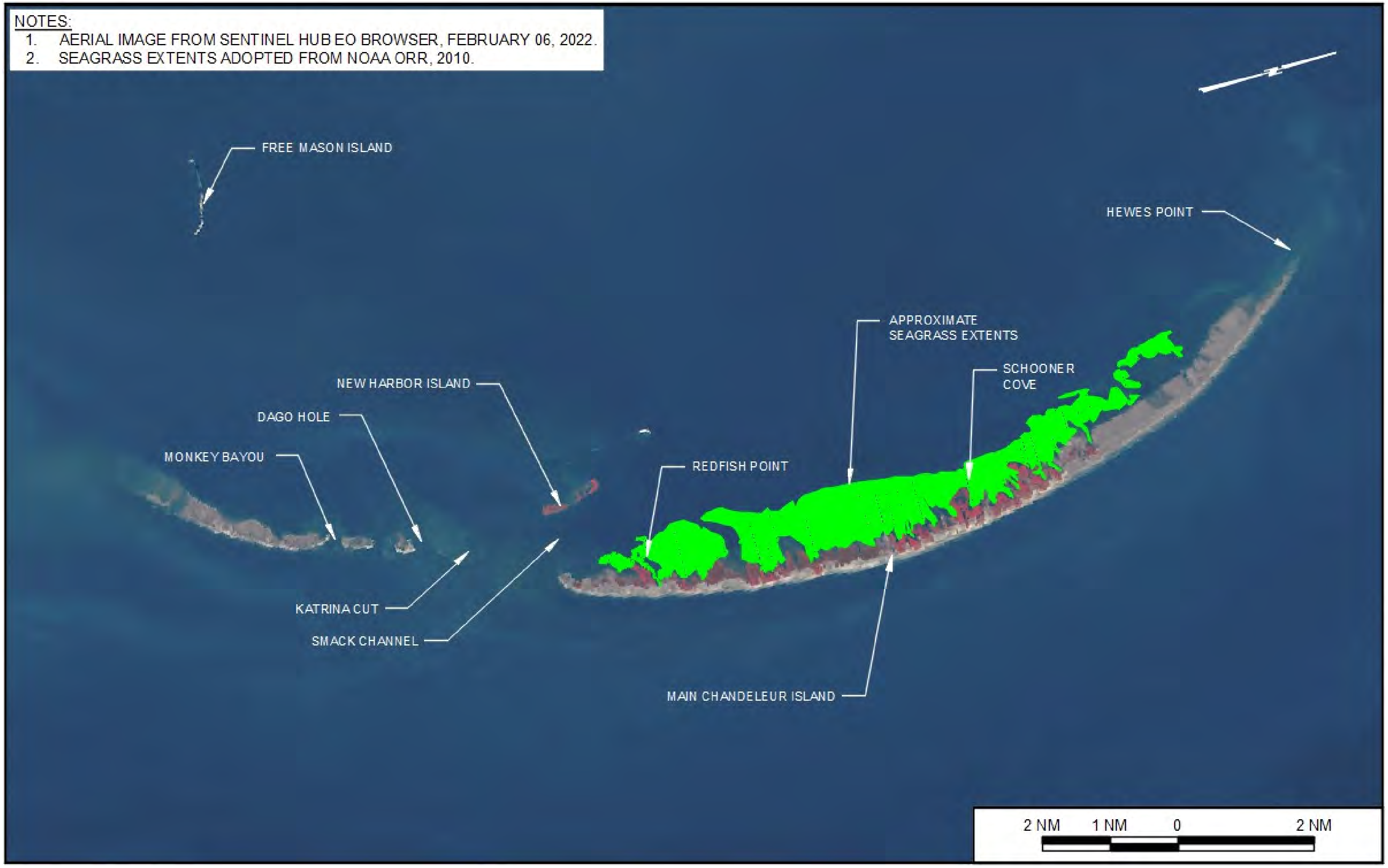

Figure 3. 2010-2011 Seagrass Bed Mapping by NOAA (NOAA 2015)

1.2 Project Area Description

The Chandeleurs Islands can be subdivided into two subsets, which are affected by different hydrologic inputs and environmental stressors. The northern islands include the main Chandeleur Island, New Harbor Island, Freemason Island, and Curlew Island. The southern islands include Grand Gosier Island and Breton Islands. The primary ecological drivers in the Project Area are attributed to natural coastal processes such as barrier island dynamics, abandoned river deltas, and damage from tropical storms and hurricanes. The southern islands are within close proximity to major passes of the Mississippi River. Due to the significant freshwater inputs, high nutrient levels and increased turbidity levels, seagrass development has been adversely impacted in this area. The northern islands are located far enough away from pollutant sources, including waters from coastal Mississippi, buffered by the Biloxi marsh system, and inputs from the Pearl River and passes of Lake Ponchartrain, and do not appear to have adverse impacts to seagrass development in this area (Handley et al. 2007).

Studies throughout the past five decades have reported varying coverage of seagrasses along the Chandeleur Islands, however the species composition has remained fairly consistent and includes turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*). Frequent damage due to passing hurricanes shown influences the species composition and abundance in certain areas. Those areas that are sheltered from damage are dominated by dense turtle grass meadows. Areas that experience higher levels of damaging forces, such as the creation of channel cuts and sediment washover features with high levels of sediment deposition, were found to have some turtle grass, but also manatee grass and shoal grass. Star grass was found to be present but was quite rare. The change in species composition from dense beds of turtle grass and manatee grass to gradual colonization of shoal grass and widgeon grass indicates a gradual pattern of stressors from storm damage over time (Handley et al. 2007).

The last comprehensive investigation for seagrass bed extent, viability, and species composition within the Chandeleur Islands was conducted by the National Oceanic and Atmospheric Administration (NOAA) and the United States Geological Survey (USGS) in 2010 and 2011. The investigation was conducted as part of the post-incident exposure of the Deepwater Horizon Oil Spill on seagrass vegetation throughout the northern Gulf of Mexico (NOAA 2015). The 2010 and 2011 seagrass coverage totals approximately 2,385 acres, and 2,614 acres, respectively (NOAA 2015). The National Aeronautics and Space Administration (NASA) Tool CREOL (NASA 2021) also provides supporting aerial imagery of the Project Area to illustrate changes in seagrass extent. The Project Area has been subjected to multiple storms of varying and increasing intensity storms. These storms have the potential to produce overwash and breaching of the dunes that can smother, bury, and otherwise impact water quality necessary for maintaining seagrass health and coverage.

2 SURVEY PLAN GOALS

The Survey Plan will utilize the available historic seagrass bed mapping and Project data to be collected including aerial photographs and imagery, topography, and bathymetry to establish the Survey Area for ground-truthing surveys of the seagrass beds. Detailed survey plan goals include:

1. Summarize the existing aerial and ground-truthed seagrass survey data from existing sources to give us an understanding of the historical seagrass bed extent and health through water quality, species composition, and biomass indicators, and to incorporate ground truthing data collection points for sample locations. The robust sampling plan will allow for consistency and reproducible data collection to evaluate trends in extent and health over time.

2. Determine the 2022 spatial distribution of seagrass beds utilizing new aerial data collected for the Project and Summer 2022 field surveys to verify boundary edges between aerial data collection timeline and field survey timeline.

3. Characterize the 2022 Seagrass communities. Primary data collection metrics will include species composition, percent cover, patchiness, and basic water quality parameters.

4. Determine and describe the biological and water quality health through secondary data collection at a subset of sampling locations, which will be used to guide future monitoring and restoration phases of the Project.

5. Set up and maintain a GIS platform (SWCA AI Platform) to evaluate in near real-time field data collection updates and compare between the 2022 aerial survey data with historic seagrass maps and aerial imagery.

2.1 Survey Plan

The limits of the 2010 and 2011 NOAA and USGS aerial data were georeferenced to establish the preliminary Survey Area and allow for reproducibility in the 2022 survey efforts: 1) verifying the entire seagrass habitat or potential habitat is identified, and 2) enable comparisons of species, compositions, and densities over time. Furthermore, the Survey Plan will incorporate Project Design Team data efforts to ensure proper data collection methods, logistics, and safety.

The work flow includes developing the preliminary Survey Area as presented herein, obtaining high resolution aerial photographs in May 2022 (separate task), mapping seagrasses utilizing the May 2022 aerial photographs, collecting topography and bathymetry in Summer 2022 (separate task), comparing and correlating Summer 2022 bathymetry to May 2022 seagrass mapping, obtaining satellite data in Summer 2022, refining seagrass edge mapping utilizing Summer 2022 data and satellite data, and finalizing the Survey Area to match the current extent of seagrasses. The seagrass survey field work is anticipated to be conducted within a two week period in August 2022 depending on weather and environmental constraints. Refining and finalizing the Survey Area will be an iterative process among the Project Design Team and CPRA.

2.2 Definition of Survey Area

In order to define a preliminary Survey Area (Figure 4), a single polygon was created identifying the maximum bounds of the 2010/2011 seagrass extent (NOAA 2015). This preliminary Survey Area will be refined based on results of the 2022 aerial data acquisition. The Survey Area will be confirmed based on the current extent of the seagrasses, which will be digitally mapped through photogrammetric interpretation. The aerial photographs will be collected in May 2022, prior to the start of the known seagrass growing season (June through September),. Topographic and bathymetric data and satellite data

will be collected in Summer 2022 to confirm the current extent at the time of the seagrass field survey The Survey Area will be refined as needed to capture the current extent of the seagrasses.

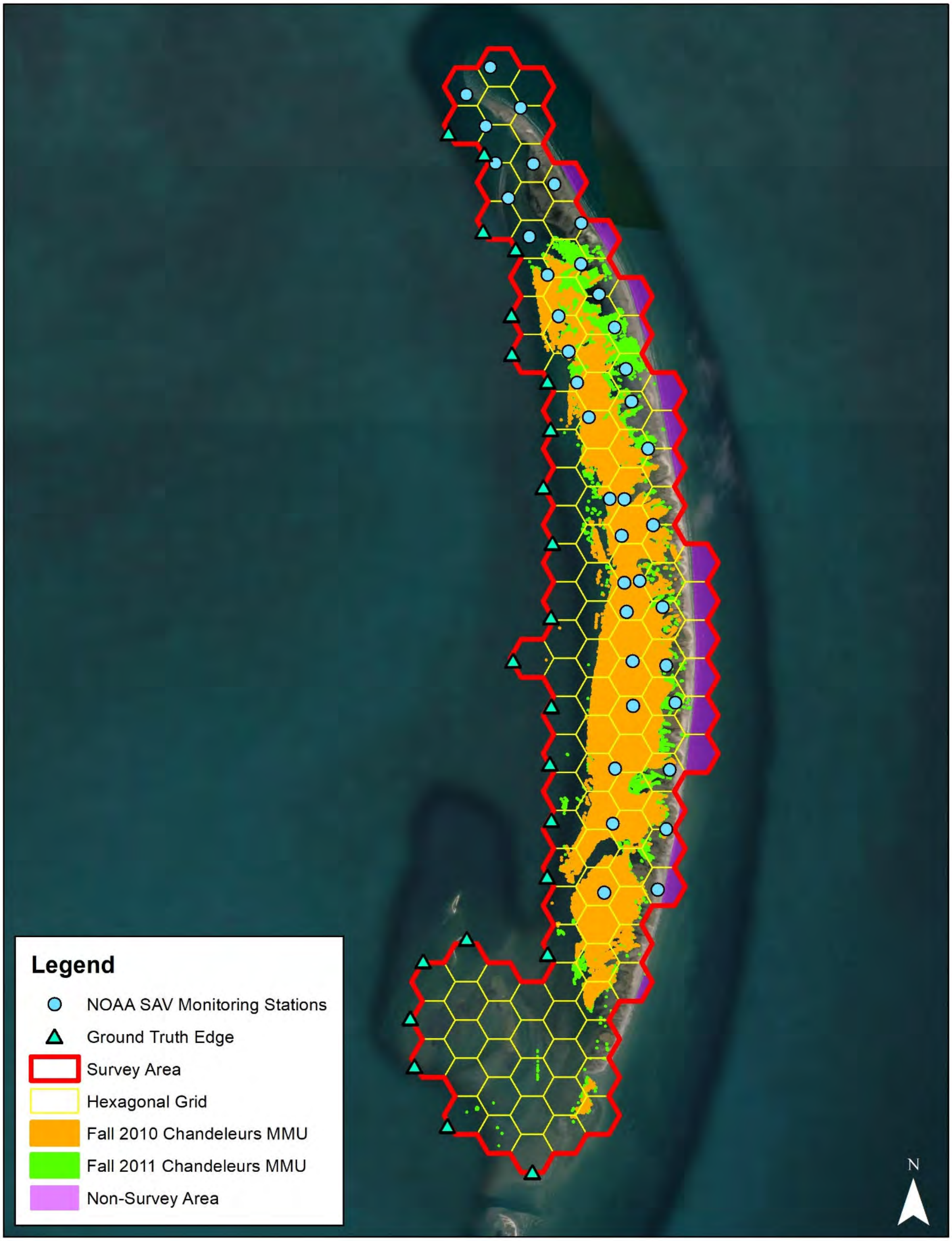

Figure 4. Seagrass Study Area

2.3 Field Survey Plan: Fixed Station Locations

The field survey plan utilizes the methods outlined in Dunton et al. (2010), as recommended by the National Academies of Sciences, Engineering and Medicine (2017), combined with the sampling locations from the 2010 and 2011 NOAA sampling program (NOAA 2015), allowing for robust data collection and reproducibility. The recommended practices utilize a grid of tessellated hexagons (500 meters per side) to identify sampling locations for all levels of seagrass monitoring. This hexagonal grid was overlaid on to the Survey Area to establish the sampling locations (Figure 4). Prior to the start of the field survey effort, one fixed sample location will be randomly selected within each hexagon, for a total of 123 sample locations. In situations where there are existing data points from the 2010 / 2011 NOAA sampling program, those station locations will be selected in lieu of the randomly selected data point for that hexagon.

For survey planning purposes, the hexagonal grid was overlaid on the most current publicly available, high resolution aerial data (Google Earth 2022). Due to the dynamic nature of the barrier islands and presumed migration of the island from the last large scale seagrass mapping effort (2011) to its current position, some survey grid locations containing historical seagrass data extensively overlap with the island and extend into the Gulf. Figure 4 illustrates how some survey hexagons will be truncated to account for island overlap. Once the April/May Project aerial data is collected, the survey grids will be similarly truncated to capture the most landward extent of the Survey Area.

Sampling will occur in the July – August 2022 time frame, during or shortly after the peak seagrass growing season for the region, which is mid to late summer. While Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Environmental Quality do not stipulate a seagrass growing season, especially as it pertains to environmental surveys, the Florida Department of Environmental Protection (FDEP 2020) further defines this season as June 1 and Sept. 30 for the Florida and the northern Gulf of Mexico coastal regions and will be utilized for this Survey Plan.

Primary Data Collection

The primary objective of the survey is to collect data metrics that will characterize the seagrass community, including species composition, percent cover, seagrass bed configuration (patchiness), and preliminary water quality information to establish a baseline condition at the peak of the 2022 growing season. Patchiness will be evaluated by the relative connectivity to surrounding seagrass beds (continuous vs patchy) and the relative biomass per unit (patchy vs very patchy). As outlined in Dunton et al. (2010) at each randomly selected, fixed location, four stations will be sampled in each of the cardinal directions surrounding the vessel. The fixed station is to be navigated to with GPS accuracy of 4 meters or better. The station is identified as having a 10-meter radius, and the four locations are sampled within this circle. Basic water quality parameters are collected with a data sonde prior to deployment of any benthic sampling equipment. Species composition and percent cover will be evaluated in the field within a 0.25 m^2 quadrat outfitted with an underwater camera to document coverage within the quadrat. Additionally, the primary data metrics will be collected during the diver-verified fringe locations, described further below. A summary primary data metrics to be collected are described in Table 1.

Secondary Data Collection

Secondary seagrass composition and metrics could be collected at a subset of the locations identified for primary data collection. These secondary data metrics would provide baseline health information that will support the restoration planning phase of the Project design and post-construction restoration monitoring and Adaptive Management (MAM). Secondary data collection could occur at 13 of the established hexagons, or 10% of the sample locations, selected accordingly to assess conditions in the shallow areas, shoaling habitats, and deeper established seagrass meadows from the northern to the southern extent of the seagrass beds. The secondary data collection locations will be selected based on final Study Area design, described above. A summary of secondary data metrics to be collected are described in Table 1.

Table 1. Survey and Sampling Metrics

Metrics	Metrics	Equipment
Primary Data Collection		
Vessel Location	Date/Time	GPS unit (submeter accuracy)
	GPS location	Sounding rod
	Water depth	Underwater light sensor
	Light attenuation	Multi-probe sonde
	Water temperature, salinity, pH, dissolved oxygen	
	Distance from shoreline	
Stations (N, E, S, W)	Sediment type	.25 m^2 quad (with underwater camera)
	Species composition	Ruler
	Total percent cover	
	Percent cover by species	
	Canopy height	
	Shoot density	
Secondary Data Collection (subset)		
Vessel Location	Biomass (above/below)	Benthic corer
	Root:shoot ratio	

2.4 Peak-Season Fringe Mapping: Remote Sensing

In order to capture the full coverage of the seagrass beds at peak or near-peak growing season (i.e. later than the May aerial photographs) and delineate the dense and patchy seagrass habitats, SWCA will obtain 50-cm resolution satellite data from Planet Labs SkySat for an approximately 105-sq km area encapsulating the known 2010 and 2011 seagrass and Study Area extent. Considering the size of Survey Area, the use of aerial imagery is a cost-effective and more precise method for delineating seagrass fringe habitat than diver delineated methods. Obtaining the aerial imagery prior to field survey will allow for spot checking in the field rather than swimming the full edge of the Survey Area. Divers will collect the primary data metrics, as outlined in Table 1, and will collect additional light attenuation measurements at depth, mid-water column, and subsurface to provide additional information to characterize that edge habitat.

2.5 Data Analysis

Aerial data interpretation will utilize colorimetric signatures to differentiate and delineate the various seagrass habitats including continuous and dense coverage, patchy coverage, sand bottom indicating no seagrass.

For standardization and rapid assessment of seagrass coverage, each of the quadrats will be scored utilizing the Braun-Blanquet classes (Dunton et al., 2010; Fourqurean et al., 2001) where the percent cover of seagrass may be visually assessed and reported to the nearest 5% or reported using the Braun-Blanquet cover-abundance scores. The abundance score for each species present within the quadrats will be scored.

ArcGIS software will be used to manage, analyze, and display water quality and seagrass data using techniques such as kriging interpolation. This process allows for accurate depiction of changes over a relatively small area and allows for the development of visually clear map products.

3 DELIVERABLES

SWCA will provide survey polygons and data mapping products as KMZs, shapefiles, required format.

SWCA will provide a Seagrass Bed Survey Report summarizing survey protocol, survey results, and data analysis including text, data tables, and maps and figures which will be provided in PDF format along with electronic files of all pictures, field notes, and data sheets.

SWCA will set up and maintain a GIS platform (SWCA AI Platform) to evaluate in near real-time field data collection updates and compare between the 2022 aerial survey data, the 2010/2011 aerial imagery, and NASA imagery.

4 REFERENCES

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Appendix B

Water Quality Data By Location

Table B-1. Water quality data by location at 0.3 m

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C101	9/22/2022	10:45	0.8	0.8	29.6	53.8	58.6	35.4	105.3	6.56	8.63
C102	9/22/2022	10:09	1.8	1.8	29.3	37.68	--	23.78	123.8	8.38	8.5
C103	9/22/2022	11:55	1	1	30.4	35.18	--	22.02	147.7	9.88	8.74
C105	9/22/2022	10:37	1.4	1.4	29.5	37.52	--	25.37	124.1	8.33	8.51
C106	9/22/2022	8:48	2.7	2.7	28.8	37.27	--	23.51	128.8	8.73	8.37
C107	9/22/2022	11:05	0.6	0.6	30.4	34.44	--	34.51	126	8.36	8.56
C109	9/21/2022	13:04	1.5	1.5	29.7	37.42	--	23.59	139.0	9.26	8.53
C110	9/21/2022	9:00	2.6	2.6	28.2	37.32	--	23.56	114.3	7.84	8.27
C111	9/21/2022	12:02	0.6	0.6	30.0	34.92	--	21.85	123.4	8.30	8.54
C113	9/21/2022	11:42	0.9	0.9	29.4	36.93	--	23.28	113.5	7.63	8.47
C114	9/21/2022	13:03	1.7	1.7	29.2	52.60	56.70	34.50	117.1	7.40	8.54
C115	9/21/2022	10:24	1.0	1.0	28.8	36.88	--	23.24	100.8	6.86	8.41
C117	9/21/2022	10:54	1.2	1.2	28.2	52.20	55.40	34.20	74.1	4.81	8.33
C119	9/21/2022	10:24	0.8	0.8	28.2	53.3	56.5	35.0	43.2	2.74	8.15
C121	9/21/2022	9:26	0.9	0.9	28.2	52.2	55.4	34.23	93.3	5.96	8.4
C123	9/21/2022	9:50	1.3	1.3	28.4	52.60	56.00	34.54	99.8	6.43	8.46
C125	9/20/2022	12:49	1.4	1.4	29.3	37.78	--	23.86	151.4	10.20	8.54
C126	9/20/2022	13:11	2.6	0.8	29	37.8	--	23.87	132.7	8.97	8.44
C127	9/20/2022	12:15	0.9	--	29.9	36.92	--	23.24	147.9	9.89	8.67
C129	9/20/2022	10:20	1.1	1.1	27.7	37.47	--	23.68	80	5.51	8.17
C130	9/20/2022	9:25	>3	2.4	28.5	38.08	--	24.09	125.6	8.62	8.36
C133	9/20/2022	12:44	1.0	1.0	29.0	52.60	56.70	34.45	145.6	9.27	8.61
C134	9/20/2022	10:03	2.3	2.2	28.1	53.6	56.7	35.1	85.3	5.26	8.52
C136	9/20/2022	9:00	2.4	2.4	28.1	54.1	57.3	E	101	6.56	8.43
C137	9/20/2022	10:54	1.9	1.2	28.3	53.4	56.9	35.15	99.3	6.39	8.44

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C138	9/19/2022	11:45	1.4	1.4	27.7	52.20	54.90	34.30	94.4	6.20	8.54
C141	9/19/2022	1:31	0.2	0.2	33.2	46.00	53.50	30.66	206.7	14.42	9.09
C142	9/19/2022	10:48	1.7	1.7	28.5	52.10	55.60	34.24	93.6	6.01	8.40
C143	9/19/2022	9:21	2.5	2.5	28.2	42.32	44.99	27.08	95.5	6.40	8.32
C145	9/19/2022	11:35	0.05	0.05	32	39.09	--	24.5	140.5	9.13	8.34
C146	9/19/2022	9:46	1	--	28.5	37.37	--	23.52	103	7.04	8.54
C148	9/19/2022	9:00	1.9	1.9	28.3	38.04	--	24.07	119.3	8.16	8.31
C149	9/19/2022	10:25	0.4	0.4	28.5	38.93	--	24.69	105.2	7.12	8.36
C150	9/18/2022	10:20	1.7	1.7	26.8	37.05	--	23.41	91.6	6.35	8.34
C152	9/18/2022	9:15	2.5	2.5	27.8	38.44	--	24.39	90.7	6.24	8.17
C153	9/18/2022	13:45	0.1	0.1	34.2	38.91	--	24.54	201.2	12.47	8.73
C155	9/18/2022	12:10	0.9	0.9	27.6	38.3	--	24.07	133.6	9.27	8.44
C156	9/18/2022	15:32	1.2	1.2	29.0	41.77	46.00	26.68	137.2	9.24	8.66
C159	9/18/2022	15:03	0.5	0.5	34.4	42.70	50.40	27.10	136.5	8.20	8.60
C160	9/18/2022	10:28	1.3	1.3	27.0	42.15	43.81	27.00	82.8	5.63	8.45
C161	9/18/2022	9:42	1.0	1.0	27.1	41.96	43.62	26.80	72.8	4.91	8.52
C165	9/15/2022	14:50	0.5	--	29.5	40.27	43.78	25.61	104.5	6.92	8.32
C30	9/25/2022	11:32	0.9	0.9	29.6	62.2	67.6	E	96.5	5.8	8.4
C32	9/25/2022	--	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	1.4	1.4	29.2	59.6	64.4	E	109.5	67.5	8.45
C41	9/24/2022	11:21	2	1.3	29.1	39.63	--	25.15	122.4	8.22	8.36
C43	9/25/2022	10:52	2.4	1.3	29.3	61.5	66.5	E	103.4	6.3	8.5
C48	9/24/2022	--	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	0.3	0.3	29.1	39.24	--	24.88	126.3	8.47	8.4
C60	9/24/2022	10:30	0.6	0.6	28.3	38.435	--	24.33	108.8	7.43	8.47
C64	9/24/2022	9:37	1	1	28.9	38.319	--	24.24	108.6	7.34	8.44

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C67	9/24/2022	9:00	2.8	1.7	28.9	38.32	--	24.25	123.8	8.4	8.43
C68	9/24/2022	10:00	0.6	0.6	28.6	38.083	--	24.09	118.1	8.01	8.43
C72	9/24/2022	12:18	1.5	1.3	29.6	58.6	63.7	E	111.6	6.9	8.6
C76	9/24/2022	11:52	0.7	0.7	29.7	57.4	62.5	E	185.4	11.3	8.9
C80	9/24/2022	12:45	1.7	1.5	29.6	58.3	63.4	E	118.8	7.38	8.6
C81	9/24/2022	11:17	0.8	0.8	29	67.7	62.1	E	113	7.1	8.6
C84	9/24/2022	--	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	1.7	1.7	29.3	58.3	63.1	28.7	105.8	6.6	8.6
C88	9/24/2022	9:57	1.8	1.8	28.9	58.3	62.6	E	92.1	5.75	8.5
C89	9/24/2022	10:30	0.8	0.8	28.2	56.2	59.6	E	87	5.5	8.66
C91	9/24/2022	--	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	0.6	0.6	30.8	54	60	35.49	176.1	10.82	8.79
C94	9/22/2022	14:24	1.8	1.8	30.5	55.7	61.6	E	123	7.58	8.54
C96	9/22/2022	--	--	--	--	--	--	--	--	--	--
C97	9/22/2022	9:50	2.1	2.1	29	55.7	59.4	E	110.4	6.9	8.54
C98	9/22/2022	9:10	2.6	1.8	29.2	55.5	59.1	E	21.7	7.5	8.54
C99	9/22/2022	10:18	0.8	0.8	29	54	58.1	35.53	87.2	5.45	8.48
S201	9/25/2022	--	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	1.4	1.4	29.1	61.90	66.80	E	96.3	5.89	8.41
S203	9/25/2022	--	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	2.5	2.3	29.1	60.40	65.20	E	102.0	6.30	8.40
S205	9/25/2022	12:11	2.0	1.4	29.4	57.20	62.10	E	115.8	7.17	8.45
S206	9/25/2022	10:39	2.2	1.7	29.0	60.80	65.50	E	101.0	6.20	8.44
S207	9/24/2022	11:48	2	2	29.1	39.8	--	25.28	128.8	8.75	8.4
S208	9/25/2022	10:30	1.8	1.4	28.9	62.30	66.90	E	100.8	6.14	8.24
S209	9/24/2022	11:58	2.1	--	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1.4	1.4	29.7	57.70	62.80	E	106.7	6.60	8.48

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S211	9/24/2022	12:11	2.2	1.3	29.9	38.39	--	24.27	136	9.05	8.53
S212	9/24/2022	14:26	1.7	1.7	30.6	37.971	--	23.95	154.8	10.2	8.57
S213	9/25/2022	12:45	1.3	1.3	29.6	58.00	63.20	E	105.2	6.50	8.48
S214	9/24/2022	14:46	1.3	1.3	30.3	37.86	--	23.89	148.6	9.82	8.55
S215	9/24/2022	12:30	2.3	1.7	30.1	38.04	--	24.02	1.4	1.3	8.56
S216	9/24/2022	12:41	>3	--	--	--	--	--	--	--	--
S217	9/24/2022	15:17	0.4	0.4	30.4	37.44	--	23.59	139.7	9.26	8.51
S218	9/24/2022	14:55	1.7	1.7	29.9	58.8	64.4	E	112.9	6.9	8.58
S219	9/24/2022	--	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	1.7	1.7	29.4	58.3	63.1	E	116.4	7.2	8.59
S221	9/24/2022	--	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	1.4	1.4	29.7	57.5	62.6	E	111.6	7	8.55
S223	9/24/2022	10:53	1.7	1.7	28.8	58.6	67.8	E	74.6	4.6	8.5
S224	9/24/2022	--	--	--	--	--	--	--	--	--	--
S225	9/22/2022	13:50	0.3	0.3	32.9	53.4	61.5	25	140.7	8.37	8.44
S226	9/22/2022	13:04	0.8	0.8	31.5	53.4	60	35	118.4	7.15	8.45
S227	9/22/2022	11:10	0.4	0.4	29.7	51.6	56.2	33.8	30.9	2.06	8.06
S228	9/22/2022	9:19	2.2	2.2	28.9	37.68	--	23.8	126.5	8.59	8.48
S229	9/22/2022	9:48	2.1	2.1	29.2	37.759	--	23.84	137	9.22	8.55
S230	9/22/2022	--	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1.1	1.0	29.8	35.48	--	22.30	131.9	8.88	8.64
S234	9/21/2022	--	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	1.6	1.6	27.9	37.49	--	23.68	101.5	6.91	8.33
S237	9/20/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S238	9/21/2022	--	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1.8	1.8	29.2	52.9	57.1	34.73	97.5	6.1	8.4
S240	9/20/2022	--	--	--	--	--	--	--	--	--	--
S241	9/21/2022	11:48	0.2	0.2	29.2	50.3	54.3	32.76	110.0	7.00	8.42
S242	9/21/2022	--	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	0.7	0.6	29.2	51.30	55.50	33.60	60.5	3.80	8.12
S246	9/20/2022	11:32	0.9	0.9	29.6	37.04	--	23.33	121.6	8.18	8.5
S247	9/20/2022	--	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	0.3	0.3	29.6	36.822	--	23.18	123.7	8.34	8.44
S249	9/20/2022	13:26	0.6	0.6	30.6	48.1	53.3	31.25	103.8	6.55	8.49
S250	9/20/2022	--	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--	--
S252	9/20/2022	--	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	0.3	0.3	31.7	47.7	54	31.26	143.9	8.97	8.49
S254	9/19/2022	--	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1.6	1.6	29.6	51.20	55.70	33.49	128.8	8.21	8.56
S257	9/19/2022	14:40	0.27	--	33.2	38.84	--	24.49	215.8	13.63	8.65
S258	9/19/2022	13:35	1.2	--	29.2	36.98	--	23.31	147.8	10.00	8.64
S259	9/19/2022	14:45	1.4	1.4	29.9	51.50	56.20	33.66	105.7	9.26	8.46
S260	9/19/2022	14:13	0.11	--	34.7	39.58	--	24.96	202.7	12.42	8.47
S261	9/19/2022	10:50	0.3	0.3	28.7	39.27	--	24.92	125.1	8.48	8.49
S262	9/18/2022	14:26	0.4	0.4	35.1	39.20	--	24.68	200.6	12.23	8.66
S263	9/18/2022	12:58	0.3	0.3	30.3	38.51	--	24.34	124.3	8.24	8.33
S264	9/18/2022	14:19	0.9	0.9	29.6	42.17	45.92	26.97	122.1	8.11	8.54

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S265	9/18/2022	--	--	--	--	--	--	--	--	--	--
S266	9/18/2022	12:47	0.1	0.1	33.4	42.17	48.96	26.80	122.9	7.36	8.56
S267	9/18/2022	11:43	0.3	0.3	29.7	42.62	46.52	27.28	153.2	9.76	8.6
S268	9/15/2022	--	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	2.0	1.4	28.9	42.10	44.44	26.83	98.6	6.52	8.31
S272	9/15/2022	--	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--	--

E = outlier readings; potential sensor error

Table B-2. Water quality data by location at 1.0 m

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C101	9/22/2022	10:45	0.8	0.8	--	--	--	--	--	--	--
C102	9/22/2022	10:09	1.8	1.8	29.2	37.69	--	23.79	124.3	8.36	8.49
C103	9/22/2022	11:55	1	1	--	--	--	--	--	--	--
C105	9/22/2022	10:37	1.4	1.4	29.5	37.53	--	23.68	126.3	8.48	8.51
C106	9/22/2022	8:48	2.7	2.7	28.9	37.26	--	23,50	129.4	8.77	8.39
C107	9/22/2022	11:05	0.6	0.6	--	--	--	--	--	--	--
C109	9/21/2022	13:04	1.5	1.5	29.7	37.40	--	23.57	144.4	9.66	8.5
C110	9/21/2022	9:00	2.6	2.6	28.3	37.31	--	23.55	114.9	7.86	8.29
C111	9/21/2022	12:02	0.6	0.6	--	--	--	--	--	--	--
C113	9/21/2022	11:42	0.9	0.9	--	--	--	--	--	--	--
C114	9/21/2022	13:03	1.7	1.7	29.0	53.30	57.40	35.00	117.8	7.50	8.54
C115	9/21/2022	10:24	1.0	1.0	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C117	9/21/2022	10:54	1.2	1.2	28.2	52.20	55.40	34.26	70.1	4.50	8.34
C119	9/21/2022	10:24	0.8	0.8	--	--	--	--	--	--	--
C121	9/21/2022	9:26	0.9	0.9	--	--	--	--	--	--	--
C123	9/21/2022	9:50	1.3	1.3	28.2	53.30	56.70	35.10	86.5	5.63	8.39
C125	9/20/2022	12:49	1.4	1.4	29.1	37.79	--	23.86	153.2	10.32	8.54
C126	9/20/2022	13:11	2.6	0.8	29	38.22	--	24.17	141.5	9.58	8.48
C127	9/20/2022	12:15	0.9	--	--	--	--	--	--	--	--
C129	9/20/2022	10:20	1.1	1.1	--	--	--	--	--	--	--
C130	9/20/2022	9:25	>3	2.4	28.5	38.09	--	24.09	128.1	8.71	8.37
C133	9/20/2022	12:44	1.0	1.0	--	--	--	--	--	--	--
C134	9/20/2022	10:03	2.3	2.2	28.3	54.5	57.7	35.8	96.7	6.23	8.49
C136	9/20/2022	9:00	2.4	2.4	28.1	56.1	59.4	E	103.1	6.59	8.44
C137	9/20/2022	10:54	1.9	1.2	28.4	53.7	57.2	35.22	99.4	6.51	8.44
C138	9/19/2022	11:45	1.4	1.4	27.7	53.40	56.20	35.15	92.2	6.08	8.54
C141	9/19/2022	1:31	0.2	0.2	--	--	--	--	--	--	--
C142	9/19/2022	10:48	1.7	1.7	28.5	54.40	58.10	35.91	109.5	6.84	8.45
C143	9/19/2022	9:21	2.5	2.5	28.3	42.45	45.11	27.19	94.7	6.41	8.32
C145	9/19/2022	11:35	0.05	0.05	--	--	--	--	--	--	--
C146	9/19/2022	9:46	1	--	--	--	--	--	--	--	--
C148	9/19/2022	9:00	1.9	1.9	28.3	38.07	--	24.08	120	8.2	8.33
C149	9/19/2022	10:25	0.4	0.4	--	--	--	--	--	--	--
C150	9/18/2022	10:20	1.7	1.7	27.5	37.20	--	23.50	92.3	6.42	8.34
C152	9/18/2022	9:15	2.5	2.5	27.8	38.53	--	24.42	90.5	6.22	8.18
C153	9/18/2022	13:45	0.1	0.1	--	--	--	--	--	--	--
C155	9/18/2022	12:10	0.9	0.9	--	--	--	--	--	--	--
C156	9/18/2022	15:32	1.2	1.2	29.1	41.99	45.24	26.84	153.6	10.28	8.71
C159	9/18/2022	15:03	0.5	0.5	--	--	--	--	--	--	--
C160	9/18/2022	10:28	1.3	1.3	27.1	42.32	44.05	27.13	91.4	6.03	8.47

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C161	9/18/2022	9:42	1.0	1.0	--	--	--	--	--	--	--
C165	9/15/2022	14:50	0.5	--	--	--	--	--	--	--	--
C30	9/25/2022	11:32	0.9	0.9	--	--	--	--	--	--	--
C32	9/25/2022	--	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	1.4	1.4	29	60.2	64.8	E	109	6.72	8.44
C41	9/24/2022	11:21	2	1.3	29.1	39.66	--	25.18	123.4	8.3	8.37
C43	9/25/2022	10:52	2.4	1.3	29.2	61.7	66.6	E	102.7	2.3	8.5
C48	9/24/2022	--	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	0.3	0.3	--	--	--	--	--	--	--
C60	9/24/2022	10:30	0.6	0.6	--	--	--	--	--	--	--
C64	9/24/2022	9:37	1	1	28	38.329	--	24.25	109	7.36	8.43
C67	9/24/2022	9:00	2.8	1.7	28	39.05	--	24.77	120.3	8.14	8.36
C68	9/24/2022	10:00	0.6	0.6	--	--	--	--	--	--	--
C72	9/24/2022	12:18	1.5	1.3	29.4	58.4	63.2	E	115.9	7.2	8.6
C76	9/24/2022	11:52	0.7	0.7	--	--	--	--	--	--	--
C80	9/24/2022	12:45	1.7	1.5	29.6	58.4	63.5	E	114.9	7.08	8.6
C81	9/24/2022	11:17	0.8	0.8	--	--	--	--	--	--	--
C84	9/24/2022	--	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	1.7	1.7	28.8	58.8	63	E	85.5	5.3	8.6
C88	9/24/2022	9:57	1.8	1.8	28.6	59	63	E	94	5.9	8.5
C89	9/24/2022	10:30	0.8	0.8	--	--	--	--	--	--	--
C91	9/24/2022	--	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	0.6	0.6	--	--	--	--	--	--	--
C94	9/22/2022	14:24	1.8	1.8	30	57.2	62.6	E	130.1	7.9	8.58
C96	9/22/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C97	9/22/2022	9:50	2.1	2.1	29	55.7	60	E	106.7	6.6	8.54
C98	9/22/2022	9:10	2.6	1.8	29.2	55.8	60.2	E	113.5	7.4	8.54
C99	9/22/2022	10:18	0.8	0.8	--	--	--	--	--	--	--
S201	9/25/2022	--	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	1.4	1.4	29.2	62.30	67.30	E	97.6	5.96	8.41
S203	9/25/2022	--	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	2.5	2.3	29.0	60.80	65.50	E	101.3	6.24	8.40
S205	9/25/2022	12:11	2.0	1.4	29.4	58.00	63.00	E	116.4	7.20	8.45
S206	9/25/2022	10:39	2.2	1.7	28.9	61.60	66.10	E	98.9	6.10	8.45
S207	9/24/2022	11:48	2	2	29.1	39.79	--	25.28	128.3	8.86	8.4
S208	9/25/2022	10:30	1.8	1.4	28.8	62.50	67.00	E	99.5	6.10	8.42
S209	9/24/2022	11:58	2.1	--	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1.4	1.4	29.4	58.30	63.30	E	107.3	6.61	8.49
S211	9/24/2022	12:11	2.2	1.3	29.7	39.16	--	24.83	127.7	8.5	8.43
S212	9/24/2022	14:26	1.7	1.7	30.6	37.973	--	23.96	156.7	10.3	8.56
S213	9/25/2022	12:45	1.3	1.3	29.7	57.90	63.10	E	102.9	6.33	8.49
S214	9/24/2022	14:46	1.3	1.3	30.3	37.86	--	23.89	150.2	9.9	8.54
S215	9/24/2022	12:30	2.3	1.7	30	38.22	--	24.16	137.9	9.22	8.54
S216	9/24/2022	12:41	>3	--	--	--	--	--	--	--	--
S217	9/24/2022	15:17	0.4	0.4	--	--	--	--	--	--	--
S218	9/24/2022	14:55	1.7	1.7	29.9	59.4	65	E	114	7	8.58
S219	9/24/2022	--	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	1.7	1.7	29.1	59.1	63.7	E	115.5	7.1	8.58
S221	9/24/2022	--	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	1.4	1.4	29.3	58.5	63.3	E	114.4	7	8.54
S223	9/24/2022	10:53	1.7	1.7	28.9	58.2	62.4	E	83.8	5.2	8.5
S224	9/24/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S225	9/22/2022	13:50	0.3	0.3	--	--	--	--	--	--	--
S226	9/22/2022	13:04	0.8	0.8	--	--	--	--	--	--	--
S227	9/22/2022	11:10	0.4	0.4	--	--	--	--	--	--	--
S228	9/22/2022	9:19	2.2	2.2	28.9	37.69	--	23.8	129.1	8.72	8.47
S229	9/22/2022	9:48	2.1	2.1	29.2	37.767	--	23.85	137.7	9.24	8.54
S230	9/22/2022	--	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1.1	1.0	29.7	35.55	--	22.29	155.0	10.51	8.71
S234	9/21/2022	--	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	1.6	1.6	28.1	37.50	--	23.69	100.7	6.91	8.33
S237	9/20/2022	--	--	--	--	--	--	--	--	--	--
S238	9/21/2022	--	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1.8	1.8	28.8	53.2	57.1	35.1	97.8	6.1	8.4
S240	9/20/2022	--	--	--	--	--	--	--	--	--	--
S241	9/21/2022	11:48	0.2	0.2	--	--	--	--	--	--	--
S242	9/21/2022	--	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	0.7	0.6	--	--	--	--	--	--	--
S246	9/20/2022	11:32	0.9	0.9	--	--	--	--	--	--	--
S247	9/20/2022	--	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	0.3	0.3	--	--	--	--	--	--	--
S249	9/20/2022	13:26	0.6	0.6	--	--	--	--	--	--	--
S250	9/20/2022	--	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S252	9/20/2022	--	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	0.3	0.3	--	--	--	--	--	--	--
S254	9/19/2022	--	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1.6	1.6	29.4	53.00	57.50	34.80	142.3	9.00	8.57
S257	9/19/2022	14:40	0.27	--	--	--	--	--	--	--	--
S258	9/19/2022	13:35	1.2	--	--	--	--	--	--	--	--
S259	9/19/2022	14:45	1.4	1.4	29.7	52.30	57.10	34.30	168.2	10.50	8.69
S260	9/19/2022	14:13	0.11	--	--	--	--	--	--	--	--
S261	9/19/2022	10:50	0.3	0.3	--	--	--	--	--	--	--
S262	9/18/2022	14:26	0.4	0.4	--	--	--	--	--	--	--
S263	9/18/2022	12:58	0.3	0.3	--	--	--	--	--	--	--
S264	9/18/2022	14:19	0.9	0.9	--	--	--	--	--	--	--
S265	9/18/2022	--	--	--	--	--	--	--	--	--	--
S266	9/18/2022	12:47	0.1	0.1	--	--	--	--	--	--	--
S267	9/18/2022	11:43	0.3	0.3	--	--	--	--	--	--	--
S268	9/15/2022	--	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	2.0	1.4	28.2	41.78	44.30	26.72	95.3	6.55	8.32
S272	9/15/2022	--	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--	--

E = outlier readings; potential sensor error

Table B-3. Water quality data by location for PAR

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
C101	9/22/2022	10:45	1152.5	1141.9	1182.9	1166.2	1175.2	--	--	--	--	--
C102	9/22/2022	10:09	997.6	1102.9	967.7	1039.5	910.7	636.4	620.5	625.7	634.2	661.2
C103	9/22/2022	11:55	1337.6	1303.6	1298.5	1301.5	1310.0	944.1	908.2	884.6	885.5	845.2
C105	9/22/2022	10:37	1059.7	1150.8	1097.7	1098.7	1099.0	813.1	687.7	793.0	902.5	831.5
C106	9/22/2022	8:48	704.4	724.1	778.5	811.4	820.0	558.9	557.5	504.6	527.7	529.8
C107	9/22/2022	11:05	1346.6	1331.4	1286.5	1279.7	1294.2	--	--	--	--	--
C109	9/21/2022	13:04	1444.4	1403.3	1425.6	1446.6	1405.5	939.4	916.3	945.8	987.7	920.6
C110	9/21/2022	9:00	348.9	340.4	332.4	333.6	330.4	230.2	231.5	238.8	242.4	238.6
C111	9/21/2022	12:02	687.3	1046.0	870.5	1079.8	927.8	631.7	762.2	588.8	452.0	477.5
C113	9/21/2022	11:42	734.8	1462.4	684.3	600.8	609.8	324.4	299.6	289.5	294.5	308.3
C114	9/21/2022	13:03	1074.2	1123.0	998.5	930.8	870.5	820.0	824.7	934.2	939.4	908.2
C115	9/21/2022	10:24	372.0	390.2	411.8	401.0	412.8	202.2	213.7	222.0	175.8	162.8
C117	9/21/2022	10:54	1264.2	1143.1	1166.7	1165.0	1168.4	901.3	901.7	909.9	916.3	888.9
C119	9/21/2022	10:24	1137.5	1079.4	1090.5	1097.3	1146.1	--	--	--	--	--
C121	9/21/2022	9:26	1101.6	1072.1	1215.0	1187.2	1162.8	751.9	744.2	665.9	712.1	685.6
C123	9/21/2022	9:50	868.8	832.4	955.2	913.3	1000.6	644.9	598.0	552.6	547.6	550.5
C125	9/20/2022	12:49	1503.1	1393.1	1494.5	1344.7	1358.4	990.3	954.8	927.8	910.7	841.4
C126	9/20/2022	13:11	1468.0	1438.4	1477.0	1447.5	1405.5	966.4	906.9	937.2	895.3	919.3
C127	9/20/2022	12:15	1530.9	1462.8	1422.2	1452.1	1466.7	1150.4	1180.4	1190.2	1177.4	1196.2
C129	9/20/2022	10:20	1228.3	1182.5	1158.5	1189.8	1144.4	752.8	719.0	699.7	749.8	740.4
C130	9/20/2022	9:25	857.7	908.2	922.7	914.6	952.2	615.8	615.0	615.0	621.4	628.2
C133	9/20/2022	12:44	1329.7	1294.2	1211.8	1159.0	1155.1	763.5	754.9	816.6	783.6	774.2
C134	9/20/2022	10:03	1206.0	1016.9	1059.2	1220.6	1233.0	763.9	711.3	661.2	665.9	659.6
C136	9/20/2022	9:00	680.0	608.6	595.3	611.5	642.8	417.9	423.8	424.0	407.3	414.3
C137	9/20/2022	10:54	1000.6	1087.9	1167.1	1129.0	1129.0	594.9	624.0	624.0	630.8	592.3
C138	9/19/2022	11:45	1072.5	1076.8	1073.8	1040.0	1011.3	481.8	491.4	501.8	484.6	473.4

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
C141	9/19/2022	1:31	1025.0	1029.3	1053.7	1043.8	1031.4	--	--	--	--	--
C142	9/19/2022	10:48	1188.9	1090.9	1059.7	1058.4	1048.8	658.2	681.3	679.6	582.0	595.6
C143	9/19/2022	9:21	1508.6	1485.5	1448.7	1349.0	1408.9	969.8	1003.2	1006.6	1009.5	1001.5
C145	9/19/2022	11:35	--	--	--	--	--	--	--	--	--	--
C146	9/19/2022	9:46	816.6	801.2	805.2	802.0	771.6	548.6	557.2	573.9	590.6	592.7
C148	9/19/2022	9:00	812.7	817.9	801.6	815.7	847.4	456.6	468.6	453.2	470.5	467.5
C149	9/19/2022	10:25	1171.8	1178.2	1121.3	1156.8	1130.7	--	--	--	--	--
C150	9/18/2022	10:20	1065.0	1071.0	1011.0	938.6	988.7	787.3	782.2	743.8	739.7	768.5
C152	9/18/2022	9:15	943.3	861.0	777.9	795.9	777.5	592.7	573.8	552.0	543.8	195.3
C153	9/18/2022	13:45	1491.5	1458.4	1641.8	1420.3	1119.5	--	--	--	--	--
C155	9/18/2022	12:10	1398.1	1451.6	1317.9	1400.2	1463.6	--	--	--	--	--
C156	9/18/2022	15:32	786.0	759.0	765.5	745.7	641.6	452.9	447.3	435.5	387.2	446.8
C159	9/18/2022	15:03	843.4	828.0	822.4	790.3	709.7	--	--	--	--	--
C160	9/18/2022	10:28	739.5	772.9	769.5	756.6	719.8	417.8	404.4	450.3	401.9	357.4
C161	9/18/2022	9:42	616.7	643.7	656.9	673.2	718.1	--	--	--	--	--
C165	9/15/2022	14:50	946.3	973.7	836.2	1152.5	1221.5	--	--	--	--	--
C30	9/25/2022	11:32	1405.5	1372.5	1309.7	1296.8	1523.3	849.1	859.8	936.4	931.2	922.3
C32	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	--	--	--	--	--	--	--	--	--	--
C41	9/24/2022	11:21	1087.0	1236.1	1229.1	126.6	1231.3	875.6	867.1	833.7	825.1	822.6
C43	9/25/2022	10:52	--	--	--	--	--	--	--	--	--	--
C48	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	1560.8	1475.2	1465.4	1483.8	1462.8	--	--	--	--	--
C60	9/24/2022	10:30	952.2	930.8	976.2	957.0	945.0	--	--	--	--	--
C64	9/24/2022	9:37	780.0	778.5	781.9	800.3	790.5	420.2	411.0	414.6	410.5	412.2
C67	9/24/2022	9:00	782.8	827.7	772.5	755.8	728.8	428.4	489.2	490.9	484.0	483.3

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
C68	9/24/2022	10:00	796.9	853.8	852.5	849.5	871.8	--	--	--	--	--
C72	9/24/2022	12:18	--	--	--	--	--	--	--	--	--	--
C76	9/24/2022	11:52	--	--	--	--	--	--	--	--	--	--
C80	9/24/2022	12:45	--	--	--	--	--	--	--	--	--	--
C81	9/24/2022	11:17	--	--	--	--	--	--	--	--	--	--
C84	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	--	--	--	--	--	--	--	--	--	--
C88	9/24/2022	9:57	--	--	--	--	--	--	--	--	--	--
C89	9/24/2022	10:30	--	--	--	--	--	--	--	--	--	--
C91	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	1270.2	1224.4	1227.0	1270.6	1228.7	--	--	--	--	--
C94	9/22/2022	14:24	1496.6	1489.0	1474.4	1508.6	1478.7	984.7	926.1	906.9	986.5	918.0
C96	9/22/2022	--	--	--	--	--	--	--	--	--	--	--
C97	9/22/2022	9:50	1467.1	1053.2	1138.0	1203.0	1235.1	687.3	702.7	716.8	730.1	706.1
C98	9/22/2022	9:10	1522.8	1309.5	1380.7	1481.2	1470.5	1183.8	1219.7	1176.9	1149.5	1180.8
C99	9/22/2022	10:18	1099.6	1135.4	1162.8	1123.4	1160.7	--	--	--	--	--
S201	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	--	--	--	--	--	--	--	--	--	--
S203	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	1321.1	1315.2	1241.5	1241.5	1194.9	843.1	820.8	862.8	789.2	829.4
S205	9/25/2022	12:11	1061.8	876.1	578.2	1441.0	1419.2	867.5	774.6	909.9	659.5	642.0
S206	9/25/2022	10:39	1222.3	1226.6	1233.0	1212.9	1208.2	820.8	812.3	791.3	803.7	773.3
S207	9/24/2022	11:48	1136.2	1298.5	1261.2	1292.0	1220.6	933.0	942.8	924.4	1000.2	906.4
S208	9/25/2022	10:30	--	--	--	--	--	--	--	--	--	--
S209	9/24/2022	11:58	--	--	--	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1470.1	1434.1	1394.8	1462.0	1446.1	1012.6	1004.0	934.7	903.0	931.2
S211	9/24/2022	12:11	1341.7	1380.2	1345.6	1313.9	1295.5	897.9	873.1	900.0	864.1	840.1
S212	9/24/2022	14:26	932.1	974.1	1010.9	1108.5	1034.0	825.1	736.5	726.6	721.1	721.1

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
S213	9/25/2022	12:45	--	--	--	--	--	--	--	--	--	--
S214	9/24/2022	14:46	1000.6	984.7	964.7	1007.5	924.4	747.7	565.3	695.5	719.4	740.0
S215	9/24/2022	12:30	1314.3	1435.9	1407.4	1385.8	1393.1	1013.5	1028.0	993.3	1045.5	988.6
S216	9/24/2022	12:41	--	--	--	--	--	--	--	--	--	--
S217	9/24/2022	15:17	1049.8	1029.3	1065.2	912.0	1193.6	--	--	--	--	--
S218	9/24/2022	14:55	--	--	--	--	--	--	--	--	--	--
S219	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	--	--	--	--	--	--	--	--	--	--
S221	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	--	--	--	--	--	--	--	--	--	--
S223	9/24/2022	10:53	--	--	--	--	--	--	--	--	--	--
S224	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
S225	9/22/2022	13:50	1223.1	1165.0	1169.2	1155.5	1133.7	--	--	--	--	--
S226	9/22/2022	13:04	1296.3	1223.6	1215.9	1221.9	1185.9	--	--	--	--	--
S227	9/22/2022	11:10	1114.9	891.9	1163.6	1158.5	1038.2	--	--	--	--	--
S228	9/22/2022	9:19	855.9	316.0	288.0	288.3	294.0	218.8	572.2	499.8	602.1	456.6
S229	9/22/2022	9:48	272.2	263.8	244.4	238.9	240.1	145.9	203.2	236.5	335.4	256.8
S230	9/22/2022	--	--	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1430.3	1405.0	1403.8	1350.3	1391.8	704.4	722.8	744.2	789.6	780.6
S234	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	444.9	485.3	712.1	695.9	663.8	401.5	432.7	384.7	225.6	218.8
S237	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S238	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1175.2	1174.8	1142.2	1138.8	1094.7	690.3	312.6	174.2	841.8	821.7
S240	9/20/2022	--	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
S241	9/21/2022	11:48	795.6	580.3	594.0	629.1	568.6	--	--	--	--	--
S242	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	897.5	973.6	944.1	972.4	963.4	448.4	292.6	360.4	425.7	248.9
S246	9/20/2022	11:32	1255.2	1227.5	1382.4	1372.5	1323.3	--	--	--	--	--
S247	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	1345.6	1325.0	1379.8	1321.1	1346.4	--	--	--	--	--
S249	9/20/2022	13:26	1345.1	1349.0	1348.5	1326.7	1318.2	--	--	--	--	--
S250	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S252	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	1266.4	1250.1	1256.5	1254.4	1253.5	--	--	--	--	--
S254	9/19/2022	--	--	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1528.3	1506.5	1505.6	1518.9	1492.0	1194.9	1203.9	1191.9	1182.5	1160.7
S257	9/19/2022	14:40	1400.8	1389.6	1419.2	1402.5	1381.9	--	--	--	--	--
S258	9/19/2022	13:35	1414.5	1456.8	1402.1	1413.6	1414.5	779.8	827.7	700.6	749.4	751.9
S259	9/19/2022	14:45	1294.2	1338.7	1375.5	1387.1	1325.0	1029.7	1016.9	1063.1	1049.4	1022.0
S260	9/19/2022	14:13	1377.2	1424.3	1563.4	1426.5	1464.1	--	--	--	--	--
S261	9/19/2022	10:50	1203.9	1219.3	1214.6	1313.0	1269.0	--	--	--	--	--
S262	9/18/2022	14:26	1170.0	1175.6	1218.9	1234.7	1236.9	--	--	--	--	--
S263	9/18/2022	12:58	1415.2	1446.5	1415.2	1399.8	1427.6	--	--	--	--	--
S264	9/18/2022	14:19	719.6	645.4	501.0	522.0	569.1	--	--	--	--	--
S265	9/18/2022	--	--	--	--	--	--	357.4	--	--	--	--
S266	9/18/2022	12:47	--	--	--	--	--	--	--	--	--	--
S267	9/18/2022	11:43	789.6	795.2	807.2	791.7	810.6	--	--	--	--	--

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
S268	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	1435.8	1399.3	1454.2	1425.0	1419.0	677.1	846.4	828.0	960.5	1013.5
S272	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--	--	--

Table B-4. Calculated diffuse attenuation coefficient (K_d)

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C101	9/22/2022	10:45	0.8	--	--	--	--	--	--	--
C102	9/22/2022	10:09	1.8	0.45	0.58	0.44	0.49	0.32	0.46	0.08
C103	9/22/2022	11:55	1	0.35	0.36	0.38	0.39	0.44	0.38	0.03
C105	9/22/2022	10:37	1.4	0.26	0.51	0.33	0.20	0.28	0.32	0.11
C106	9/22/2022	8:48	2.7	0.23	0.26	0.43	0.43	0.44	0.36	0.09
C107	9/22/2022	11:05	0.6	--	--	--	--	--	--	--
C109	9/21/2022	13:04	1.5	0.43	0.43	0.41	0.38	0.42	0.41	0.02
C110	9/21/2022	9:00	2.6	0.42	0.39	0.33	0.32	0.33	0.36	0.04
C111	9/21/2022	12:02	0.6	0.08	0.32	0.39	0.87	0.66	0.47	0.27
C113	9/21/2022	11:42	0.9	0.82	1.59	0.86	0.71	0.68	0.93	0.33
C114	9/21/2022	13:03	1.7	0.27	0.31	0.07	-0.01	-0.04	0.12	0.14
C115	9/21/2022	10:24	1	0.61	0.60	0.62	0.82	0.93	0.72	0.14
C117	9/21/2022	10:54	1.2	0.34	0.24	0.25	0.24	0.27	0.27	0.04
C119	9/21/2022	10:24	0.82	--	--	--	--	--	--	--
C121	9/21/2022	9:26	0.9	0.38	0.37	0.60	0.51	0.53	0.48	0.09

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C123	9/21/2022	9:50	1.3	0.30	0.33	0.55	0.51	0.60	0.46	0.12
C125	9/20/2022	12:49	1.4	0.42	0.38	0.48	0.39	0.48	0.43	0.04
C126	9/20/2022	13:11	2.6	0.42	0.46	0.45	0.48	0.42	0.45	0.02
C127	9/20/2022	12:15	0.9	0.29	0.21	0.18	0.21	0.20	0.22	0.04
C129	9/20/2022	10:20	1.1	0.49	0.50	0.50	0.46	0.44	0.48	0.03
C130	9/20/2022	9:25	>3	0.33	0.39	0.41	0.39	0.42	0.39	0.03
C133	9/20/2022	12:44	0.95	0.55	0.54	0.39	0.39	0.40	0.46	0.07
C134	9/20/2022	10:03	2.3	0.46	0.36	0.47	0.61	0.63	0.50	0.10
C136	9/20/2022	9:00	2.4	0.49	0.36	0.34	0.41	0.44	0.41	0.05
C137	9/20/2022	10:54	1.9	0.52	0.56	0.63	0.58	0.65	0.59	0.05
C138	9/19/2022	11:45	1.4	0.80	0.78	0.76	0.76	0.76	0.77	0.02
C141	9/19/2022	1:31	0.2	--	--	--	--	--	--	--
C142	9/19/2022	10:48	1.7	0.59	0.47	0.44	0.60	0.57	0.53	0.06
C143	9/19/2022	9:21	2.5	0.44	0.39	0.36	0.29	0.34	0.37	0.05
C145	9/19/2022	11:35	0.05	--	--	--	--	--	--	--
C146	9/19/2022	9:46	1	0.40	0.36	0.34	0.31	0.26	0.33	0.05
C148	9/19/2022	9:00	1.9	0.58	0.56	0.57	0.55	0.59	0.57	0.02
C149	9/19/2022	10:25	0.4	--	--	--	--	--	--	--
C150	9/18/2022	10:20	1.7	0.30	0.31	0.31	0.24	0.25	0.28	0.03
C152	9/18/2022	9:15	2.5	0.46	0.41	0.34	0.38	1.38	0.60	0.40
C153	9/18/2022	13:45	0.14	--	--	--	--	--	--	--
C155	9/18/2022	12:10	0.9	--	--	--	--	--	--	--
C156	9/18/2022	15:32	1.2	0.55	0.53	0.56	0.66	0.36	0.53	0.10
C159	9/18/2022	15:03	0.5	--	--	--	--	--	--	--
C160	9/18/2022	10:28	1.3	0.57	0.65	0.54	0.63	0.70	0.62	0.06
C161	9/18/2022	9:42	1	--	--	--	--	--	--	--
C165	9/15/2022	14:50	0.5	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C30	9/25/2022	11:32	0.9	0.50	0.47	0.34	0.33	0.50	0.43	0.08
C32	9/25/2022	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	1.4	--	--	--	--	--	--	--
C41	9/24/2022	11:21	2	0.22	0.35	0.39	0.43	0.40	0.36	0.07
C43	9/25/2022	10:52	2.4	--	--	--	--	--	--	--
C48	9/24/2022	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	0.3	--	--	--	--	--	--	--
C60	9/24/2022	10:30	0.6	--	--	--	--	--	--	--
C64	9/24/2022	9:37	1	0.62	0.64	0.63	0.67	0.65	0.64	0.02
C67	9/24/2022	9:00	2.8	0.60	0.53	0.45	0.45	0.41	0.49	0.07
C68	9/24/2022	10:00	0.6	--	--	--	--	--	--	--
C72	9/24/2022	12:18	1.5	--	--	--	--	--	--	--
C76	9/24/2022	11:52	0.7	--	--	--	--	--	--	--
C80	9/24/2022	12:45	1.7	--	--	--	--	--	--	--
C81	9/24/2022	11:17	0.8	--	--	--	--	--	--	--
C84	9/24/2022	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	1.7	--	--	--	--	--	--	--
C88	9/24/2022	9:57	1.8	--	--	--	--	--	--	--
C89	9/24/2022	10:30	0.8	--	--	--	--	--	--	--
C91	9/24/2022	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	0.6	--	--	--	--	--	--	--
C94	9/22/2022	14:24	1.8	0.42	0.47	0.49	0.42	0.48	0.46	0.03
C96	9/22/2022	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C97	9/22/2022	9:50	2.1	0.76	0.40	0.46	0.50	0.56	0.54	0.12
C98	9/22/2022	9:10	2.6	0.25	0.07	0.16	0.25	0.22	0.19	0.07
C99	9/22/2022	10:18	0.8	--	--	--	--	--	--	--
S201	9/25/2022	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	1.4	--	--	--	--	--	--	--
S203	9/25/2022	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	2.5	0.45	0.47	0.36	0.45	0.37	0.42	0.05
S205	9/25/2022	12:11	2	0.20	0.12	0.55	0.78	0.79	0.49	0.28
S206	9/25/2022	10:39	2.2	0.40	0.41	0.44	0.41	0.45	0.42	0.02
S207	9/24/2022	11:48	2	0.20	0.32	0.31	0.26	0.30	0.28	0.05
S208	9/25/2022	10:30	1.8	--	--	--	--	--	--	--
S209	9/24/2022	11:58	2.1	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1.4	0.37	0.36	0.40	0.48	0.44	0.41	0.05
S211	9/24/2022	12:11	2.2	0.40	0.46	0.40	0.42	0.43	0.42	0.02
S212	9/24/2022	14:26	1.7	0.12	0.28	0.33	0.43	0.36	0.30	0.10
S213	9/25/2022	12:45	1.3	--	--	--	--	--	--	--
S214	9/24/2022	14:46	1.3	0.29	0.55	0.33	0.34	0.22	0.35	0.11
S215	9/24/2022	12:30	2.3	0.26	0.33	0.35	0.28	0.34	0.31	0.04
S216	9/24/2022	12:41	>3	--	--	--	--	--	--	--
S217	9/24/2022	15:17	0.4	--	--	--	--	--	--	--
S218	9/24/2022	14:55	1.7	--	--	--	--	--	--	--
S219	9/24/2022	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	1.7	--	--	--	--	--	--	--
S221	9/24/2022	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	1.4	--	--	--	--	--	--	--
S223	9/24/2022	10:53	1.7	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
S224	9/24/2022	--	--	--	--	--	--	--	--	--
S225	9/22/2022	--	--	--	--	--	--	--	--	--
S226	9/22/2022	13:04	0.8	--	--	--	--	--	--	--
S227	9/22/2022	11:10	0.4	--	--	--	--	--	--	--
S228	9/22/2022	9:19	2.2	1.36	-0.59	-0.55	-0.74	-0.44	-0.19	0.78
S229	9/22/2022	9:48	2.1	0.62	0.26	0.03	-0.34	-0.07	0.10	0.32
S230	9/22/2022	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1.1	0.71	0.66	0.63	0.54	0.58	0.62	0.06
S234	9/21/2022	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	1.6	0.10	0.11	0.62	1.13	1.11	0.61	0.45
S237	9/20/2022	--	--	--	--	--	--	--	--	--
S238	9/21/2022	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1.8	0.53	1.32	1.88	0.30	0.29	0.87	0.63
S240	9/20/2022	--	--	--	--	--	--	--	--	--
S241	9/21/2022	11:48	0.2	--	--	--	--	--	--	--
S242	9/21/2022	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	0.65	0.69	1.20	0.96	0.83	1.35	1.01	0.24
S246	9/20/2022	11:32	0.9	--	--	--	--	--	--	--
S247	9/20/2022	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	0.3	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
S249	9/20/2022	13:26	0.6	--	--	--	--	--	--	--
S250	9/20/2022	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--
S252	9/20/2022	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	0.3	--	--	--	--	--	--	--
S254	9/19/2022	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1.6	0.25	0.22	0.23	0.25	0.25	0.24	0.01
S257	9/19/2022	14:40	0.27	--	--	--	--	--	--	--
S258	9/19/2022	13:35	1.2	0.60	0.57	0.69	0.63	0.63	0.62	0.04
S259	9/19/2022	14:45	1.4	0.23	0.27	0.26	0.28	0.26	0.26	0.02
S260	9/19/2022	14:13	0.11	--	--	--	--	--	--	--
S261	9/19/2022	10:50	0.3	--	--	--	--	--	--	--
S262	9/18/2022	14:26	0.415	--	--	--	--	--	--	--
S263	9/18/2022	12:58	0.26	--	--	--	--	--	--	--
S264	9/18/2022	14:19	0.9	--	--	--	--	--	--	--
S265	9/18/2022	--	--	--	--	--	--	--	--	--
S266	9/18/2022	12:47	0.1	--	--	--	--	--	--	--
S267	9/18/2022	11:43	0.3	--	--	--	--	--	--	--
S268	9/15/2022	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	2	0.75	0.50	0.56	0.39	0.34	0.51	0.14
S272	9/15/2022	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--

APPENDIX C

Seagrass Cover and Stem Height Data

Table C-1. Seagrass cover data by location (*H. wrightii, T. testudinum, S. filiforme, and H. engelmannii*)

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C101	60	70	75	80	0	0	0	0	0	0	0	0	0	0	0	0
C102	100	95	100	65	0	0	0	0	0	0	0	0	0	0	0	0
C103	0	0	0	0	95	95	90	95	0	0	0	0	0	0	0	0
C105	0	0	0	0	100	95	20	100	0	0	0	0	0	0	0	0
C106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C107	84	80	25	35	0	0	0	0	0	0	0	0	0	0	0	0
C109	0	0	0	0	100	0	85	95	0	0	0	0	0	0	0	0
C110	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
C111	40	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0
C113	0	0	1	0	0	100	0	0	0	0	0	0	0	0	0	0
C114	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0
C115	0	0	0	1	0	0	0	0	0	0	0	0	35	0	20	29
C117	0	0	0	0	95	95	80	80	0	0	0	0	0	0	0	0
C119	75	5	0	0	0	55	85	95	0	0	0	0	0	0	0	0
C121	85	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0
C123	65	0	80	90	0	0	0	0	0	0	0	0	0	0	0	0
C125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C127	0	0	0	0	100	100	100	85	0	0	0	0	0	0	0	0
C129	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
C130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C133	0	30	1	0	0	0	0	0	0	0	0	0	0	0	0	0
C134	25	8	10	15	0	0	0	0	0	0	0	0	0	0	0	0
C136	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
C137	10	5	5	2	0	0	0	0	0	0	0	0	0	0	0	5

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C138	95	90	75	95	0	0	0	0	0	0	0	0	0	0	0	0
C141	90	90	70	75	0	0	0	0	0	0	0	0	0	0	0	0
C142	40	0	0	30	0	0	0	0	0	0	15	0	0	25	0	0
C143	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
C145	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C146	100	100	95	100	0	0	0	0	0	0	0	0	0	0	0	0
C148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C149	1	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C150	0	2	15	1	0	0	0	0	0	0	0	0	0	0	0	0
C152	1	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0
C153	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C155	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0
C156	75	95	85	90	0	0	0	0	0	0	0	0	0	0	0	0
C159	3	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C160	0	80	20	80	0	0	0	0	0	0	0	0	0	0	0	0
C161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C165	0	35	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C64	85	95	94	80	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C68	100	100	99	100	0	0	0	0	0	0	0	0	0	0	0	0
C72	20	5	0	0	0	5	1	10	0	0	0	0	0	0	0	0
C76	90	95	95	85	0	0	0	0	0	0	0	0	0	0	0	0
C80	10	30	45	2	0	0	0	0	0	0	0	0	0	0	0	0
C81	65	60	55	50	0	0	0	0	0	0	0	0	0	0	0	0
C84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C85	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
C88	20	35	25	15	0	0	0	0	0	0	0	0	0	0	0	0
C89	95	80	90	95	0	0	0	0	0	0	0	0	0	0	0	0
C91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C92	60	55	80	90	0	0	0	0	0	0	0	0	0	0	0	0
C94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C97	0	0	0	0	60	60	90	80	0	0	0	0	0	0	0	0
C98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C99	95	95	85	70	0	0	0	0	0	0	0	0	0	0	0	0
S201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S203	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S207	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S208	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S209	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S213	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S216	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S217	35	1	1	30	0	0	0	0	0	0	0	0	0	0	0	0
S218	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S219	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S222	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S223	35	15	10	0	1	0	0	0	0	0	0	0	0	0	0	0
S224	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S225	95	90	95	95	0	0	0	0	0	0	0	0	0	0	0	0
S226	60	70	10	5	0	0	5	0	0	0	0	0	0	0	0	0
S227	45	5	10	50	0	0	0	0	0	0	0	0	0	0	0	0
S228	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S229	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0
S230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S233	100	85	0	95	0	0	90	0	0	0	0	0	0	0	0	0
S234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S236	40	95	75	0	5	0	0	85	0	0	0	0	0	0	0	0
S237	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	**AFT STB**	**AFT PRT**	**FWD PRT**	**FWD STB**	**AFT STB**	**AFT PRT**	**FWD PRT**	**FWD STB**	**AFT STB**	**AFT PRT**	**FWD PRT**	**FWD STB**	**AFT STB**	**AFT PRT**	**FWD PRT**
S238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S239	0	0	0	0	0	0	0	0	0	0	0	0	15	75	5	0
S240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S241	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0
S242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S245	40	35	70	10	0	0	0	0	0	0	0	0	0	0	0	0
S246	1	0	0	1	64	95	0	0	0	0	0	0	0	0	0	1
S247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S248	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S249	90	0	5	5	0	95	90	30	0	0	0	0	0	0	0	0
S250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S251	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S252	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S253	2	5	5	15	0	0	0	0	0	0	0	0	0	0	0	0
S254	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S256	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S257	15	5	15	15	0	0	0	0	0	0	0	0	0	0	0	0
S258	35	65	98	100	0	0	0	0	0	0	0	0	0	0	0	0
S259	85	70	80	45	0	0	0	0	0	0	0	0	0	0	0	0
S260	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
S261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S262	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S263	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S264	90	100	75	80	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S266	5	5	4	15	0	0	0	0	0	0	0	0	0	0	0	0
S267	5	10	40	15	0	0	0	0	0	0	0	0	0	0	0	0
S268	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S269	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S270	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S271	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S272	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S273	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-2. Seagrass cover data by location (*R. maritima,* Bare Ground, and Total Cover)

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C101	0	0	0	0	40	30	25	20	60	70	75	80
C102	0	0	0	0	0	5	0	0	100	95	100	100
C103	0	0	0	0	5	5	10	5	95	95	90	95
C105	0	0	0	0	0	5	80	0	100	95	20	100
C106	0	0	0	0	100	100	100	100	0	0	0	0
C107	1	0	0	0	15	20	75	65	85	80	25	35
C109	0	0	0	0	0	100	15	5	100	0	85	95
C110	0	0	0	0	100	100	100	100	0	1	0	0
C111	0	0	1	0	60	100	100	0	40	0	1	100

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C113	0	0	0	0	100	0	100	100	0	100	1	0
C114	0	0	0	0	100	98	100	98	0	2	0	2
C115	0	0	0	0	65	100	80	70	35	0	20	30
C117	0	0	0	0	5	5	20	20	95	95	80	80
C119	0	0	0	0	25	40	15	5	75	60	85	95
C121	5	0	0	0	10	100	100	65	90	0	0	35
C123	0	0	0	0	35	100	20	10	65	0	80	90
C125	0	0	0	0	100	100	100	100	0	0	0	0
C126	0	0	0	0	100	100	100	100	0	0	0	0
C127	0	0	0	0	0	0	0	15	100	100	100	85
C129	0	1	0	0	100	100	100	100	0	1	1	1
C130	0	0	0	0	100	100	100	100	0	0	0	0
C133	0	0	0	0	100	70	99	100	0	30	1	0
C134	0	0	0	0	75	92	90	85	25	8	10	15
C136	0	0	0	0	100	100	100	100	0	0	0	1
C137	0	0	0	0	90	95	95	93	10	5	5	7
C138	0	0	0	0	5	10	25	5	95	90	75	95
C141	1	0	0	0	9	10	30	25	91	90	70	75
C142	0	5	0	5	60	70	85	65	40	30	15	35
C143	0	0	0	0	96	100	98	100	4	0	2	0
C145	0	0	0	0	100	99	99	99	0	1	1	1
C146	0	0	0	0	0	0	5	0	100	100	95	100
C148	0	0	0	0	100	100	100	100	0	0	0	0
C149	0	0	0	0	99	95	99	99	1	5	1	1
C150	0	0	0	0	100	98	85	100	0	2	15	1
C152	0	0	0	0	100	100	97	100	1	1	3	1
C153	1	1	1	1	100	100	98	100	2	2	2	2

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C155	0	0	0	0	0	0	0	0	100	100	100	100
C156	0	0	5	0	25	5	10	10	75	95	90	90
C159	0	0	5	5	97	80	95	95	3	20	5	5
C160	100	20	80	20	0	0	0	0	100	100	100	100
C161	0	0	0	0	100	100	100	100	0	0	0	0
C165	0	0	0	0	100	65	100	100	0	35	1	1
C30	0	0	0	0	100	100	100	100	0	0	0	0
C32	0	0	0	0	0	0	0	0	0	0	0	0
C33	0	0	0	0	0	0	0	0	0	0	0	0
C36	0	0	0	0	0	0	0	0	0	0	0	0
C38	0	0	0	0	100	100	100	100	0	0	0	0
C41	0	0	0	0	100	100	100	100	0	0	0	0
C43	0	0	0	0	100	100	100	100	0	0	0	0
C48	0	0	0	0	0	0	0	0	0	0	0	0
C52	0	0	0	0	100	100	100	100	0	0	0	0
C60	95	75	98	95	5	25	2	5	95	75	98	95
C64	0	0	1	0	15	5	5	20	85	95	95	80
C67	0	0	0	0	100	100	100	100	0	0	0	0
C68	0	0	1	0	0	0	0	0	100	100	100	100
C72	0	0	0	0	80	90	99	90	20	10	1	10
C76	0	0	0	0	10	5	5	15	90	95	95	85
C80	0	0	0	0	90	70	55	98	10	30	45	2
C81	0	0	0	0	45	40	45	50	65	60	55	50
C84	0	0	0	0	0	0	0	0	0	0	0	0
C85	0	0	0	0	100	100	100	99	0	0	0	1
C88	0	0	0	0	80	65	75	85	20	35	25	15
C89	0	0	0	0	5	20	10	5	95	80	90	95

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C91	0	0	0	0	0	0	0	0	0	0	0	0
C92	0	0	0	0	40	45	20	10	60	55	80	90
C94	0	0	0	0	100	100	100	100	0	0	0	0
C96	0	0	0	0	0	0	0	0	0	0	0	0
C97	0	0	0	0	40	40	10	20	60	60	90	80
C98	0	0	0	0	100	100	100	100	0	0	0	0
C99	0	0	15	0	5	5	0	30	95	95	100	70
S201	0	0	0	0	0	0	0	0	0	0	0	0
S202	0	0	0	0	100	100	100	100	0	0	0	0
S203	0	0	0	0	0	0	0	0	0	0	0	0
S204	0	0	0	0	100	100	100	100	0	0	0	0
S205	0	0	0	0	100	100	100	100	0	0	0	0
S206	0	0	0	0	100	100	100	100	0	0	0	0
S207	0	0	0	0	100	100	100	100	0	0	0	0
S208	0	0	0	0	100	100	100	100	0	0	0	0
S209	0	0	0	0	100	100	100	100	0	0	0	0
S210	0	0	0	0	100	100	100	100	0	0	0	0
S211	0	0	0	0	100	100	100	100	0	0	0	0
S212	0	0	0	0	100	100	100	100	0	0	0	0
S213	0	0	0	0	100	100	100	100	0	0	0	0
S214	0	0	0	0	100	100	100	100	0	0	0	0
S215	0	0	0	0	100	100	100	100	0	0	0	0
S216	0	0	0	0	100	100	100	100	0	0	0	0
S217	0	0	0	0	65	99	99	70	35	1	1	30
S218	0	0	0	0	100	100	100	100	0	0	0	0
S219	0	0	0	0	0	0	0	0	0	0	0	0
S220	0	0	0	0	100	100	100	100	0	0	0	0

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S221	0	0	0	0	0	0	0	0	0	0	0	0
S222	0	0	0	0	100	100	100	100	0	0	0	0
S223	0	0	0	0	64	85	90	100	36	15	10	0
S224	0	0	0	0	0	0	0	0	0	0	0	0
S225	0	0	0	0	5	10	5	5	95	90	95	95
S226	0	0	0	0	40	30	90	95	60	70	10	5
S227	25	10	5	30	30	85	85	20	70	15	15	80
S228	0	0	0	0	100	100	100	100	0	0	0	0
S229	0	0	0	0	100	95	100	99	0	5	0	1
S230	0	0	0	0	0	0	0	0	0	0	0	0
S231	0	0	0	0	0	0	0	0	0	0	0	0
S232	0	0	0	0	0	0	0	0	0	0	0	0
S233	0	0	0	0	0	15	10	5	100	85	90	95
S234	0	0	0	0	0	0	0	0	0	0	0	0
S235	0	0	0	0	0	0	0	0	0	0	0	0
S236	0	0	0	0	55	5	25	15	45	95	75	85
S237	0	0	0	0	0	0	0	0	0	0	0	0
S238	0	0	0	0	0	0	0	0	0	0	0	0
S239	0	0	0	0	85	25	95	100	15	75	5	0
S240	0	0	0	0	0	0	0	0	0	0	0	0
S241	0	0	0	20	100	100	100	50	0	0	0	50
S242	0	0	0	0	0	0	0	0	0	0	0	0
S243	0	0	0	0	0	0	0	0	0	0	0	0
S244	0	0	0	0	0	0	0	0	0	0	0	0
S245	0	0	0	0	60	65	30	90	40	35	70	10
S246	0	0	0	0	35	5	100	99	>65	95	0	>2
S247	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S248	0	0	0	0	100	100	100	100	0	0	0	0
S249	0	0	0	0	10	5	5	65	90	95	95	35
S250	0	0	0	0	0	0	0	0	0	0	0	0
S251	0	0	0	0	0	0	0	0	0	0	0	0
S252	0	0	0	0	0	0	0	0	0	0	0	0
S253	0	10	0	10	98	85	95	75	2	15	5	25
S254	0	0	0	0	0	0	0	0	0	0	0	0
S255	0	0	0	0	0	0	0	0	0	0	0	0
S256	0	0	0	0	100	98	100	100	0	2	0	0
S257	5	30	40	60	80	65	35	25	20	35	65	75
S258	5	0	2	0	60	35	0	0	40	65	100	100
S259	0	0	0	0	15	30	20	55	85	70	80	45
S260	1	1	1	0	98	98	98	100	2	2	2	0
S261	75	65	85	80	25	35	15	20	75	65	85	80
S262	1	100	70	0	100	0	30	100	2	100	70	0
S263	1	0	1	0	100	100	100	100	1	1	1	0
S264	0	0	0	0	10	0	25	20	90	100	75	80
S265	0	0	0	0	0	0	0	0	0	0	0	0
S266	0	0	1	0	95	95	95	85	5	5	5	15
S267	65	80	20	70	30	10	40	15	70	90	60	85
S268	0	0	0	0	0	0	0	0	0	0	0	0
S269	0	0	0	0	0	0	0	0	0	0	0	0
S270	0	0	0	0	0	0	0	0	0	0	0	0
S271	0	0	0	0	100	100	100	100	0	0	0	0
S272	0	0	0	0	0	0	0	0	0	0	0	0
S273	0	0	0	0	0	0	0	0	0	0	0	0

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-3. Seagrass stem height data by location (*H. wrightii* and *T. testudinum*)

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C101	27	23	29	19	13	14	23	14	18	19	16	17	--	--	--	--	--	--	--	--	--	--	--	--
C102	28	22	30.5	39.5	35	38	24	22.5	30	37	30.5	30	--	--	--	--	--	--	--	--	--	33	35	33
C103	--	--	--	--	--	--	--	--	--	--	--	--	32.5	31.5	38	40.5	41.5	45.5	30.5	38	40.5	24	35.5	39
C105	--		--	--	--	--	--	--	--	--	--	--	30.5	27.5	30	40.5	31.5	41.5	30.5	16.5	31	25	27	31.5
C106	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C107	30.5	27	26	12	20.5	25.5	19	24.5	17.5	13	17	27.5	--	--	--	--	--	--	--	--	--	--	--	--
C109	--	--	--	--	--	--	--	--	--	--	--	--	39.5	34.5	38	--	--	--	40	20	22.5	38	40.5	39.5
C110	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C111	5	55	4.5	--	--	--	65	5	4.5	30.5	23.5	25	--	--	--	--	--	--	--	--	--	--	--	--
C113	--	--	--	--	--	--	5.5	7	4	--	--	--	--	--	--	38	15.5	37.5	--	--	--	--	--	--
C114	--	--	--	2	3	5	--	--	--	17	20	18.5	--	--	--	--	--	--	--	--	--	--	--	--
C115	--	--	--	--	--	--	--	--	--	13.5	17	-	--	--	--	--	--	--	--	--	--	--	--	--
C117	--	--	--	--	--	--	--	--	--	--	--	--	40	45.5	42	49	45	40	38	13	28	29	23	35.5
C119	19	22	24	9	3	4	--	--	--	--	--	--	--	--	--	7	16	25	22	23	29.5	32	34	42
C121	12	14	15	--	--	--	--	--	--	15	11	12	--	--	--	--	--	--	--	--	--	--	--	--
C123	21	22	18	--	--	--	22	19	23	25	19	13	--	--	--	--	--	--	--	--	--	--	--	--
C125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C126	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C127	--	--	--	--	--	--	--	--	--	--	--	--	36	51	38.5	39	34.5	35	29.5	28.5	26.5	17.5	22.5	24
C129	--	--	--	--	--	--	--	--	--	4.5	--	--	--	--	--	--	--	--	22.5	--	--	--	--	--
C130	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C133	--	--	--	5	9	13.5	6	2	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C134	19	20	17	7	8.5	6	14	15	10	11	16	20	--	--	--	--	--	--	--	--	--	--	--	--
C136	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C137	11	12	12.5	7	6	9	10	13	9	5	6	4	--	--	--	--	--	--	--	--	--	--	--	--
C138	45	40	41	56	47	52	48.5	44	34	38	40	43	--	--	--	--	--	--	--	--	--	--	--	--
C141	38	22.5	24.5	21	22	22	25.5	27	20	8	22.5	21.5	--	--	--	--	--	--	--	--	--	--	--	--
C142	3	4	8	--	--	--	--	--	--	28	28.5	22	--	--	--	--	--	--	--	--	--	--	--	--
C143	3	4	3.5	--	--	--	1.5	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C145	--	--	--	7.5	4	--	5	11.5	2.5	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C146	28	29	28	26	32	34	24	26	23.5	33	38	31	--	--	--	--	--	--	--	--	--	--	--	--
C148	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C149	4.5	7.5	6	12	17	6	8	2	7	5	5.5	6	--	--	--	--	--	--	--	--	--	--	--	--
C150	--	--	--	17	--	--	14	27	20	11	17	10	--	--	--	--	--	--	--	--	--	--	--	--
C152	21	19	--	7.5	8	8	7.5	7.5	8.5	9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C153	5	--	--	5.5	13.5	--	4.5	11.5	5	7	5	6.5	--	--	--	--	--	--	--	--	--	--	--	--
C155	30.5	38.5	33	45	46	38	44.5	46.5	51	38	43	41	--	--	--	--	--	--	--	--	--	--	--	--
C156	31	32.5	31.5	30	38	28	30	38	28	20	32	34	--	--	--	--	--	--	--	--	--	--	--	--
C159	14	8	18.5	16	14	14.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C160	--	--	--	26	29	28	28	32	27	33	35	26	--	--	--	--	--	--	--	--	--	--	--	--
C161	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C165	--	--	--	8	6	6.5	1	2	2	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C36	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C43	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C64	25	35.5	34	36.5	35	37.5	34	36	37.5	40	30	39.5	--	--	--	--	--	--	--	--	--	--	--	--
C67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C68	31.5	23	23.5	30	21.5	27	29.5	23	22.5	39	29	25.5	--	--	--	--	--	--	--	--	--	--	--	--
C72	21	12	18	6	8	10.5	--	--	--	4	5	-	--	--	--	28	36	34	16	--	--	24	15	23
C76	26	30	23	24	24	16	30	20	28	21	29	18	--	--	--	--	--	--	--	--	--	--	--	--
C80	18	15	11	10	20	17	10	17	15	6	7	4	--	--	--	--	--	--	--	--	--	--	--	--
C81	12	12	19	10	11	11	13	14	17	13	13	18	--	--	--	--	--	--	--	--	--	--	--	--
C84	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C85	--	--	--	--	--	--	--	--	--	4	5	--	--	--	--	--	--	--	--	--	--	--	--	--
C88	7	10	12	11.5	8	12	14	13	19	14	13.5	12	--	--	--	--	--	--	--	--	--	--	--	--
C89	30	22	23	20	26	18	22	23	22	33	27	28	--	--	--	--	--	--	--	--	--	--	--	--
C91	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C92	24	25	21.5	25	27.5	28	29	25	21	19	22	30	--	--	--	--	--	--	--	--	--	--	--	--
C94	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C97	--	--	--	--	--	--	--	--	--	--	--	--	22	23	33	31	27	34	36	37	44	31	42	43
C98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C99	22	29	27	27	25	31	22	18	20	17	23	19	--	--	--	--	--	--	--	--	--	--	--	--
S201	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S202	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S203	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S204	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S205	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S206	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S207	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S208	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S209	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S210	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S211	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S212	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S213	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S214	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S215	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S216	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S217	7.5	8	6	6	3.5	3.5	2	-	-	6	5.5	5	--	--	--	--	--	--	--	--	--	--	--	--
S218	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S219	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S220	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S221	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S222	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S223	25	17	24	14	12	10	114	17	8	--	--	--	34	--	--	--	--	--	--	--	--	--	--	--
S224	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S225	22	25	24	22	25	23	24	26	23	25.5	26	24	--	--	--	--	--	--	--	--	--	--	--	--
S226	7	12	15	12	12	14	7	4	8	3	2	4	--	--	--	--	--	--	10	5	8	--	--	--
S227	13	12	10	8	6	7	11.5	11	10	15.5	10.5	12	--	--	--	--	--	--	--	--	--	--	--	--
S228	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S229	--	--	--	7.5	9	8.5	--	--	--	4	2.5	7	--	--	--	--	--	--	--	--	--	--	--	--
S230	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S231	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S232	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S233	42	21	19.5	32.5	38	36	--	--	--	31.5	33	16	--	--	--	--	--	--	24	31	32	--	--	--
S234	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S235	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S236	31.5	27.5	12	32.5	33	23	34.5	27	45.5	--	--	--	32	32.5	37.5	--	--	--	--	--	--	20	25.5	35.5
S237	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S239	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S241	--	--	--	--	--	--	--	--	--	7	9	6	--	--	--	--	--	--	--	--	--	--	--	--
S242	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S243	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S244	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S245	13	16	11	11.6	6	17	31	22	34	5	8	10.5	--	--	--	--	--	--	--	--	--	--	--	--
S246	4.5	12	19.5	--	--	--	--	--	--	3	2	--	14	12	9.5	29.5	12	24	--	--	--	--	--	--
S247	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S249	8.5	7.5	6	--	--	--	9	11	13	4	5	5.5	--	--	--	22	10	9	10	2.4	22	9.5	6	10
S250	7.5	--	--	--	--	--	9	11	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S251	6	--	--	--	--	--	9	11	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S252	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S253	4	4.5	5	13	12	10	5.5	8	10	7	7	7.5	--	--	--	--	--	--	--	--	--	--	--	--
S254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S255	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S256	--	--	--	9.5	13	11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S257	11	6	17.5	6.5	8	10	17	10.5	8	19	10	19.5	--	--	--	--	--	--	--	--	--	--	--	--
S258	10.5	12.5	4	15	15.5	27.5	30	26	34	20	32	31	--	--	--	--	--	--	--	--	--	--	--	--
S259	44.5	50	43.5	41	38	41.5	34	38	40	22	10	16	--	--	--	--	--	--	--	--	--	--	--	--
S260	15.5	15	14	7.5	7.5	9	11	7	9.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S261	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S262	24.4	15.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S263	--	--	--	4	22.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S264	31	20.5	10	31.5	44	35	9.5	8	6	40	34	31	--	--	--	--	--	--	--	--	--	--	--	--
S265	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S266	8	7	8	7.5	8	8.5	5	6	6	6.5	5	7	--	--	--	--	--	--	--	--	--	--	--	--
S267	10	9	11	8	7	6	12	12	8	10	12.5	7	--	--	--	--	--	--	--	--	--	--	--	--
S268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S269	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S270	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S271	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S272	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S273	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-4. Seagrass stem height data by location (*S. filiforme and H. engelmannii*)

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii Stem Height (cm)*											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C101	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C102	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C103	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
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Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
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Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
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Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii Stem Height (cm)*											
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Station ID	*S. filiforme* Stem Height (cm)												***H. engelmannii* Stem Height (cm)**											
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Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
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S271	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S272	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S273	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-5. Seagrass stem height data by location (*R. maritima*)

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C101	--	--	--	--	--	--	--	--	--	--	--	--
C102	--	--	--	--	--	--	--	--	--	--	--	--
C103	--	--	--	--	--	--	--	--	--	--	--	--
C105	--	--	--	--	--	--	--	--	--	--	--	--
C106	--	--	--	--	--	--	--	--	--	--	--	--
C107	16.5	20.5	21.5	--	--	--	--	--	--	--	--	--
C109	--	--	--	--	--	--	--	--	--	--	--	--
C110	--	--	--	--	--	--	--	--	--	--	--	--
C111	--	--	--	--	--	--	7.5	3.5	--	--	--	--
C113	--	--	--	--	--	--	--	--	--	--	--	--
C114	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C115	--	--	--	--	--	--	--	--	--	--	--	--
C117	--	--	--	--	--	--	--	--	--	--	--	--
C119	--	--	--	--	--	--	--	--	--	--	--	--
C121	8	10	13	--	--	--	--	--	--	--	--	--
C123	--	--	--	--	--	--	--	--	--	--	--	--
C125	--	--	--	--	--	--	--	--	--	--	--	--
C126	--	--	--	--	--	--	--	--	--	--	--	--
C127	--	--	--	--	--	--	--	--	--	--	--	--
C129	--	--	--	7.5	4	5	--	--	--	--	--	--
C130	--	--	--	--	--	--	--	--	--	--	--	--
C133	--	--	--	--	--	--	--	--	--	--	--	--
C134	--	--	--	--	--	--	--	--	--	--	--	--
C136	--	--	--	--	--	--	--	--	--	--	--	--
C137	--	--	--	--	--	--	--	--	--	--	--	--
C138	--	--	--	--	--	--	--	--	--	--	--	--
C141	27.5	23.5	--	--	--	--	--	--	--	--	--	--
C142	--	--	--	28.5	17	26	--	--	--	22	36	28.5
C143	--	--	--	--	--	--	--	--	--	--	--	--
C145	--	--	--	--	--	--	--	--	--	--	--	--
C146	--	--	--	--	--	--	--	--	--	--	--	--
C148	--	--	--	--	--	--	--	--	--	--	--	--
C149	--	--	--	--	--	--	--	--	--	--	--	--
C150	--	--	--	--	--	--	--	--	--	--	--	--
C152	--	--	--	--	--	--	--	--	--	--	--	--
C153	27.5	6.5	--	5.5	--	--	34.5	8	--	12.5	22	--
C155	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C156	--	--	--	--	--	--	46.5	34.5	28	--	--	--
C159	--	--	--	--	--	--	10	9	9.5	5	4.5	7
C160	40	27	33	34	24	42	42	64	54	34	40	44
C161	--	--	--	--	--	--	--	--	--	--	--	--
C165	--	--	--	--	--	--	--	--	--	--	--	--
C30	--	--	--	--	--	--	--	--	--	--	--	--
C32	--	--	--	--	--	--	--	--	--	--	--	--
C33	--	--	--	--	--	--	--	--	--	--	--	--
C36	--	--	--	--	--	--	--	--	--	--	--	--
C38	--	--	--	--	--	--	--	--	--	--	--	--
C41	--	--	--	--	--	--	--	--	--	--	--	--
C43	--	--	--	--	--	--	--	--	--	--	--	--
C48	--	--	--	--	--	--	--	--	--	--	--	--
C52	--	--	--	--	--	--	--	--	--	--	--	--
C60	19	18.5	23	14	18.5	20.5	30	33.5	24	23	28	24.5
C64	--	--	--	--	--	--	42.5	27	--	--	--	--
C67	--	--	--	--	--	--	--	--	--	--	--	--
C68	--	--	--	--	--	--	23	22	30	--	--	--
C72	--	--	--	--	--	--	--	--	--	--	--	--
C76	--	--	--	--	--	--	--	--	--	--	--	--
C80	--	--	--	--	--	--	--	--	--	--	--	--
C81	--	--	--	--	--	--	--	--	--	--	--	--
C84	--	--	--	--	--	--	--	--	--	--	--	--
C85	--	--	--	--	--	--	--	--	--	--	--	--
C88	--	--	--	--	--	--	--	--	--	--	--	--
C89	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C91	--	--	--	--	--	--	--	--	--	--	--	--
C92	--	--	--	--	--	--	--	--	--	--	--	--
C94	--	--	--	--	--	--	--	--	--	--	--	--
C96	--	--	--	--	--	--	--	--	--	--	--	--
C97	--	--	--	--	--	--	--	--	--	--	--	--
C98	--	--	--	--	--	--	--	--	--	--	--	--
C99	--	--	--	--	--	--	17	19	16	--	--	--
S201	--	--	--	--	--	--	--	--	--	--	--	--
S202	--	--	--	--	--	--	--	--	--	--	--	--
S203	--	--	--	--	--	--	--	--	--	--	--	--
S204	--	--	--	--	--	--	--	--	--	--	--	--
S205	--	--	--	--	--	--	--	--	--	--	--	--
S206	--	--	--	--	--	--	--	--	--	--	--	--
S207	--	--	--	--	--	--	--	--	--	--	--	--
S208	--	--	--	--	--	--	--	--	--	--	--	--
S209	--	--	--	--	--	--	--	--	--	--	--	--
S210	--	--	--	--	--	--	--	--	--	--	--	--
S211	--	--	--	--	--	--	--	--	--	--	--	--
S212	--	--	--	--	--	--	--	--	--	--	--	--
S213	--	--	--	--	--	--	--	--	--	--	--	--
S214	--	--	--	--	--	--	--	--	--	--	--	--
S215	--	--	--	--	--	--	--	--	--	--	--	--
S216	--	--	--	--	--	--	--	--	--	--	--	--
S217	--	--	--	--	--	--	--	--	--	--	--	--
S218	--	--	--	--	--	--	--	--	--	--	--	--
S219	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
S220	--	--	--	--	--	--	--	--	--	--	--	--
S221	--	--	--	--	--	--	--	--	--	--	--	--
S222	--	--	--	--	--	--	--	--	--	--	--	--
S223	--	--	--	--	--	--	--	--	--	--	--	--
S224	--	--	--	--	--	--	--	--	--	--	--	--
S225	--	--	--	--	--	--	--	--	--	--	--	--
S226	--	--	--	--	--	--	--	--	--	--	--	--
S227	15.5	16	26	26	23.5	16	9.5	--	--	20	20	19.5
S228	--	--	--	--	--	--	--	--	--	--	--	--
S229	--	--	--	--	--	--	--	--	--	--	--	--
S230	--	--	--	--	--	--	--	--	--	--	--	--
S231	--	--	--	--	--	--	--	--	--	--	--	--
S232	--	--	--	--	--	--	--	--	--	--	--	--
S233	--	--	--	--	--	--	--	--	--	--	--	--
S234	--	--	--	--	--	--	--	--	--	--	--	--
S235	--	--	--	--	--	--	--	--	--	--	--	--
S236	--	--	--	--	--	--	--	--	--	--	--	--
S237	--	--	--	--	--	--	--	--	--	--	--	--
S238	--	--	--	--	--	--	--	--	--	--	--	--
S239	--	--	--	--	--	--	--	--	--	--	--	--
S240	--	--	--	--	--	--	--	--	--	--	--	--
S241	--	--	--	--	--	--	--	--	--	22	17.5	17
S242	--	--	--	--	--	--	--	--	--	--	--	--
S243	--	--	--	--	--	--	--	--	--	--	--	--
S244	--	--	--	--	--	--	--	--	--	--	--	--
S245	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
S246	--	--	--	--	--	--	--	--	--	--	--	--
S247	--	--	--	--	--	--	--	--	--	--	--	--
S248	--	--	--	--	--	--	--	--	--	--	--	--
S249	--	--	--	--	--	--	--	--	--	--	--	--
S250	--	--	--	--	--	--	--	--	--	--	--	--
S251	--	--	--	--	--	--	--	--	--	--	--	--
S252	--	--	--	--	--	--	--	--	--	--	--	--
S253	--	--	--	12	32	21	--	--	--	12	10	9.5
S254	--	--	--	--	--	--	--	--	--	--	--	--
S255	--	--	--	--	--	--	--	--	--	--	--	--
S256	--	--	--	--	--	--	--	--	--	--	--	--
S257	11.5	9.5	20	10.5	16	15	14	10	30	11.5	14	7.5
S258	22	--	--	--	--	--	29	20.5	--	--	--	--
S259	--	--	--	--	--	--	--	--	--	--	--	--
S260	12	17	19	17.5	8	12	11	--	--	--	--	--
S261	27	16.5	17	16	9.5	7.5	28	11	7.5	10.5	12	19
S262	19	--	--	40.5	48.5	39	21.5	43	22.5	--	--	--
S263	4	7	--	--	--	--	1.5	0.5	3	--	--	--
S264	--	--	--	--	--	--	--	--	--	--	--	--
S265	--	--	--	--	--	--	--	--	--	--	--	--
S266	--	--	--	--	--	--	17	--	--	--	--	--
S267	31	26	32	24	25	31	29	28	30.5	25	35	42
S268	--	--	--	--	--	--	--	--	--	--	--	--
S269	--	--	--	--	--	--	--	--	--	--	--	--
S270	--	--	--	--	--	--	--	--	--	--	--	--
S271	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
S272	--	--	--	--	--	--	--	--	--	--	--	--
S273	--	--	--	--	--	--	--	--	--	--	--	--

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

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Appendix D

Survey Station Coordinates

Table D-1. Station Coordinates

Station ID	Lat	Long	Station ID	Lat	Long
C101	29.90365	-88.83431	**S203**	29.83164	-88.84133
C102	29.90932	-88.84174	**S204**	29.83347	-88.86866
C103	29.90827	-88.83225	**S205**	29.83600	-88.84726
C105	29.91266	-88.83865	**S206**	29.84282	-88.87116
C106	29.91284	-88.84734	**S207**	29.84336	-88.85456
C107	29.91466	-88.83007	**S208**	29.84456	-88.86300
C109	29.91983	-88.83905	**S209**	29.84523	-88.85418
C110	29.92412	-88.84770	**S210**	29.84651	-88.88432
C111	29.92513	-88.83080	**S211**	29.84809	-88.85961
C113	29.92695	-88.83356	**S212**	29.84833	-88.87510
C114	29.93256	-88.84474	**S213**	29.85199	-88.88078
C115	29.93188	-88.83106	**S214**	29.85345	-88.87611
C117	29.93762	-88.83875	**S215**	29.85464	-88.85909
C119	29.94001	-88.83600	**S216**	29.85503	-88.84894
C121	29.94052	-88.84055	**S217**	29.85599	-88.86586
C123	29.94623	-88.83916	**S218**	29.85864	-88.88296
C125	29.95087	-88.84160	**S219**	29.85986	-88.83799
C126	29.95238	-88.84450	**S220**	29.85993	-88.86998
C127	29.95115	-88.83575	**S221**	29.86499	-88.85034
C129	29.95794	-88.84112	**S222**	29.86580	-88.87531
C130	29.96039	-88.84584	**S223**	29.87933	-88.84143
C133	29.96334	-88.84247	**S224**	29.88093	-88.83004
C134	29.96797	-88.84436	**S225**	29.88971	-88.82999
C136	29.97170	-88.85176	**S226**	29.89521	-88.82934
C137	29.97144	-88.84027	**S227**	29.90335	-88.82726
C138	29.97974	-88.84335	**S228**	29.90701	-88.84689
C141	29.97757	-88.84110	**S229**	29.90760	-88.84286
C142	29.98152	-88.84600	**S230**	29.90771	-88.82406
C143	29.98698	-88.85777	**S231**	29.91428	-88.85374
C145	29.99496	-88.84318	**S232**	29.91557	-88.82378
C146	29.99957	-88.85286	**S233**	29.92180	-88.83067
C148	29.99938	-88.85947	**S234**	29.92482	-88.82375
C149	30.00001	-88.84569	**S235**	29.92560	-88.86001
C150	30.00301	-88.85736	**S236**	29.92999	-88.84113
C152	30.00935	-88.86631	**S237**	29.93154	-88.85086
C153	30.01000	-88.84907	**S238**	29.93155	-88.82369
C155	30.01164	-88.85461	**S239**	29.93333	-88.83833
C156	30.01433	-88.86075	**S240**	29.93687	-88.85215

Station ID	Lat	Long	Station ID	Lat	Long
C159	30.01739	-88.85904	**S241**	29.94035	-88.82539
C160	30.02240	-88.86615	**S242**	29.94111	-88.84800
C161	30.02605	-88.86812	**S243**	29.94523	-88.85544
C165	30.03624	-88.86672	**S244**	29.94618	-88.82434
C30	29.82349	-88.86035	**S245**	29.94171	-88.82933
C32	29.82602	-88.86887	**S246**	29.95335	-88.83160
C33	29.82769	-88.85345	**S247**	29.95671	-88.85070
C36	29.83539	-88.88362	**S248**	29.95772	-88.83058
C38	29.82950	-88.85211	**S249**	29.96047	-88.83877
C41	29.84350	-88.84459	**S250**	29.96422	-88.85111
C43	29.83674	-88.86860	**S251**	29.96495	-88.83034
C48	29.84350	-88.84459	**S252**	29.97042	-88.84745
C52	29.85086	-88.84111	**S253**	29.97408	-88.83349
C60	29.85568	-88.84199	**S254**	29.97891	-88.85710
C64	29.86087	-88.84192	**S255**	29.98190	-88.83287
C67	29.86316	-88.84942	**S256**	29.98719	-88.85440
C68	29.86134	-88.84003	**S257**	29.98748	-88.84232
C72	29.86971	-88.84065	**S258**	29.98936	-88.84520
C76	29.87077	-88.83676	**S259**	29.98977	-88.85351
C80	29.87509	-88.84184	**S260**	29.99069	-88.84025
C81	29.87721	-88.83492	**S261**	30.00076	-88.84275
C84	29.87710	-88.85499	**S262**	30.00510	-88.84806
C85	29.87626	-88.83876	**S263**	30.01294	-88.84837
C88	29.88597	-88.84649	**S264**	30.01376	-88.85625
C89	29.88228	-88.83631	**S265**	30.01846	-88.87288
C91	29.88662	-88.85232	**S266**	30.02324	-88.85458
C92	29.88939	-88.83623	**S267**	30.02733	-88.85997
C94	29.89297	-88.84791	**S268**	30.03582	-88.88091
C96	29.89138	-88.85224	**S269**	30.03912	-88.86392
C97	29.89728	-88.84057	**S270**	30.04133	-88.87354
C98	29.89847	-88.84699	**S271**	30.04424	-88.87565
C99	29.90053	-88.83626	**S272**	30.04266	-88.86486
S201	29.82791	-88.86383	**S273**	30.04610	-88.86592
S202	29.82993	-88.86030			

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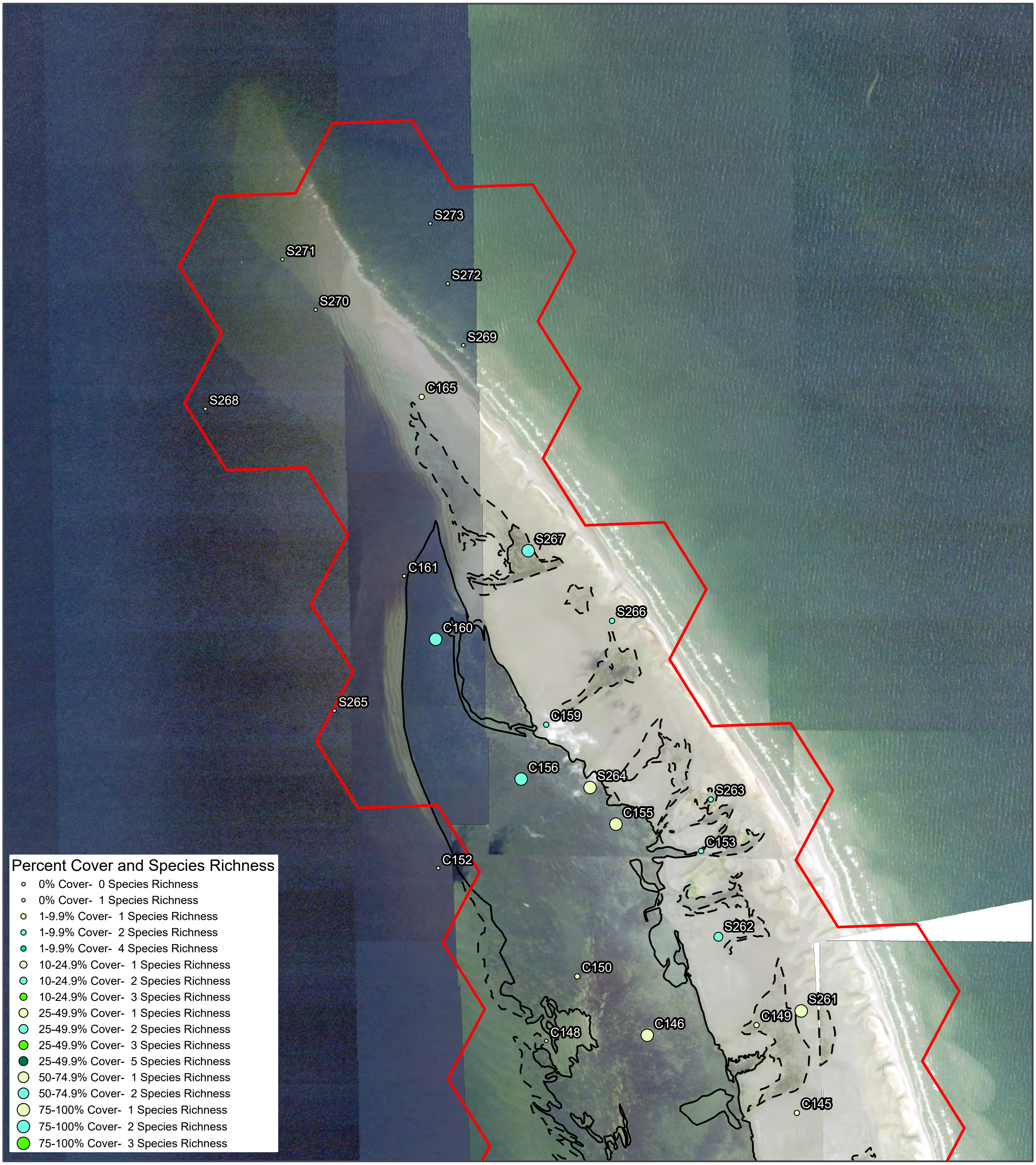
Appendix E

Seagrass Study Results Map Book



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 1 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
30.0255°N 88.8607°W

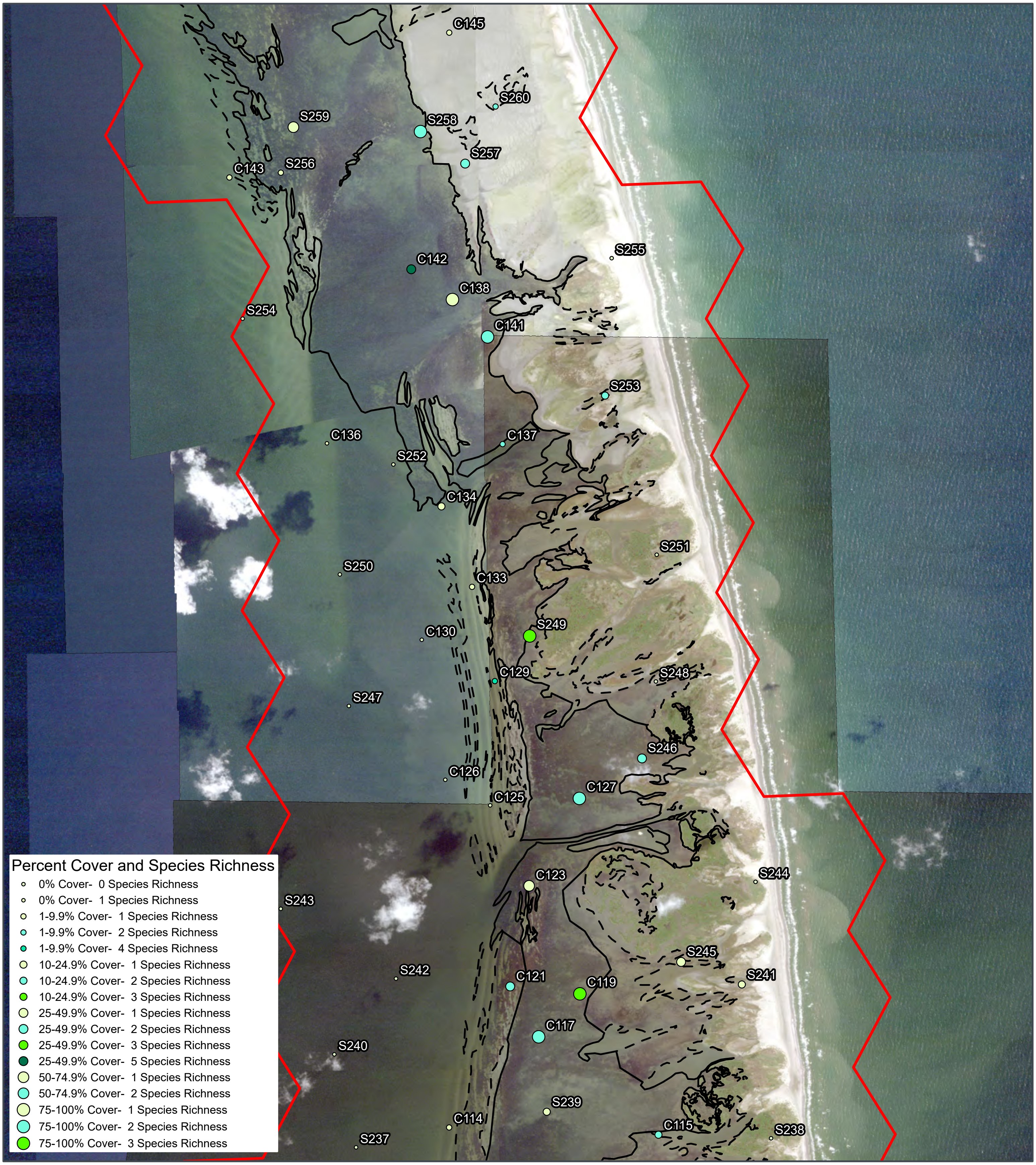
0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

SWCA ENVIRONMENTAL CONSULTANTS



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 2 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
29.9635°N 88.8395°W

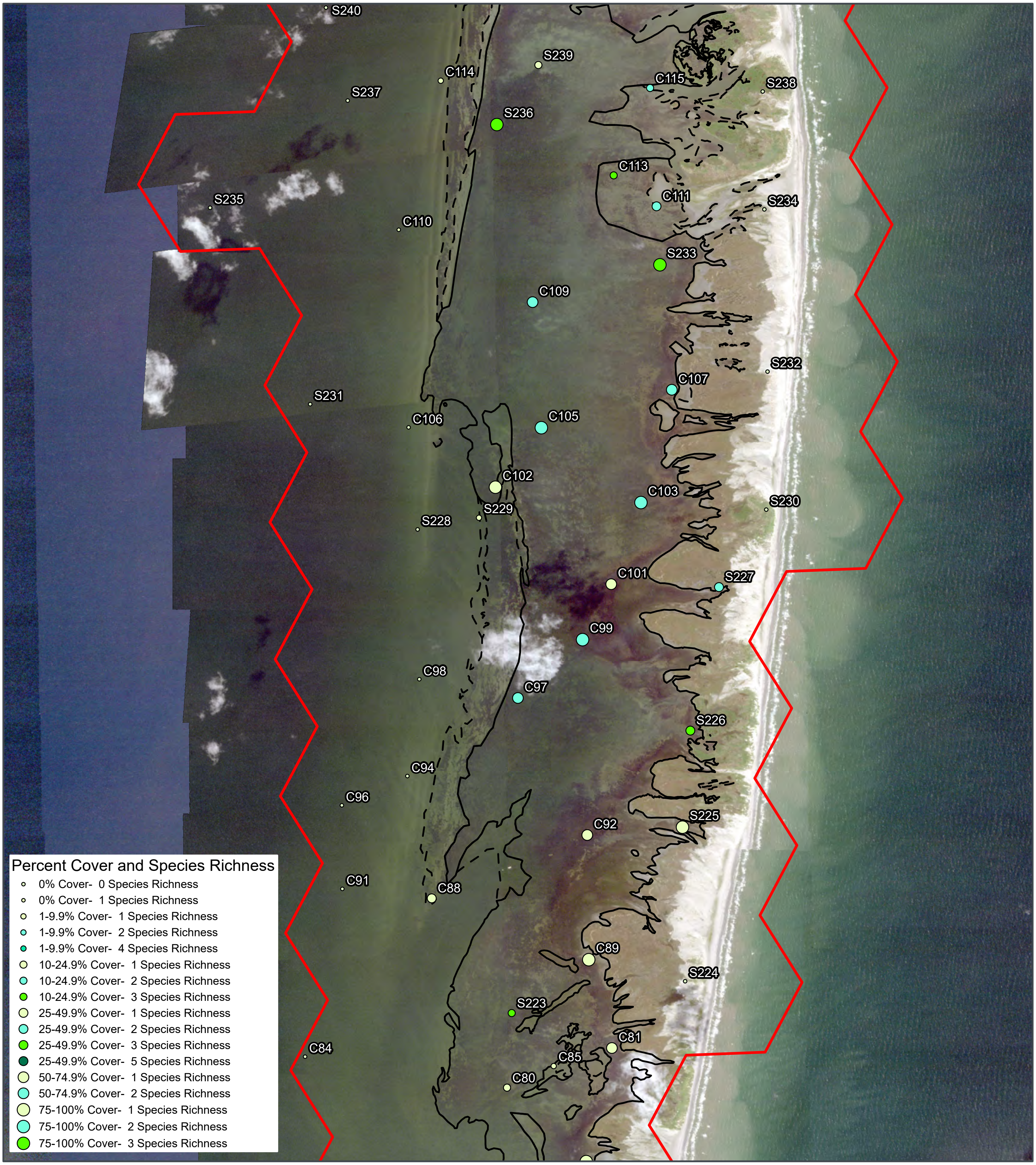
0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

SWCA ENVIRONMENTAL CONSULTANTS



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 3 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
29.9039°N 88.8404°W

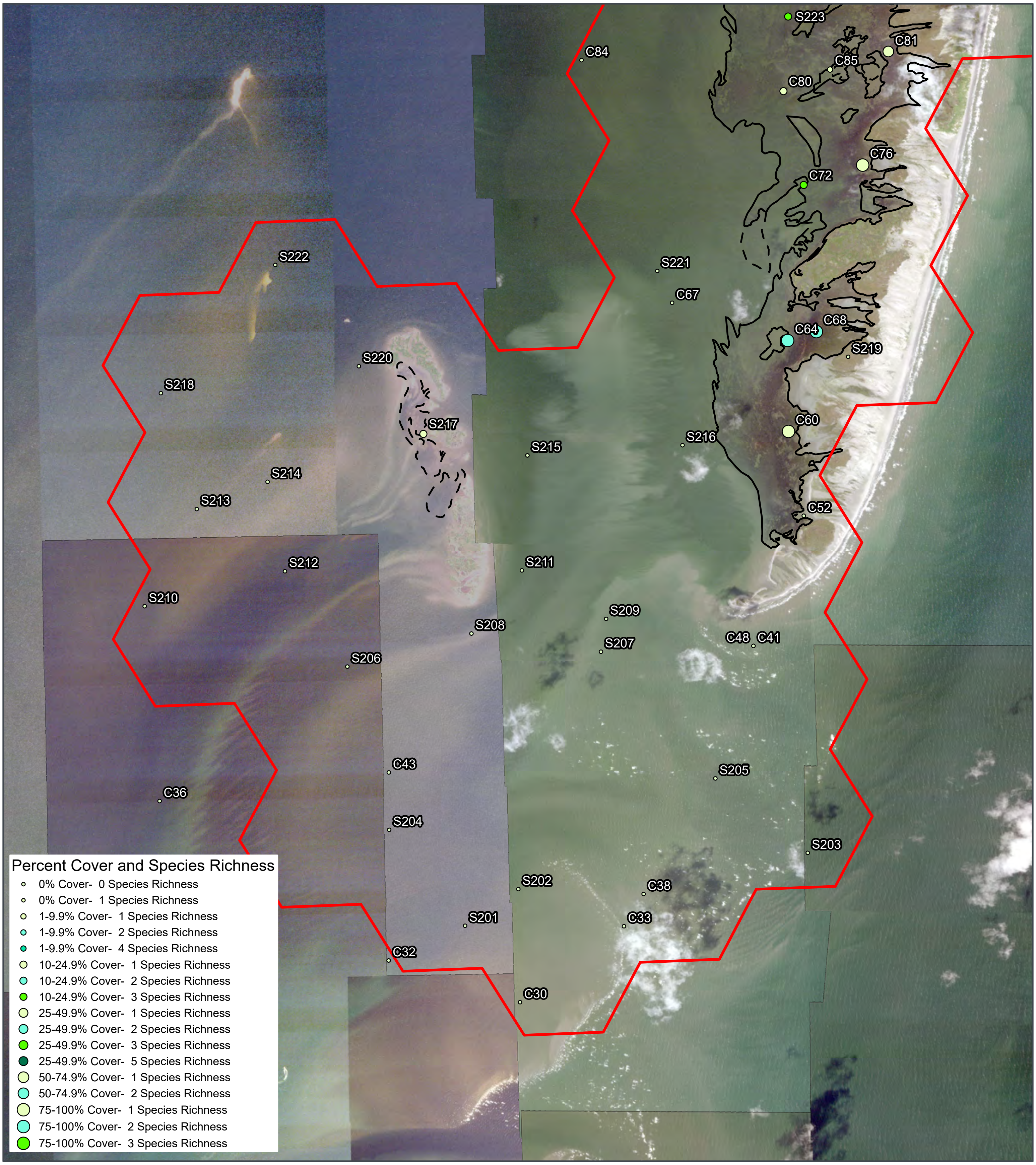
0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

SWCA ENVIRONMENTAL CONSULTANTS



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 4 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
29.8474°N 88.8599°W

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SWCA ENVIRONMENTAL CONSULTANTS

Appendix F:

Essential Fish Habitat Assessment

ESSENTIAL FISH HABITAT ASSESSMENT

Chandeleur Islands Restoration Project
Chandeleur Islands, Louisiana

04/07/2025

Prepared for

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TABLE OF CONTENTS

LIST OF ATTACHMENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
BOEM	Bureau of Ocean Energy Management
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CPRA	Louisiana Coastal Protection and Restoration Authority
dB	decibel
dB re 1 µPa2s	decibels relative to 1 µPa squared normalized to 1 second
dB re 1µPa	decibels relative to 1 µPa
DOI	Department of the Interior
DWH	Deepwater Horizon
EBB	Eastern Berm Reach E4 project
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EFHA	Essential Fish Habitat Assessment
FMC	Fishery Management Council
FMP	Fishery Management Plan
ft	feet
GMFMC	Gulf of Mexico Fishery Management Council
Gulf	Gulf of America
HAPC	Habitat Areas of Particular Concern
HMS	Highly Migratory Species
HPBA	Hewes Point Borrow Area
Joint RP/EA #1	Joint Restoration Plan and Environmental Assessment #1: Chandeleur Islands - Wetlands, Coastal, and Nearshore Habitats, Fish and Water Column Invertebrates, Sea Turtles, Submerged Aquatic Vegetation, and Birds
MHW	mean high water
MSA	Magnuson-Stevens Fishery Conservation and Management Act
mSAV	marine submerged aquatic vegetation
NAVD88	North American Vertical Datum of 1988
NMFS	National Marine Fisheries Service
NWR	National Wildlife Refuge
OSI	Ocean Surveys, Inc.
P.L.	Public Law
Pa	Pascal
PDARP	Final Programmatic Damage Assessment and Restoration Plan
PEIS	Final Programmatic Environmental Impact Statement
Project	Chandeleur Island Restoration Project
Regionwide RP/EA #1	Final Restoration Plan / Environmental Assessment 1: Birds, Marine Mammals, Oysters, and Sea Turtles

RMS	root mean square
SAV	submerged aquatic vegetation
SELcum	cumulative sound exposure level
SPL	sound pressure level
TIG	Regionwide Trustee Implementation Group
TY	Target Year
U.S.C.	United States Code
USCG	United States Coast Guard
YOY	young-of-the-year
μPa	microPascals

EXECUTIVE SUMMARY

Following approval of funding from the Regionwide Trustee Implementation Group (TIG) in their Final Restoration Plan / Environmental Assessment 1: Birds, Marine Mammals, Oysters, and Sea Turtles (Regionwide RP/EA #1), the Louisiana Coastal Protection and Restoration Authority (CPRA) is managing efforts to engineer and design restoration activities on the Chandeleur Islands. This Project is referred to as the Chandeleur Island Restoration Project (Project). The Project team has conducted field investigations and developed engineering alternatives which the Louisiana and Open Ocean TIGs are jointly evaluating for implementation funding in Joint Restoration Plan and Environmental Assessment #1: Chandeleur Islands - Wetlands, Coastal, and Nearshore Habitats, Fish and Water Column Invertebrates, Sea Turtles, Submerged Aquatic Vegetation, and Birds (Joint RP/EA #1). The current design, as discussed below, includes multiple restoration activities along North Chandeleur and New Harbor Islands. Habitat creation/restoration would support marine life (including fish, crustaceans, and the local food web) and increase the longevity of the islands. This Essential Fish Habitat Assessment (EFHA) has been developed to initiate consultation with the National Marine Fisheries Service (NMFS) regarding the proposed Project, and to satisfy the Magnuson-Stevens Fishery Conservation and Management Act (MSA) obligations of the Louisiana and Open Ocean TIGs, should they authorize funding for the Project under Joint RP/EA #1.

The Project is located within the Chandeleur Islands chain in St. Bernard Parish, Louisiana, and within the Breton National Wildlife Refuge. The Chandeleur Islands comprise those lands between Chandeleur Sound and the Gulf of America (Gulf), including Chandeleur Island (North and South), the Gosier Islands, the Grand Gosier Islands, the Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands. The restoration activities associated with this Project are focused on North Chandeleur Island, New Harbor Island, and the marine submerged aquatic vegetation, or seagrass (mSAV) beds and water bottoms adjacent to these two islands. The Proposed Action includes multiple restoration activities, including beach, dune, and marsh fill on North Chandeleur Island, as well as creation of a feeder beach and seven sand reservoirs and/or pocket marshes. In addition, construction at New Harbor Island would include marsh fill and shoreline protection features.

The Project area is North Chandeleur Island, with a 6-mile buffer, which includes New Harbor Island, the Hewes Point Borrow Area (HPBA), access channels, the offshore pump-out areas, and the nearshore and offshore conveyance corridors.

The Project would result in predominantly short-term, minor, and adverse impacts on Essential Fish Habitat (EFH) through construction activities associated with dredging and fill placement, with some long-term, minor, adverse impacts from permanent fill and conversion of limited habitat to either another EFH type or supratidal habitats that would ultimately result in the long-term protection of EFH habitats through increased island longevity. Similarly, predominantly short-term, minor, adverse effects on managed species and their prey would occur from dredging activities (including changes in water quality from increased turbidity), the presence and operation of construction equipment and vessels, and underwater noise from pile-driving. Long-term impacts on managed species and their prey may also occur from habitat fill as they relocate to adjacent habitats. However, overall, the Project would result in a significant increase in island longevity, which would result in long-term benefits on both EFH and managed species from the maintenance of higher-elevation areas that would protect vegetated EFH types.

1. INTRODUCTION

Following approval of funding from the Regionwide Trustee Implementation Group (TIG) in their Final Restoration Plan / Environmental Assessment 1: Birds, Marine Mammals, Oysters, and Sea Turtles (Regionwide RP/EA #1), the Louisiana Coastal Protection and Restoration Authority (CPRA) is managing efforts to engineer and design restoration activities on the Chandeleur Islands. This Project is referred to as the Chandeleur Island Restoration Project (Project). The Project team has conducted field investigations and developed engineering alternatives which the Louisiana and Open Ocean TIGs are jointly evaluating for implementation funding in Joint Restoration Plan and Environmental Assessment #1: Chandeleur Islands - Wetlands, Coastal, and Nearshore Habitats, Fish and Water Column Invertebrates, Sea Turtles, Submerged Aquatic Vegetation, and Birds (Joint RP/EA #1). The current design, as discussed below, includes multiple restoration activities along North Chandeleur and New Harbor Islands. Habitat creation/restoration would support marine life (including fish, crustaceans, and the local food web) and increase the longevity of the islands.

The Project involves restoration of the North Chandeleur and New Harbor Islands in accordance with ecosystem restoration goals identified in the Deepwater Horizon (DWH) Oil Spill Final Programmatic Damage Assessment and Restoration Plan (PDARP) and Final Programmatic Environmental Impact Statement (PEIS). The Project includes restoring barrier island habitat along North Chandeleur Island through fill placement to restore beach, dune, and marsh habitat; restoration of marsh and mangrove habitat through fill placement on New Harbor Island; shoreline protection of New Harbor Island through construction of shoreline and detached rock breakwaters; and enhancement of the marine submerged aquatic vegetation, or seagrass (mSAV) beds through the added protection from offshore waves and storms afforded by the restoration of the beach and dune system on North Chandeleur Island.

1.1. Purpose and Need

The PDARP/PEIS identified a need for comprehensive integrated ecosystem restoration to address extensive and complex injuries to natural resources and their services across the Gulf of America (Gulf) as a result of the DWH oil spill, consistent with the Oil Pollution Act. Based on this need, the Louisiana TIG and Open Ocean TIG have undertaken this restoration planning effort for the purpose of contributing to the compensation for and restoration of natural resources and their services injured, as described in the PDARP/PEIS, in the Louisiana and Open Ocean Restoration Areas. The Project is subject to evaluation under the National Environmental Policy Act through issuance of Joint RP/EA #1, which is consistent with the PDARP/PEIS and falls within the scope of the purpose and need identified therein.

The proposed Project addresses two of the programmatic goals identified in the Final PDARP/PEIS: “replenish and protect living coastal and marine resources” and “restore and conserve habitat.” Together, these goals are intended to benefit injured coastal and nearshore habitats, as well as many injured species throughout their life stages by providing food, shelter, breeding, and nursery habitat.

The fisheries of the United States are managed within a framework of overlapping federal, state, interstate, and tribal authorities. The Magnuson-Stevens Fishery Conservation and Management Act (MSA), Public Law (P.L.) 104-297, 16 United States Code (U.S.C.) 1801 et seq., established eight Fishery Management Councils responsible for protecting and managing certain fisheries within specific geographic jurisdictions. The councils are required to prepare fishery management plans (FMP) to regulate commercial and recreational fishing and to identify Essential Fish Habitat (EFH) for managed species. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). As required by the MSA, this Essential Fish Habitat Assessment (EFHA) has been developed to satisfy obligations of the Louisiana and Open Ocean TIG, should they authorize funding for the Project under Joint RP/EA #1, and includes a description of the action, an analysis of the potential impacts on both the managed species and their designated EFH, conclusions regarding the effects of the action on EFH, and proposed mitigation measures selected to minimize expected Project effects.

2. DESCRIPTION OF THE PROPOSED ACTION

The Project is located within the Chandeleur Islands chain in St. Bernard Parish, Louisiana, and within the Breton National Wildlife Refuge (NWR; see Attachment A). The Chandeleur Islands comprise those lands between Chandeleur Sound and the Gulf, including Chandeleur Island (North and South), the Gosier Islands, the Grand Gosier Islands, the Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands. The restoration activities associated with this Project are focused on North Chandeleur Island, New Harbor Island, and the mSAV beds and water bottoms adjacent to these two islands. The Proposed Action includes the following features, as depicted in Attachment B:

1. North Chandeleur Island:
    - Beach, dune, and marsh fill
    - Feeder beach development
    - Construction of seven sand reservoirs and/or pocket marshes
2. New Harbor Island:
    - Marsh fill with shoreline protection features

2.1. Restoration Schedule

Construction is currently planned to commence in Q1 2026 and extend through Q2 2028. In-water work is likely to occur across the entire construction timeline. Although the vast majority of the Gulf-facing beach habitat would be affected by beach and dune restoration activities, with sand placement and equipment movement occurring throughout the construction period, the beach activities along North Chandeleur Island would occur sequentially, along three segments. The three segments would vary in length, with Segment 1 affecting about 5.7 miles of beach and adjacent in-water work at the northern end of the island, Segment 2 affecting the central 5.1 miles, and Segment 3 affecting about 3.2 miles at the southern end of the island.

2.2. Project Components

2.2.1. North Chandeleur Island

Restoration of North Chandeleur Island would consist of multiple restoration features. Beach and dune fill would be designed to provide and enhance habitat for nesting sea turtles and birds, as well as winter bird foraging habitat. Widening the island footprint would provide increased island longevity. Marsh fill and pocket marshes would involve the placement of sediment on the west side of the island, providing future marsh habitat. Sand reservoirs and the feeder beach would increase sediment available for land-building. Each of these features is depicted in Attachment A. Vegetation plantings on North Chandeleur Island are planned for dunes, marshes, pocket marshes, sand reservoirs, and mSAV beds. Currently anticipated plantings include bitter panicgrass (*Panicum amarum*), smooth cordgrass (*Sporobolus alterniflorus,* previously *Spartina alterniflora*), and various mSAV species, although the specific plantings would be chosen based on site conditions and/or construction variables. In addition, sand fences (porous barriers designed such that windblown sand accumulates on the fences) would be installed atop the restored dunes.

Beach and dune fill would be accomplished utilizing compatible sediments from Hewes Point Borrow Area (HPBA). Fill material would be placed at varying elevations and widths along the existing shoreline. Typical beach sections would be constructed to a target elevation of +4.5 feet (ft)[1] from the toe of the dune with a slope of 1V:200H extending seaward to an elevation of +3.2 ft. Here the slope would increase to 1V:50H down to mean high water (MHW) at an elevation of +1.2 ft where the slope would increase again to 1V:30H down to existing grade. Typical dune features would be constructed to a target elevation of +8.0 ft with side slopes of 1V:25H and a crest width of 100 ft. These elevations, slopes, and distances were selected because they have been shown to lend themselves best to habitat creation and sustainability for nesting sea turtles and birds.

Marsh fill would be initially constructed to a target elevation of +3.0 ft. The marsh fill would be completed on the north end of North Chandeleur Island behind the constructed beach and dune fill, where a narrow bare sandy beach and an expansive low-lying, nearly unvegetated, sandy intertidal platform currently exists. Marsh fill elevations were selected to provide bird foraging habitats as well as a stable platform to accept wash-over sediments enhancing the longevity of

[1] All elevations are in North American Vertical Datum of 1988 (NAVD88).

the Project. The marsh elevation may be refined once the geotechnical engineering settlement analysis is completed during the preliminary design phase of the Project.

Seven areas along the west side of North Chandeleur Island were identified as potential locations for sand reservoir or pocket marsh construction. The sand reservoirs would function as future sediment supplies, dispersing sand into the system, as the island migrates westward. These sites were selected because of their degraded existing vegetation. Fill placement in these areas would provide twofold benefits: additional sediment input into the existing system over time and increased intertidal and supratidal habitat acres. The typical sand reservoir feature would be initially constructed to a target elevation of +4.0 ft with slopes of 1V:30H down to existing grade. Typical pocket marsh features would be initially constructed to a target elevation of +3.0 ft with a bay slope of 1V:30H down to existing grade. The marsh elevation may be refined once the geotechnical engineering settlement analysis is completed during the preliminary design phase of the Project. The final ratio of pocket marshes to sand reservoirs would be determined in later design stages; however, the total number and location of these features would be as shown in Attachment A.

A nodal zone that was identified along the central to south-central Gulf-facing shoreline of North Chandeleur Island presents an opportunity to provide a sustainable source of sediment to the system through the longshore transport processes. Placement of a feeder beach near the nodal zone would take advantage of longshore transport to the north and south of this point, thereby allowing natural processes to nourish the beach over time. This feeder beach feature widens the beach platform up to 800 ft at its widest point at a target elevation of +3.2 ft with a slope of 1V:50H down to MHW, then a slope of 1V:30H from MHW to the toe of fill. Final centroidal location of the feeder beach feature would be determined during the later design stages to maximize the feature’s benefits to island longevity.

2.2.2. New Harbor Island

To protect existing mangrove habitat and restore eroded avian nesting habitat, a shoreline protection system would be constructed consisting of a detached rock breakwater on the eastern side of the island and a shoreline rock breakwater on the western side of the island. Approximately 250 ft from the eastern shoreline of the island, the detached rock breakwater would be constructed to a maximum elevation of +4.6 ft with side slopes of 1V:3H and five incorporated gaps. This detached breakwater is intended to protect existing habitat from erosion from wind and waves while maintaining hydrologic exchange and fisheries access. The shoreline rock breakwater off the western side of the island would also be constructed to a maximum elevation of +4.6 ft with side slopes of 1V:3H, with no incorporated gaps. Between the western shoreline rock breakwater and the existing island shoreline, sediment would be placed to a target elevation of +3.0 ft with a side slope of 1V:30H to intersect with the existing grade of the island, which would create about 145 acres of habitat for colonial nesting birds and migratory birds; this fill area would be planted with black mangrove (*Avicennia germinans*). Each of these features is generally depicted in Attachment A; detailed engineering drawings are provided in Attachment B.

2.2.3. Other Components

Project implementation would also involve activities at the HPBA, a nearshore conveyance corridor, three offshore pump-out areas and associated conveyance corridors, and access channels. The HPBA is a submerged shoal that is within one mile of the north end of North Chandeleur Island. The sand deposits within the 1,680-acre HPBA are sediment collected from longshore transport from North Chandeleur Island and are suitable for restoration purposes.

The nearshore conveyance corridor would extend the full length of North Chandeleur Island (Gulf-facing side); from the corridor used during the construction of the Eastern Berm Reach E4 project (EBB) completed in 2010 in response to the DWH oil spill to the island's Gulf-side shoreline. Three offshore pump-out areas and associated offshore conveyance corridors would allow for direct pump-out of sediments from a hopper dredge or scow barges via sediment pipeline corridors for sediment transport to North Chandeleur and New Harbor Islands. As shown in Attachment A, the pump-out areas are each about 2 to 4 miles from the Gulf-facing shore of North Chandeleur Island.

Temporary access channels may be dredged to provide construction access to North Chandeleur and New Harbor Islands for equipment and personnel. The temporary access channels would be utilized for the Project duration and would be backfilled upon Project completion. Three locations along North Chandeleur Island were identified that minimized impacts on submerged aquatic vegetation, specifically turtle grass (*Thalassia testudinum*). These access channels are positioned on the north end, central area, and south end on the bay-side of North Chandeleur Island. A fourth channel is also planned around the perimeter of New Harbor Island.

2.3. Restoration Procedures

Construction procedures to complete the habitat restoration proposed for the Project are described below. Any construction best management practices are incorporated into the construction procedures and are discussed in the applicable sections. Specific construction methodologies include dredging via hydraulic cutterhead dredge with booster pumps, hopper dredge, or cutterhead dredge-scow barge operation; fill activities, including the placement of rocks to install shoreline protection features around New Harbor Island; and limited (timber) pile-driving.

Fill to create the restoration features on North Chandeleur and New Harbor Islands would be completed using sediments transported from the HPBA. With any of the three dredging and transport methods, the dredged material would be discharged into the restoration template where it would be graded using conventional earth moving equipment. In addition to the HPBA, a nearshore conveyance corridor and three offshore pump-out areas with associated offshore conveyance corridors have been identified for use during the Project. The sediment pipeline installed within the conveyance corridors and pump-out areas would not require excavation for pipeline installation, as the sediment pipelines would be placed directly on the sea floor.

Several types of sea-borne equipment, land-based earth moving equipment, and transportation equipment are employed during a restoration project. Sea-borne equipment for the Project would likely include dredging vessels, booster pump(s), tugboats, scow barges, equipment ramp barges, and survey vessels. Land-based earth moving equipment would likely include bulldozers, marshbuggy excavators, tracked excavators, and articulated loaders. Transportation and support equipment would likely include crew and supply transport vessels, all-terrain vehicles, welding machines, air compressors, light plants, field survey office, field engineering office and quarters barges.

2.4. Maintenance Procedures

Once restoration activities are complete, no ongoing maintenance activities are planned or proposed; however, CPRA may occasionally revisit the area to ensure the success of revegetation and may conduct limited replantings and fence replacements/maintenance as needed. No further sand or sediment work would occur.

3. RESTORATION PROJECT AREA

The Chandeleur Islands can be categorized into two subsets, the northern island chain and the southern island chain. The two subsets resulted from a breach in Chandeleur Island that formed as a result of Hurricane Katrina in 2005 now called the Katrina Cut. The northern island chain includes North Chandeleur and New Harbor Islands, which fall within the restoration Project area (an area approximately 6 miles on either side of North Chandeleur Island, excluding waters deeper than 59 feet that may occur on the outer side of this area) and are proposed for restoration action associated with the Project. The Project area also includes several Project features including the HPBA, three offshore pump-out areas and associated offshore conveyance corridors, a nearshore conveyance corridor, and temporary access channels providing construction access to the north end, central area, and south end of North Chandeleur Island and around the perimeter of New Harbor Island, as depicted in Attachments A and B. In addition to the specific restoration activities, support and construction vessels would travel between the Project area and existing shore-based ports in Louisiana, Mississippi, and/or Alabama; these vessels traveling outside of the Project area would adhere to any applicable regulations during transit and are not discussed further.

4. FISHERY MANAGEMENT PLANS

The National Marine Fisheries Service (NMFS) and Fishery Management Councils (FMC) created under the MSA, jointly manage fishery resources in the U.S. Exclusive Economic Zone (EEZ). The Gulf of Mexico Fishery Management Council (GMFMC) was established for the Gulf to regulate commercially and recreationally valuable species and stocks through FMP. Together, NMFS and GMFMC maintain FMPs for specific species or species groups to regulate commercial and recreational fishing within their geographic regions. NMFS also manages the FMP for Highly Migratory Species (HMS), including billfish, tuna, swordfish, and sharks in the

Gulf. Jurisdiction is determined by species rather than location, as species ranges often cross administrative boundaries.

FMCs are required to identify EFH for each fishery covered under an FMP, as well as Habitat Areas of Particular Concern (HAPC). EFH is defined as the waters and seafloor necessary for spawning, breeding, or growth to maturity of managed fish species (16 U.S.C. 1802[10]). HAPCs are defined as subsets of EFH that exhibit one or more of the following traits: rare, stressed by human development, provide important ecological functions for federally managed species, or are especially vulnerable to anthropogenic (or human impact) degradation (NMFS 2020). Managed species identified as potentially occurring within the Project area are included in the following five FMPs:

- Shrimp (3 species)
- Reef Fish (6 species)
- Red Drum
- Coastal Migratory Pelagics (3 species)
- Highly Migratory Species (11 species)

Each of these FMPs has been developed for the management of one or more species. Managed species potentially occurring in the Project area are listed by FMP in Table 4-1. Many of the managed species are economically important as commercial and recreational fisheries.

Five shrimp species are managed under the Shrimp FMP, the most abundant of which are brown shrimp and white shrimp. Adult shrimp are found over soft bottom estuarine, inshore, and offshore habitats throughout the Gulf. Most species occur at depths up to 328 ft; however, royal red shrimp occur in deeper water (GMFMC 2016). Red drum occur throughout the Gulf in a variety of habitats ranging from shallow estuarine waters to depths of approximately 131 ft offshore and occur from Massachusetts along the western Atlantic coast to northern Mexico (GMFMC 2016). They are common in the majority of Gulf estuaries, existing in a dynamic range of substrates including seagrass, sand, mud, and oyster reefs as well as in offshore habitats (GMFMC 2016). Reef fish include species that live on or near coral reef or hard bottom habitat, such as snapper, grouper, tilefish, bass, triggerfish, and other species groups (GMFMC 2016).

Coastal Migratory Pelagic species include king mackerel, Spanish mackerel, and cobia; these species occur in the coastal and continental shelf waters throughout the Gulf and to the northeastern United States. Each of these species occurs in nearshore and pelagic open water (GMFMC 2004). NMFS' Highly Migratory Species (HMS) Division manages an FMP for HMS (sharks, tuna, billfish, and swordfish) as they cross domestic and international boundaries. These species use a variety of habitats throughout the Gulf (NMFS 2017).

Table 4-1: Managed Species Potentially within the Project Area

Shrimp	
brown shrimp (*Farfantepenaeus aztecus*)	pink shrimp (*Farfantepenaeus duorarum*)
white shrimp (*Litopenaeus setiferus*)	
Red Drum	
red drum (*Sciaenops ocellatus*)	
Reef Fish	
lane snapper (*Lutjanus synagris*)	red snapper (*Lutjanus campechanus*)
vermilion snapper (*Rhomboplites aurorubens*)	gray (mangrove) snapper (*Lutjanus griseus*)
greater amberjack (*Seriola dumerili*)	gray triggerfish (*Balistes capriscus*)
Coastal Migratory Pelagic Fishes	
king mackerel (*Scomberomorus cavalla*)	Spanish mackerel (*Scomberomorus maculatus*)
cobia (*Rachycentron canadum*)	
Highly Migratory Species	
Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)	blacknose shark (*Carcharhinus acronotus*)
blacktip shark (*Carcharhinus limbatus*)	bull shark (*Carcharhinus leucas*)
spinner shark (*Carcharhinus brevipinna*)	scalloped hammerhead (*Sphyrna lewini*)
bonnethead shark (*Sphyrna tiburo*)	finetooth shark (*Carcharhinus isodon*)
whale shark	tiger shark
dusky shark	

5. ESSENTIAL FISH HABITAT

As described above, EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity," and specifically includes the "physical, chemical, and biological properties" of those waters (50 Code of Federal Regulations [CFR] 600.10).

The GMFMC and NMFS have developed FMPs, which provide details on EFH and other management issues for commercially, recreationally, and ecologically important resources in the Project area, including shrimp, red drum, reef fishes, coastal migratory pelagic fishes, and HMS. The entire northern coast of the Gulf to a depth of about 600 ft has been identified as EFH for at least one species. Life stages of all but the HMS are defined in five stages:

- Eggs: The fertilized product of individuals that have spawned; they depend completely on their yolk-sac for nutrition in this unhatched phase.
- Larvae: Individuals that have hatched and can capture prey.
- Juveniles: Individuals that are not sexually mature but that have fully formed organ systems, similar to those of adults.
- Adults: Sexually mature individuals that are not necessarily in spawning condition.
- Spawning adults: Adults that are capable of producing offspring.

EFH designations for species managed by the FMPs are based on species-specific life stage associations with different habitat types. EFH is designated in the Project area for the Shrimp, Red Drum, Reef Fish, Coastal Migratory Pelagic, and HMS FMPs. Detailed life history information for each managed species has been provided by the GMFMC and NMFS in the relevant FMPs (GMFMC 2016; NMFS 2006, 2009, 2010, 2017); these life history descriptions are incorporated from the noted references, and are summarized in Attachment C. Life stages for the cartilaginous (i.e., shark) HMS are grouped in three categories based on common habitat usage:

- Neonates: Primarily including newborns and small young-of-the-year (YOY) that have been born within the past year.
- Juveniles: All immature sharks from young to older and late juveniles.
- Adults: Sexually mature sharks; the largest size class.

5.1. Essential Fish Habitat in the Project Area

To develop EFH for the fisheries, the GMFMC and NMFS categorized substrates and biogenic features by zone and type. Habitat zones include estuarine (bays, estuaries, and waters inshore of barrier islands), nearshore (marine waters less than 59 ft deep), and offshore (marine waters greater than 59 ft deep); offshore waters would not be affected by the Project. Habitat types are further classified into 12 categories that are distributed across the estuarine, nearshore, and offshore zones (Table 5-1; GMFMC 2016). Based on review of publicly available data and the results of habitat surveys, the habitats present in the Project area include submerged aquatic vegetation (SAV), mangroves, estuarine wetlands, soft bottoms (including sand/shell bottoms), occasional occurrences of *Sargassum*, shoals, and water column habitat. These habitats are described in detail below.

5.1.1. Seagrass

Marine seagrass beds are a highly productive and ecologically important habitat for a variety of invertebrates, fish, reptiles, and mammals, serving as foraging and nursery habitat. Within Louisiana, mSAV are limited to the leeward side of the Chandeleur Islands where the clear, high-salinity, low-nutrient waters are suitable for their growth (Poirrier 2007). As summarized in Project-specific mSAV surveys (SWCA 2023, Attachment D), decades of studies have reported varying coverage of mSAV along the Chandeleur Islands; however, the species composition has remained fairly consistent and includes turtle grass, manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*) (Poirrier and Handley 2007, Kenworthy et al. 2017). Areas that are sheltered from storm damage are dominated by dense turtle grass meadows (Franze 2002, Poirrier and Handley 2007). Areas subject to higher levels of damaging forces have some turtle grass, but mainly manatee grass and shoal grass. Star grass was also found to be present in disturbed areas but was quite rare (Handley et al. 2007). Furthermore, a comparison of aerial mapping efforts at the Chandeleur Islands from 1992 to 2005 documented rapid rates of land loss and declining mSAV coverage along the islands, supporting the causation between land loss and declining mSAV coverage (Pham et al. 2014).

Project-specific mSAV surveys (SWCA 2023, Attachment D) conducted along the bay-side of North Chandeleur Island in 2022 identified a higher coverage of shoal grass in the northern and southern portions of North Chandeleur Island, as well as isolated patches of widgeon grasses in the southern areas; turtle grass was not dominant in these zones and manatee grass was limited to one identified location. Only one location supporting seagrass was identified at New Harbor Island, which included a relatively low coverage of shoal grass. In total, 5,194 acres of seagrass beds were identified in the survey area, much of which included multiple species of seagrasses. Of the total acreage, shoal grass was found across 4,970 acres, turtle grass across 2,580 acres, widgeon grass across 2,260 acres, star grass across 2,260 acres, and manatee grass across 475 acres.

Table 5-1: Estuarine and Nearshore EFH Habitat Types

Habitat Type	Associated Terms	Description	Presence within the Project Area
Submerged Aquatic Vegetation (SAV)	Seagrasses, benthic algae	Marine and vascular plants found in shallow estuaries and some nearshore habitats (Williams and Heck 2001). Algae may be epiphytic or may grow attached to shell/rubble. This habitat provides important nursery habitat for numerous species.	Yes
Mangroves	--	Communities of halophytic trees and shrubs in typically soft sediments with regular tidal inundation, some freshwater inputs, and low to moderate wave energy. Found where the sea meets land and contain terrestrial and aquatic elements.	Yes
Drifting algae	*Sargassum*	Floating mats of seaweed that travels through the Gulf with the currents and supports a diverse assemblage of marine organisms.	Occasionally
Emergent marshes	Tidal wetlands, salt marshes, tidal creeks, rivers/streams	Vegetated wetlands with typically soft sediments, regular tidal inundation, some freshwater inputs, and low to moderate wave energy. Found where the sea or body of water meets land and contain terrestrial and aquatic elements.	Yes
Soft bottoms	Mud, clay, silt	Areas where the bottom sediments are soft mud, clay, or silt. Shrimp and many demersal species of fish often actively select for this substrate type.	Yes
Sand/shell bottoms	Sand	Areas where the bottom sediments consist of soft sand and/or shell. Generally included in the term "soft bottom".	Yes
Hard bottoms	Live hard bottoms, low- and high-relief irregular bottoms	Subtidal hard bottom communities, usually submerged rocky outcroppings. Generally dominated by epifaunal organisms (e.g., sponges, corals, hydroids).	No
Oyster reefs	--	Aggregations of live and dead oysters with associated flora and fauna. Occur in intertidal and subtidal areas where salinities are relatively high. Estuaries with suitable substrate, calm and continuous water flow, and low sedimentation are ideal for development.	No[a]
Banks/shoals	--	Submerged ridges or bars of bottom sediment (such as sand) that rises from the water bottom to provide shallower water depths than surrounding areas (Pickens et al. 2020).	Yes
Reefs	Reefs, reef halos, patch reefs, deep reefs	Hermatypic (hard) and ahermatypic (soft) coral assemblages that dominate a habitat.	No
Shelf edge/slope	Shelf edge, shelf slope	The continental slopes is a transitional environment influenced by processes of both the shelf, which ends at roughly the 200- m isobath, and the deep sea. The shelf/slope transition zone occurs between depths of 150 and 450 m.	No
Water Column Associated	Pelagic, planktonic, coastal pelagic	Open water areas within which the above habitats are present.	Yes

Source: GMFMC 2016.

[a] While the Project area overlaps public oyster seed grounds, the Project is not expected to affect oyster reefs or other hardbottom habitat. Any permit conditions for the protection of oyster resources would be implemented.

5.1.2. Sargassum

Sargassum is a genus of pelagic brown algae that forms dense floating mats in tropical Atlantic waters and is transported into the Gulf on circumtropical currents. The floating mats provide habitat to a wide range of species in the water column and are an essential component of the water column habitat in the Gulf. They include a diverse community of epibiota (algae, fungi, and invertebrates), more than 100 species of fish, and 4 species of sea turtle. About 10 percent of the invertebrate species and two fish species found using *Sargassum* mats are endemic (native or restricted to *Sargassum*) (GMFMC 2004).

Shrimp and crab come into contact with *Sargassum* as it drifts with the current through the Gulf, comprising the bulk of the invertebrates that utilize *Sargassum* mats. *Sargassum* also acts as a vehicle for dispersal of some of its inhabitants and is important in the life histories of many species of fish, providing them with a substrate, protection against predation, and concentration of food in the open Gulf. Large predators associated with the *Sargassum* complex include amberjacks (*Seriola dumerili*), dolphin (*Coryphaena hippurus*), and almaco jacks (*Seriola rivoliana*) (GMFMC 2004). *Sargassum* habitat occurs in nearshore and offshore waters of the Gulf in the Project area.

5.1.3. Emergent Marshes and Mangroves

Wetland habitats, including marshes and mangroves, provide necessary habitat for many managed species, serving as nursery areas for larval and juvenile invertebrates and fish and providing organic material for detrital food webs (GMFMC 2004). Marsh and mangrove habitats typically occur in areas of soft sediments with regular tidal inundation, and may stabilize sediment as they grow. In addition to providing habitat for larval and juvenile fish and invertebrates, these habitats are important in global nutrient cycling and remove contaminants from water (GMFMC 2004). During periods of high tide, black mangrove and tidal marsh habitats provide a refuge for fish and shrimp (GMFMC 2004).

North Chandeleur Island is approximately 14 miles in length with an average width of 0.5 miles. Its topography varies from north to south with the northern expanses being bare sandy beaches at or near intertidal elevations. As the island progresses to the south, the beaches become narrower with broken vegetated dunes and overwash locations (LDWF-LNHP 2009). These upland habitats extend into salt flats, and smooth cordgrass and black mangrove dominate the back marshes at the westernmost extent of the island. Emergent marshes, including tidal wetlands and salt marshes, within the Project area consist of *Sporobolus* marshes along North Chandeleur Island. Mangroves are the dominant species on New Harbor Island with few herbaceous salt marsh species intermixed. New Harbor Island is currently a mangrove stand of approximately 35 acres; no uplands are present.

5.1.4. Soft Bottom Habitat (Including Sand/Shell)

Soft bottom benthic habitat refers to any seafloor habitats, except for hard bottom, which may include unconsolidated mud, clay, silt, sand, and shell fragments. A variety of species use these unconsolidated bottom habitats for spawning, burrowing, and feeding. Soft bottom habitats support both infauna (organisms that live in the substrate) and epifauna (organisms that live on the substrate), which provide an important trophic base for secondary consumers (Ward 2017). Infaunal communities generally include polychaete worms (bristleworms), crustaceans, and mollusks whereas epifaunal communities may include crustaceans, echinoderms, mollusks, hydroids, sponges, and soft and hard corals (BOEM 2017, Darnell 2015).

Soft bottom habitats are the primary benthic habitat in the northern Gulf. Throughout the northern Gulf, densities of benthic macrofauna are typically higher at inshore locations and lowest at the outer shelf margin. In various studies, macrofauna were dominated by polychaete annelid worms, amphipods, and bivalve mollusks (Ward 2017).

In 2023, borings were performed at different sites within the Project area. These borings revealed that the east side of Chandeleur Island consists of loose to firm sandy soils with some silt and clays extending from 14 to 33 ft below the surface. The shallow water areas contain sandy soil with silt and clay extending from 14 to 58 ft below the surface of the water bottom. Borings performed in the Chandeleur Sound contain mostly loose to dense sand with silt and clays. Additionally, borings performed near New Harbor Island showed 2 to 8 ft of loose sandy silt overlaying very soft to soft clay with some silt and sand (GeoEngineers 2024).

Results from a high-resolution geophysical survey (Ocean Surveys, Inc. [OSI] Report No. 23ES011) performed in the Project area found that the shallow subsurface of the northernmost pump-out area is characterized by unconsolidated sediments composed primarily of varying assemblages of silt and clay with a slight buildup of sand nearshore and in the vicinity of a shoal encroaching into the conveyance corridor near New Harbor Island. The HPBA has a 93% sand content that is greater than the #200 sieve and has a median grain size of 0.13 millimeters. Other sediments in this area include silt and organic rich and gaseous clay (Flocks et al. 2022, OSI 2024).

5.1.5. Banks/Shoals

Shoals are common geologic features on the continental shelf and are defined as sand, or other unconsolidated material, that result in shallower water depths than surrounding areas; they may also be identified as ridges, banks, or bars. Shoals are used by reef fish, shrimp, coastal pelagics, demersal fish, and sharks (Rutecki et al. 2014; Pickens et al. 2020).

No named shoals are present within the Project area, with the closest being the St. Bernard Shoals approximately 9 miles to the southwest of North Chandeleur Island. However, results from a high-resolution geophysical survey (Ocean Surveys, Inc. [OSI] Report No. 23ES011) indicated that the HPBA (including the expansion area) is an area of higher relief relative to the surrounding waterbottom, with areas of minimal variable relief at its crest. Depths in the HPBA range from 12 to 14 feet down to approximately 44 feet around the edges of the surveyed area that is proposed for use as a sand borrow site (see Attachment A). Depths gradually increase from south to the north. In general, slope grades notably increase from the 16-foot depth contour to the offshore limits of the HPBA. Maximum depths and slope grades (up to 2.3%) were observed along the northwestern side of the expansion area. In addition, a shoal is present within the southernmost offshore conveyance corridor within the Katrina Cut. The shoal raises to elevations of about -4 feet, with the immediately surrounding seafloor including elevations of between -5 and -7 feet (see Attachment A).

5.1.6. Water Column

The water column (habitat within the mass of water between the surface and the substrate but excluding benthic or structural features) provides EFH for many species. Waters occurring above the continental shelf within the neritic zone (down to about 656 ft) of the ocean are included in the photic zone, where sunlight can penetrate and photosynthesis can occur. Outside of the islands and mSAV beds, the Project area is characterized by open water, with measured salinities during Project-specific mSAV surveys ranging from 21.8 to 35.9 parts per thousand. Mean monthly surface water temperatures collected in the Project vicinity between 2007 and 2024 at Coastwide Reference Monitoring System Station No. CRMS1069-H01, about 43 miles west of the Project, range from a low of 48.6 degrees Fahrenheit (°F) in January 2014 to a high of 90.1°F in August 2023 (CPRA 2025). Luke Offshore Test Platform, about 55 miles southeast of the Project in the Gulf, range from 69.8 °F in January to 86.1°F in August.

The open waters of North Chandeleur Island include both estuarine habitat within the Chandeleur Sound and marine habitat along the Gulf-facing side of the island. The bay-side of the island contains the mSAV beds and relatively calm waters when compared to the Gulf-facing side, which is subject to more wave action and higher salinities. Water depths vary within the Project area; open water areas are most shallow as the waterbottom approaches islands, and generally become deeper with distance either into the Gulf or toward the mainland. Depths within the conveyance corridors gradually increase from the shoreline to approximately 40 ft at the offshore extent in the pump-out area. In the segment of the offshore conveyance corridor leading from North Chandeleur Island to New Harbor Island, depths range from about 15 ft at the eastern end to about 3 ft along the New Harbor Island shoreline (OSI 2024). Significant wave heights in the Project area have a peak of 1.5 ft on average, with less frequent waves higher than 3.3 ft occurring approximately 4% of the year and waves higher than 6.6 ft occurring approximately 1% of the year (Miner et al. 2021).

The base of the open-ocean food web is plankton, which includes small plants (phytoplankton) and animals (zooplankton) that are generally at the mercy of currents. Phytoplankton are photosynthetic organisms that produce the bulk of organic matter in aquatic ecosystems. Zooplankton include organisms that remain in the planktonic community throughout their lives (holoplankton), as well as planktonic life stages of larger organisms that will eventually leave the planktonic community (meroplankton). Zooplankton may exhibit some motility and/or diurnal migrations (Ward 2017). A relatively small component of the zooplankton community in the upper 656 ft of the water column are ichthyoplankton, which includes eggs, larvae, and juveniles (SWFC 2019). The distribution of ichthyoplankton is a function of the location of spawning adults, currents, and sea-surface temperatures (Ward 2017).

5.2. Habitat Areas of Particular Concern

HAPCs are localized areas of EFH that are ecologically important, sensitive, stressed, and/or rare areas. Although designated HAPCs have no regulatory protections above all other EFH, projects impacting HAPCs may be more scrutinized, and may be subject to additional conservation measures (NMFS 2015). The Project would not impact any designated HAPCs and the closest one, (Alabama Alps Reef) is approximately 52 miles southeast of North Chandeleur Island.

5.3. Managed Species in the Project Area

In addition to those habitat types described in Section 5.1, the GMFMC divided the Gulf into five ecoregions to further refine species distribution. The boundaries of each ecoregion represent ecological breaks (e.g., boundaries of biogeographic provinces, boundaries of heaviest influence by large rivers) and also coincide with NMFS' statistical grid for fishing efforts (GMFMC 2016). The Project is located in the estuarine and nearshore waters of Ecoregion 3, which covers an area from Pensacola Bay to the Mississippi Delta. Ecoregion 3 experiences fluctuations in nearshore salinity due to influence from the Mississippi and Atchafalaya Rivers. The ecoregion is dominated by softbottom habitat, but also contains large areas of marsh and oyster reefs (GMFMC 2016, NMFS 2015).

A total of 24 managed species are identified as occurring within the estuarine and nearshore habitats of Ecoregion 3 (see Tables 5-2 and 5-3). Detailed discussions on the life histories for each managed species is provided, where available, by the GMFMC and NMFS in the relevant FMPs and EFH amendments (GMFMC 2016, NMFS 2006 and 2010). Attachment C summarizes the life history information for the federally managed species for which EFH is present in the Project area for all or part of their life cycles.

Table 5-2: GMFMC Managed Fishes Identified in Ecoregion 3 by Life Stage

Common Name	Scientific Name	Life Stage				
		Eggs	Larvae	Juveniles	Adults	Spawning Adults
Shrimp						
brown shrimp	*Farfantepenaeus aztecus*	x	x	x	x	x
pink shrimp	*Farfantepenaeus duorarum*	x	x	x	x	x
white shrimp	*Litopenaeus setiferus*	x	x	x	x	x
Red Drum						
red drum	*Sciaenops ocellatus*	x	x	x	x	x
Reef Fish						
red snapper	*Lutjanus campechanus*	x	x	x	x	x
gray (mangrove) snapper	*Lutjanus griseus*	--	--	--	x	x
lane snapper	*Lutjanus synagris*	x	x	x	x	--
vermilion snapper	*Rhomboplites aurorubens*	--	--	x	x	--
greater amberjack	*Seriola dumerili*	x	x	x	x	x
gray triggerfish	*Balistes capriscus*	--	x	x	x	x
Coastal Migratory Pelagic Fishes						
king mackerel	*Scomberomorus cavalla*	x	x	x	x	x
Spanish mackerel	*Scomberomorus maculatus*	x	x	x	x	x
cobia	*Rachycentron canadum*	x	x	x	x	x

Key:
"--" indicates that the species is not identified as occurring in Ecoregion 3 for the indicated life stage.
"X" indicates the species is identified as occurring in Ecoregion 3 for the indicated life stage.
Source: GMFMC 2016

Table 5-3: Highly Migratory Species in the Project Area by Life Stage

Common Name	Scientific Name	Neonates	Juveniles	Adults
scalloped hammerhead shark	*Sphyrna lewini*	--	x	x
blacktip shark	*Carcharhinus limbatus*	x	x	x
bull shark	*Carcharhinus leucas*	x	x	x
dusky shark	*Carcharhinus obscurus*	--	x	x
spinner shark	*Carcharhinus brevipinna*	x	x	x
tiger shark	*Galeocerdo cuvier*	--	x	x
whale shark	*Rhincodon typus*	x	x	x
bonnethead shark	*Sphyrna tiburo*	x	x	x
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	x	x	x
blacknose shark	*Carcharhinus acronotus*	--	x	x
finetooth shark	*Carcharhinus isodon*	x	x	x

"--" indicates that the species is not identified as occurring in the Project area for the indicated life stage.
"x" indicates that the species is identified as occurring in the Project area for the indicated life stage.
Source: NMFS 2017

6. IMPACTS ON ESSENTIAL FISH HABITAT, MANAGED SPECIES, AND PREY

For purposes of this document, impacts are assessed in accordance with the approach taken in Chapter 6 of the Final PDARP/PEIS, including the guidelines for National Environmental Policy Act (NEPA) impact determinations. To determine whether an action has the potential to result in significant impacts, the context and intensity of the action must be considered. Context refers to the area of impacts (for example, local, statewide) and their duration (for example, whether they are short- or long-term impacts). The duration of an impact can be defined differently depending on the resource being analyzed; for habitats as well as marine and estuarine fauna, short-term indicates impacts lasting less than two growing or breeding seasons and long-term impacts are those that last two more growing or breeding seasons.

Intensity refers to the severity of an impact and could include the timing of the action (for example, more intense impacts would occur during wildlife breeding/rearing). Intensity is also described in terms of whether the impact would be beneficial or adverse. Impacts are characterized as minor, moderate, or major, and short-term or long-term and are generally defined as follows:

- Minor: Minor impacts are generally those that might be detectable but, in their context, may nonetheless not be measurable because any changes they cause are so slight as to be impossible to define.
- Moderate: Moderate impacts are those that are more detectable and, typically, more quantifiable or measurable than minor impacts.
- Major: Major impacts are those that, in their context and due to their severity, have the potential to meet the thresholds for significance set forth in Council on Environmental Quality (CEQ) regulations (40 CFR Section 1508.27) and, thus, warrant heightened

attention and examination for potential benefit of mitigation.

A beneficial impact is one that creates a positive outcome in the manmade or natural environment. Because the proposed restoration activities are intended to result in significant, major benefits to injured resources, evaluation of the intensity of the benefits to resource categories is not described. For resource areas where there is no expected effect from Project activities, a “no impact” conclusion is made.

Section 6.1 describes the potential beneficial and adverse, direct and indirect impacts of the Proposed Action on EFH and managed species. Specific construction methodologies include dredging; temporary changes in water quality; fill activities (habitat alteration and loss); underwater noise; artificial lighting; and vessel traffic. As the purpose of the Project is to create, enhance, and maintain habitat, a section on habitat benefits following completion of restoration activities is also included. Following construction, no further disturbance to EFH or managed species is anticipated (see Section 2.1).

6.1. Effects of the Proposed Action

Short-term to long-term, minor to moderate, adverse impacts on marine and estuarine aquatic fauna, including managed fish species, and EFH present in the Project area are expected due to construction activities associated with the Proposed Action. These impacts include displacement and disturbance of aquatic fauna during construction due to noise and the presence of vessels and equipment, as well as temporary impacts on water quality due to increased turbidity and suspended sediment concentrations, and potential leaks from construction equipment and vehicle fuels and fluids.

6.1.1. Dredging

It is anticipated the methods of mining the HPBA and conveying it to North Chandeleur and New Harbor Islands would be a hydraulic cutterhead dredge with booster pumps, hopper dredge, or cutterhead dredge-scow barge operation. Cutterhead dredges utilize a rotary excavating bit to loosen the sediment. The loosened slurry is pumped up to a large suction pump in the dredge hull, which also pumps it ashore through a submerged pipeline, often aided by booster pump(s). With hopper dredge operation, the excavated sand would be moved to the vessel’s hull and transported to the designated pump-out areas to be hydraulically unloaded. The third method involves use of a conventional cutterhead dredge, which would excavate the sand and transfer it through a spider barge distribution system into scow barges. The scows would be towed to the designated pump-out areas and hydraulically unloaded directly from the scow barges. Sediment pipelines would be placed within the nearshore conveyance corridor adjacent to the Gulf-facing side of North Chandeleur Island, and within the offshore conveyance corridors associated with the offshore pump-out areas; these conveyance corridors and pump-out areas would not require excavation for pipeline installation, as the sediment pipelines would be placed directly on the sea floor. With all three dredging and transport methods, the dredged material would be discharged into the restoration template where it would be graded using conventional earth moving equipment.

The HPBA, three offshore pump-out areas, and the nearshore and offshore conveyance corridors are characterized by softbottom sediments. Adverse impacts would occur in softbottom habitats undergoing dredging activities (i.e., the HPBA), including area avoidance by managed species and the loss of benthic prey species from smothering or mechanical impact during sediment movement. However, once activities have stopped or moved on to another location, the benthic community can start to recover through planktonic larval recruitment, lateral migration from adjacent areas, or vertical migration where sedimentation has occurred adjacent to dredging activities. Recovery through lateral migration occurs over days or weeks, whereas recovery through planktonic settlement can take weeks, months, or years. (Bolam 2011). Infaunal organisms are accustomed to burrowing through sediment, but the depth of deposited sediment through which individuals can potentially vertically migrate varies by species, with smaller infauna being limited to less than 2.5 inches and up to nearly 12 inches for some burrowing polychaetes, amphipods, and mollusks (Wilber et al. 2008, Bolam 2011).

In addition, benthic invertebrates within the path of the dredge pipelines placed in the nearshore and offshore conveyance channels may be smothered. Based on the wide expanse of soft bottom habitat in the Project area, the short-term impact on benthic prey species within these areas would have a minor (to no) impact on managed species. Sediment disturbance and dredging would also increase suspended sediment concentrations, causing a localized decrease in water quality during active restoration (see Section 6.1.3, below).

Each of the four temporary access channels may be dredged. Three access channels (each of which could be up to 150-ft wide, with up to an additional 150 ft on each side for spoil storage) would be dredged to provide construction access to North Chandeleur Island for equipment and personnel (see Attachments A and B). The fourth temporary access channel (also up to 150-ft wide, but with spoil storage limited to 150 ft on one side) would be dredged along the perimeter of New Harbor Island. The temporary access channels would be utilized for the Project duration and would be backfilled upon Project completion. Three of the temporary access channels (those providing access to North Chandeleur Island) would result in the temporary loss of approximately 52 acres of vegetated EFH through the dredging and sidecast of sediments, including about 43 acres of mSAV, 4 acres of emergent marsh, and 5 acres of mangrove. These access channels would be used for approximately three growing seasons, and would be restored after use; appropriate vegetation species would be planted during restoration (see Attachment B, Sheet 36 of 40). The fourth access channel, surrounding New Harbor Island, would affect approximately 50 acres of open water with soft bottom habitat. Following restoration, the Project is expected to protect vegetated EFH and provide habitat benefits as further described in Section 6.1.7, below.

Mechanical, hopper, and hydraulic/cutterhead dredges may be used to support Project construction. The use of cutterhead dredges would minimize the potential for entrainment of fish and prey species, as most mobile species are expected to avoid active dredging. Further, in accordance with the measures in the PDARP/PEIS, to minimize the risk to protected species (and thereby minimize risks to managed species and their prey), pumps would be disengaged when the cutterhead is not in the substrate, and operators would avoid pumping water from the bottom of the water column. However, hopper dredges move rapidly and can therefore injure or kill managed species due to entrainment within the hopper dredge or impingement on the draghead. Because most managed species could likely avoid this activity and the area in which sediment removal would be limited to the HPBA, this impact is anticipated to be short-term and minor.

6.1.2. Habitat Conversion

In addition to the temporary impact on EFH from dredging activities, various habitat types would be converted during fill activities along North Chandeleur and New Harbor Islands, and during construction of the rock breakwater around New Harbor Island.

Some areas of EFH would be filled with dredged material to construct elevated habitat. Table 6-1 provides the acreage of existing vegetation in the Project area, as well as the impacts on that vegetation from the Proposed Action, which accounts for all dredge and fill activities. As described above, soft bottom and open water habitat would also be affected by dredging and material placement. The Proposed Action would result in the most impacts on vegetated EFH; however, as described above, appropriate vegetation species would be planted during restoration (see Attachment B, Sheet 36 of 40), which would result in a portion of the affected habitat being retained, but converted to either another type of EFH (likely at a higher elevation) or supratidal habitat. Supratidal habitats, although not immediately available for use by managed species, may return to intertidal or subtidal levels over time, as erosional forces and sea-level rise continue, but would provide immediate and long-term protection for vegetated EFH adjacent to the restoration template (see Section 6.1.7). Further, mSAV directly affected by construction of the Project would be restricted to areas of the more common shoal and widgeon grasses; siting of the restoration features and access channels was designed to avoid impact on the less common mSAV species (turtle, manatee, and star grasses).

If fill material were to extend into adjacent habitats, outside of the restoration template, vegetation smothering could occur, particularly of mSAV. Studies have shown that seagrasses take 3 to 5 years to recover if buried by no more than 3 inches of sediment, although shoal grass could quickly invade buried sites and could outcompete other native species prior to their recovery (USACE and Interagency Coordination Team 2002). However, best management practices would be used during the placement of material to minimize the potential for impacts on sensitive habitats due to misplacement or migration of materials into areas not planned for Project impacts.

Table 6-1: Direct Impacts on Existing Vegetation within Essential Fish Habitat from Construction

Existing or Proposed Scenario	Intertidal Vegetation (acres)	Mangrove Vegetation (acres)	mSAV (acres)[a]
Existing Vegetation	944	197	5,243
Proposed Action	315	47	159

[a] Conversion of mSAV would be limited to areas of shoal and widgeon grasses; turtle, manatee, and star grasses would not be impacted.

The placement of shoreline protection features around New Harbor Island would cause the permanent loss of softbottom habitat, but would convert it to hardbottom substrate for sessile aquatic fauna to colonize and provide a source of prey for managed species. Further, the shoreline protection features would provide long-term benefits by protecting mangrove habitat on New Harbor Island from erosion and loss. However, about 29 acres of mSAV (of the 159 acres identified in Table 6-1) and 116 acres of open water on the leeward side of New Harbor Island would be permanently converted to higher-elevation habitat during marsh fill. While five species of mSAV were documented during surveys of the Project area, only one species (shoal grass*)* was documented at New Harbor Island, and water clarity was lower in New Harbor Island seagrass beds than surrounding areas. Further, only minimal (16.8 percent) mSAV coverage was observed at a single, shallow location during the survey (see Attachment D). In addition, New Harbor Island is subject to erosion and other coastal processes such that, without restoration action, seagrass losses would continue along previously identified trends (see Section 5.1.1). Therefore, while restoration of New Harbor Island would result in minor, long-term and adverse impacts on seagrass and open water EFH types, there would be long-term benefits from the protection of mangrove habitat.

6.1.3. Water Quality

Waterbottom disturbance due to dredging and the placement of fill and other material would result in suspended sediments and increased turbidity, which would also result in minor changes in dissolved oxygen, nutrients, temperature, and salinity in the immediate vicinity of sediment disturbance. The fine fraction of sediments (including silt and clay) has the greatest potential to become suspended in the water column, whereas coarse sediments would fall out of suspension and resettle quickly. The material that would be dredged from the HPBA, and subsequently used for fill, is predominantly sand, with larger, denser particles unlikely to remain suspended in the water column for long periods; therefore, once restoration at a given location is complete, local water turbidity would be expected to quickly return to pre-construction levels.

Increased turbidity and sedimentation from in-water restoration activities would result in indirect impacts on the soft bottom and water column habitat that occurs immediately adjacent to dredging or restoration activities, and the fauna that use them. Because offshore soft bottom habitat is highly variable and experiences frequent natural disturbances, any disturbance to the seafloor environment would have an initial impact, but the affected habitat should recover rapidly by benthic recruitment from the surrounding community (Brooks et al. 2006). In areas of increased turbidity, it is expected that mobile species would be displaced temporarily from the habitat but would return to the area almost immediately following construction. Similarly, the benthic community is expected to recolonize disturbed areas shortly after construction, such that no long-term effects on the community are expected. Therefore, impacts are anticipated to be minor and short-term.

The Chandeleur Sound has seasonal bottom hypoxia (dissolved oxygen levels of 2 milligrams per liter [mg/l] or lower). Although the extent of the hypoxic zone changes based on current conditions (e.g., water temperature, depth, current action), past studies have identified local bottom hypoxia beginning at depths of around 12 to 13 feet (Henkel et. al. 2012). As discussed in Section 5.1.5, the HPBA extends from depths of 12 to 14 feet down to approximately 44 feet, indicating that seasonal bottom hypoxia may be present; however, dredging portions of the HPBA may increase the occurrence of hypoxic conditions based on the final (deeper) depths, as well as from the increased turbidity during active dredging. As discussed in Section 6.1.1, the benthic community recovers over a period of time after dredging concludes; however, if hypoxic conditions are present, recovery rates would likely decrease and ongoing community stress from annual hypoxic conditions may result in changes in species diversity (particularly if dissolved oxygen decreases below 0.5 mg/l) and biomass (Turner 2005). Because the highest point of the HPBA is within the depth range likely to experience seasonal hypoxia, dredging activities are not anticipated to significantly change the existing dissolved oxygen conditions.

Accidental spills of hazardous materials could also occur during construction activities, and potentially adversely affect water quality. Best management practices, including equipment maintenance and implementation of a Spill Prevention, Response, and Reporting Plan, would be implemented to minimize the potential for spills and leaks of hazardous materials to impact habitats. Construction debris would be disposed of properly, and construction activities would comply with applicable permit conditions, including any requirements for the protection of water quality. These measures would limit the potential for water quality impacts on managed species and their prey, including exposure to hazardous materials.

Overall, water quality impacts from sediment disturbance due to dredging and materials placement (including the presence of construction equipment) would be temporary, minor, and consistent with other, similar disturbance events in the Gulf (such as storms or maintenance or borrow dredging activity). Anchors from vessels and equipment operating in nearshore areas could also result in temporary, minor impacts on total suspended sediments and turbidity. Conditions are expected to return to pre-disturbance levels quickly at any single location.

6.1.4. Underwater Noise

Underwater noise associated with vessel traffic, dredging, and pile-driving would temporarily increase sound levels and potentially impact managed species during Project construction. Noise from vessels and dredging is expected to be consistent with other, ongoing vessel activity in the vicinity. Continuous noise from vessel transits and dredging would contribute to the sound levels near the Project, but noise impacts would be intermittent over the construction period and dependent on the specific construction activity.

The greatest potential for impacts from underwater noise would occur during impact pile-driving to install 30 timber piles for rock breakwater warning signs near New Harbor Island, and potentially for submerged pipeline warning markers or submerged spoil markers along the temporary access channels. Impacts from pile-driving would be temporary and limited to the duration of pile installation. While Project construction is underway, it is likely that it would take no more than a day to drive each individual pile, such that the maximum duration of pile-driving is estimated to be about 30 days. Pile-driving would be limited to daylight hours. It is anticipated that managed species would naturally move away from any noise disturbances and avoid any significant, prolonged exposure to harmful noise levels.

Because sound consists of variations in pressure, the unit for measuring sound is referenced to a unit of pressure, the Pascal (Pa). A decibel (dB) is defined as the ratio between the measured sound pressure level (SPL) in microPascals (μPa) and a reference pressure. In water, the reference level is "dB re 1 μPa," which is decibels relative to 1 microPascal. NMFS has developed guidelines for noise thresholds likely to either cause behavioral effects via disturbance or injury via hearing loss to fish, including managed species, as presented in Table 6-2 (NMFS 2023). Because pile-driving for the Project could exceed applicable thresholds for fish, the potential for impacts from impulsive sound due to pile-driving are presented herein.

NMFS has also developed calculation tools to identify the distances at which those thresholds may be exceeded. Table 6-3 summarizes the applicable thresholds and isopleth distances based on the available multi-species acoustic tool (NMFS 2024a). While the specific details of pile-driving are not known, a conservative scenario based on driving 15, 12-inch-diameter timber piles per day using 360 strikes per pile was used to assess potential impacts. As noted above, pile-driving is likely to extend over a longer period, resulting in fewer strikes per day and a smaller region of influence.

Table 6-2: Thresholds for Injury and Behavioral Disturbance from Impulsive Noise and Pile-Driving Sound Levels

Fish Size / Sound Source Level	Permanent Injury Criteria, Peak SPL (dB re 1µPa)	Permanent Injury Criteria, SELcum (dB re 1 µPa^{2}s)	Behavioral Response, RMS SPL (dB re 1µPa)
Fish			
Fish (≥ 2 grams)	206	187	150
Fish (< 2 grams)	206	183	150
Pile-Driving Sound Level			
Source sound level, 12-inch timber pile at 10 m (33 ft)	182	157	167

Source: Caltrans 2020, NMFS 2023, 2024a

dB = decibels; dB re 1 µPa = decibels relative to 1 microPascal; dB re 1 µPa2s = decibels relative to 1 microPascal squared normalized to 1 second; NA = not applicable (source level does not exceed threshold); peak = peak sound pressure, RMS = root mean square; SELcum = cumulative sound exposure level; SPL = sound pressure level.

Table 6-3: Isopleth Distances to Injury and Behavioral Disturbance from Impulsive Noise, Meters (ft)

Fish Size	Permanent Injury Criteria, Peak SPL meters (ft)	Permanent Injury Criteria, SELcum meters (ft)	Behavioral Response, RMS SPL meters (ft)
Fish (≥ 2 grams)	0.3 (0.8)	29.3 (96.1)	135.9 (446.0)
Fish (< 2 grams)	0.3 (0.8)	29.3 (96.1)	135.9 (446.0)

Source: NMFS 2023, 2024b-d

dB = decibels; dB re 1 µPa = decibels relative to 1 microPascal; dB re 1 µPa2s = decibels relative to 1 microPascal squared normalized to 1 second; NA = not applicable (source level does not exceed threshold); peak = peak sound pressure, RMS = root mean square; SELcum = cumulative sound exposure level; SPL = sound pressure level.

6.1.5. Artificial Lighting

Artificial lighting may be required to ensure safe construction of the Project, including during any nighttime construction or vessel operations and to mark the sediment pipeline and construction workspaces in accordance with any United States Coast Guard (USCG) requirements. While Project construction is underway, lighting would be limited to the minimum needed to safely implement the Project, and is expected to be minimal overall. Lighting of surface waters could cause marine organisms that typically use the sun or moonlight as a behavioral cue to locally aggregate, attracting prey and predators; however, the adverse effects of vessel lighting are expected to be minor and short-term.

6.1.6. Vessel Traffic

Any *Sargassum* directly in the path of oncoming support and transport vessels may be submerged to depths under the vessel, and portions of the mat may be destroyed by passage through the propeller. However, smaller mats of *Sargassum* mats may be pushed away from the oncoming vessel due to the pressure of the bow waves and the buoyant nature of the mats. Overall, impacts on *Sargassum* would be short-term, minor, and adverse.

6.1.7. Habitat Benefits

Geologic processes no longer contribute new sediment to the Chandeleur Islands; as such, the islands have experienced accelerating land loss during the last decade, resulting in an average of 31 feet of shoreline change per year, which is 3 times the Louisiana state average (Flocks et al. 2022). These changes are influenced by severe storm events (such as Hurricane Camille and Hurricane Katrina) and exacerbated by sea-level rise and scarcity of sediments to nourish the island chain, resulting in increased erosion and the inability to maintain many island subaerial features (Suir et al. 2016, Suir and Sasser 2019). For example, Hurricane Katrina segmented the island arc into multiple small marsh islets separated by wide hurricane-cut tidal passes, resulting in much less vegetation (mangroves) and elevation (dunes) on the islands that would otherwise impede overwash processes (Miner et al. 2021, Flocks et al. 2022). Over time, this continued land loss could lead to conversion of the islands into shallow sand shoals (Flocks et al. 2022).

The northern islands are more stable due to higher sand content and robust back barrier marshes compared to the southern islands that are sand-starved and lack significant back barrier marshes Miner et al. 2021). Back barrier marshes provide a platform for sand deposition during overwash processes, which prevents submergence during post-storm recovery (SWCA 2023). For instance, the northern expanses are characterized by wide sandy beaches at or near intertidal elevations, but this topography varies along the 14 miles southward extension of North Chandeleur Island as the beaches become narrower with broken vegetated dunes, marshes, and mangrove stands expanding to the western side (Byrnes et al. 2018, Miner et al. 2021). However, as the northern island chain has undergone rapid land loss by thinning and shortening over the past 3 decades, the islands have reached a collapsed stage where sand previously sequestered in beach and dune deposits is increasingly eroded (Miner et al. 2021, Flocks et al. 2022). As such, the largest sediment loss from the barrier island system in the Chandeleur Islands is through sand transport north to Hewes Point from tidal activity (Ellis and Stone 2006, Flocks et al. 2022). Moreover, the New Harbor Island is a small intertidal 35-acre mangrove stand located on the southwest side of the North Chandeleur Island that is exposed to winds and wave action through the Chandeleur Sound, making it vulnerable to complete island submergence.

The past and continuing land loss in the island chain has changed the distribution of EFH, including a decrease in mSAV coverage and quality. By restoring North Chandeleur and New Harbor Islands, and providing shoreline protection and sand resources via several design features, the Project is expected to prolong the existence of essential barrier island habitat, supporting habitat for managed species and their prey, including the mSAV beds. The Project would result in long-term benefits on both terrestrial and aquatic habitats within the Project area by increasing the total quantity of available barrier island habitat and adding longevity to the existing island footprint. In addition, the placement of beach, dune, and marsh fill would increase the elevation of North Chandeleur and New Harbor Islands, reducing the long-term susceptibility of the Project area to habitat loss. Areas of fill would also protect mSAV beds from further loss and erosion, particularly on the northern end of North Chandeleur Island, where approximately 1,350 acres of mSAV beds would experience a decrease in damaging forces (such as wave action), resulting in not only protection from further erosion, but in lower turbidity conditions. The protection and water quality benefits from the Project would result in an increase in mSAV species diversity and percent coverage over time.

Marsh fill would be placed to create new marsh habitat on an existing, sandy intertidal platform that is sparsely vegetated. Vegetation plantings on North Chandeleur and New Harbor Islands would prevent erosion and enhance dune and wetland vegetation. Sand fences (porous barriers designed such that windblown sand accumulates on the fences) would increase sand deposition and associated dune elevations, as well as protect vegetation plantings. These vegetative plantings and sand fences will help control erosion and help to maintain higher elevations and island longevity.

Where proposed, the sand reservoirs would provide sediment supplies as North Chandeleur Island changes over time, and would increase the area of sandy shoreline habitat. Similarly, the pocket marshes would provide a sediment source for future conditions, while increasing the elevation of existing marsh areas with degraded vegetation. The feeder beach would be used to provide an immediate source of sediment, allowing longshore transport to nourish beach sediment over time and sustain existing sandy beach habitat. Under the Proposed Action, habitat creation on North Chandeleur and New Harbor Islands would include up to an estimated 1,841 acres of beach and dune habitat and 740 acres of marsh. Of that, the placement of fill on New Harbor Island would create an estimated 145 acres of marsh; New Harbor Island is currently about 35 acres and dominated by mangroves. Shoreline protection features, including shoreline and a detached rock breakwater, would support habitat longevity on New Harbor Island by reducing potential erosion due to currents and wave action. Although much of the created land may not be at an elevation that is immediately available for use by managed species, as discussed above, it would increase the longevity of the islands, protecting the existing EFH from further degradation and loss.

Table 6-4 below, provides the total acreage of habitat types projected to be present on North Chandeleur Island over a 20-year analysis period based on a modeling analysis, reflecting changes in habitat due to coastal processes such as erosion, sea-level change, subsidence, and overwash that would affect the Project area. While subtidal and intertidal habitats provide EFH for managed species, supratidal and dune habitats restored by the Proposed Action would also influence the longevity of areas of vegetated EFH (including mSAV beds, marsh, and mangroves). The analysis of habitat longevity is based on habitat elevation, rather than vegetation class; however, in general, subtidal and intertidal habitats include sand flats, marsh, and mangroves.

Table 6-4: Habitat Sustainability on North Chandeleur and New Harbor Islands

Modeled Scenario	Target Year[a]	Subtidal Habitat	Intertidal Habitat	Supratidal Habitat	Dune Habitat	Total Acres in the Project Area
		Acres at Elevation -1.5 ft to 0.0 ft	Acres at Elevation 0.0 ft to 2.0 ft	Acres at Elevation 2.0 ft to 5.0 ft	Acres at Elevation > 5.0 ft	
Projected Trend (without restoration)[b]	TY-0	1,596	2,339	966	39	4,941
	TY-5	1,557	2,193	319	0	4,069
	TY-10	1,591	1,615	0	0	3,206
	TY-15	1,469	913	0	0	2,381
	TY-20	1,205	337	0	0	1,543
Proposed Action[b]	TY-0	1,430	1,475	1,805	410	5,120
	TY-5	1,420	1,447	1,539	410	4,816
	TY-10	1,397	1,311	1,929	0	4,637
	TY-15	1,381	1,307	1,739	0	4,427
	TY-20	1,371	1,300	1,565	0	4,235

[a] TY-0 is representative of the expected beach profile and conditions immediately following Project implementation.
[b] Acreages associated with New Harbor Island are excluded from the modeled data.

6.1.8. Prey Species and the Food Web

Prey items for the managed species identified in Table 5-2 vary by group and/or species, as noted in Attachment C. Shrimp primarily prey on planktonic or benthic algae or invertebrates. Red drum, as they grow into juveniles and adults, eat a variety of fish, crab, shrimp, and smaller invertebrates. The identified reef fish eat primarily fish, squid, crab, and shrimp, with the exception of the gray triggerfish, which eats a variety of other benthic invertebrates, including starfish, urchins, and barnacles. The coastal pelagic species each prey on fish, squid, shrimp, and other crustaceans. Most of the managed shark species generally eat fish (including other sharks), cephalopods, and crustaceans, but some (such as the bull shark) will also eat additional species groups such as turtles, rays, and birds. Two exceptions include the whale shark, which is planktivorous, and the bonnethead, which predominantly eats crab (and sometimes seagrass, although this may be incidentally ingested; NMFS 2025, Branham et al. 2022).

As discussed in the above sections, prey for managed species (including managed species that are prey for higher level consumers) can also be affected by habitat modifications, particularly from dredging activities and fill placement, habitat conversion, and habitat restoration. Benthic invertebrates can be crushed or smothered during dredging within the HPBA, as well as where fill material is placed, resulting in a localized decrease in infauna and less mobile epifauna following construction and until the benthic community fully recovers, which may take weeks to years (Wilber et al. 2008, Bolam 2011). Larger epifauna, such as penaeid shrimp and blue crab would likely return from surrounding areas as water quality returns to pre-construction conditions. Seasonal hypoxia occurs in the waters surrounding North Chandeleur Island (in depths of approximately 12 feet or deeper, including the HPBA) and benthic community recovery, as well as the potential for managed species to access benthic prey, would be delayed or precluded during periods of hypoxia.

Benthic producer species and lower trophic level consumer species can live on the shoots of marsh grasses and mSAV. These lower trophic level benthic groups include benthic algae (for example, chlorophytes, cyanophytes, and diatoms), infauna (for example, amphipods, polychaetes, nematodes, and oligochaetes), and epifauna (for example, small clams, snails, and marsh periwinkles). Changes in the distribution and composition of benthic resources have been linked to shifts in food web structure, increases in invasive species, and declines in the abundance of historical fish populations in other major U.S. estuaries (Kimmerer 2002, Kimmerer 2004, Dynamic Solutions 2012, Tango and Batiuk 2016, Kimmerer and Thompson 2014, Adamack et al. 2017). Once the Project is complete, the local food web, particularly those species using or supported by the structured habitat (marsh, mangrove, and mSAV) in the Project area, will have a decreased risk of habitat loss, thereby helping to maintain the existing food web. Further, the Project is anticipated to result in an increase in mSAV density and would increase marsh habitat, both of which would likely increase the biomass of lower level consumers (including shrimp and crab) and result in overall benefits to the food web.

6.1.9. Conclusion

The Proposed Action would result in short-term construction impacts on EFH and managed species, as well as long-term habitat modifications. However, it would also result in the creation of the significant habitat acreage, providing the greatest long-term benefits to aquatic fauna and EFH. The Proposed Action would provide a benefit to those species that depend on marsh habitat, and areas of beach, dune, and marsh fill would protect seagrass beds from further loss and erosion, extending the longevity of available seagrass habitat to support marine fauna, including managed species. Overall, while construction impacts are expected to be short-term, minor to moderate, and adverse, impacts following Project implementation are expected to be long-term and beneficial.

6.2. Cumulative Impacts

Cumulative impacts are the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Past, present, and reasonably foreseeable future actions near the Chandeleur Island Restoration Project were identified to effectively consider the potential cumulative impacts. This list of past, present, and future projects was compiled using Louisiana Department of Energy and Natural Resources, United States Army Corps of Engineers, United States Environmental Protection Agency, National Fish and Wildlife Foundation, United States Fish and Wildlife Service, United States Department of Agriculture, National Oceanic and Atmospheric Administration, and Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies Council websites, reports, and databases and are described in Table 6-5. The Restoration Plan/Environmental Assessment for this Project provides additional detail on identification of actions for consideration in the cumulative impacts analysis, as well as a discussion of impacts on additional resources; however, this EFH

Assessments focuses on the potential cumulative impacts of the proposed Project on EFH and managed species.

Since the past, present, and reasonably foreseeable future actions identified in Table 6-5 are similar in nature or compatible with the proposed Project, the cumulative effects from the proposed Project and the identified actions are expected to result in net cumulative beneficial impacts on EFH. The previously constructed Chandeleur Islands Marsh Restoration project contributed to habitat benefits through vegetation plantings on North Chandeleur Island, which provided secondary benefits to managed species that use marsh. The Emergency Berm project on North Chandeleur increased the available sediment supply on North Chandeleur Island, increasing overall island and habitat longevity and, as a result, protecting mSAV and marsh habitats. Each of these past projects has influenced the baseline EFH conditions in the Project area, which are described further in Section 5.1. The Louisiana Outer Coast Restoration, North Breton Island Early Restoration project provided similar resource benefits as the proposed Project at the southern end of the Chandeleur Island chain through placement of fill material, vegetation plantings, and sand fencing. The proposed dredging of the Gulfport Harbor Federal Navigation Channel includes the possible placement of dredged material off the northeast corner of North Chandeleur Island. Depending upon the properties of this dredged material, such placement could contribute new sediment for island nourishment through littoral transport. While material placement could result in loss or disturbance of some existing softbottom habitat, the material could also further serve to protect and enhance mSAV on the leeward side of North Chandeleur Island from erosion and coastal processes, dependent on placement.

Table 6-5: Project Considered in the Cumulative Impacts Analysis

Category	Project Name	Applicant/ Proponent	Summary	Estimated Timeframe
Future	Maintenance Dredging and Activities for the Gulfport Harbor Federal Navigation Channel	U.S. Army Corps of Engineers (USACE), Mobile District	Continued maintenance dredging and placement for 5 years. Approximately 1.5 to 2.0 MCY of dredged material may be placed at a littoral zone site east of Chandeleur Island a maximum of every 6-10 years.	2024-2029
Past	Chandeleur Islands Marsh Restoration	CWPPRA	Provide stabilization to 364 acres of unvegetated overwash deposits on 22 overwash fan sites through smooth cordgrass (*Sporobolus alterniflorus*) plantings.	2001
Past	Emergency Berms	CPRA	Emergency berm constructed to 6 ft NAVD88 after DWH.	2010
Past	Louisiana Outer Coast Restoration; North Breton Island Early Restoration	LA TIG	From the period of 2020 to 2022 the island was expanded from 290 acres to 426 acres of constructed barrier island habitat, including beaches, dunes, and back barrier marsh through the placement of approximated 6.59 MCY of fill. During construction approximately 14,700 linear ft sand fencing was installed and 66,400 native plants were installed during 2023 to facilitate development of nesting habitat. Additional plantings may be installed after 2024. The Department of the Interior (DOI) is the lead Trustee for the design and construction of this component, working cooperatively with Louisiana and NOAA. DOI began post-construction monitoring in 2022 and would continue monitoring efforts until 2031.	2020-2022

7. CONSERVATION MEASURES

The following conservation measures would be implemented for dredging and material placement, as well as vessel operations and the operation of equipment during Project implementation.

- To minimize the risk to protected species during operation of cutterhead dredges, and in accordance with the measures in the PDARP/PEIS, pumps would be disengaged when the cutterhead is not in the substrate, and operators would avoid pumping water from the bottom of the water column.
- Best management practices would be used during the placement of material to minimize the potential for impacts on sensitive habitats due to misplacement or migration of materials into areas not planned for Project impacts.

- Best management practices, including equipment maintenance and implementation of a Spill Prevention, Response, and Reporting Plan, would be implemented to minimize the potential for spills and leaks of hazardous materials to impact habitats.
- Construction debris would be disposed of properly, and construction activities would comply with applicable permit conditions, including any requirements for the protection of water quality.
- Consideration of sensitive and higher-quality habitat during design of the restoration template, to minimize impacts while maximizing long-term benefits to species and habitats.
- To minimize impacts on mSAV all access corridors and placement areas have been located in areas that will avoid impacts on sensitive mSAV species such as turtle grass, manatee grass, and star grass.
- If subsidence occurs within the breakwaters around New Harbor Island over time, CPRA will consider adding fish dips to the breakwater as an adaptive management strategy, which will be designed in accordance with NMFS coordination and recommendations.

8. SUMMARY OF EFFECTS

The Proposed Action would result in predominantly short-term, minor, and adverse impacts on EFH through construction activities associated with dredging and fill placement, with some long-term, minor, adverse impacts from permanent fill and conversion of limited habitat to either another EFH type or supratidal habitats that would ultimately result in the long-term protection of EFH habitats through increased island longevity. Similarly, predominantly short-term, minor, adverse effects on managed species and their prey would occur from dredging activities (including changes in water quality from increased turbidity), the presence and operation of construction equipment and vessels, and underwater noise from pile-driving. Long-term impacts on managed species and their prey may also occur from habitat fill as they relocate to adjacent habitats. However, overall, the Project would result in a significant increase in island longevity, which would result in long-term benefits on both EFH and managed species from the maintenance of higher-elevation areas that would protect vegetated EFH types. Table 8-1 summarizes the impacts of the Proposed Action, and compares the projected impacts on EFH if no intervention on habitat loss occurs. The Project is proposed to move forward based on benefits anticipated to all species and habitats (including managed species and EFH), but also due to specific benefits to species protected under the Endangered Species Act (specifically sea turtles and birds).

Table 8-1: Summary of Essential Fish Habitat Impacts

Type of Habitat	Projected Impacts	
	Proposed Action	Without Restoration
mSAV	Short-term to long-term, minor (159 acres), adverse impacts from temporary or permanent fill during construction; long-term beneficial impacts from plantings, and increased island longevity (4,235 acres of total habitat between -1.5 and >5.0 ft) 20 years (TY-20) after restoration is complete. It is anticipated that 1,350 acres of existing mSAV will be enhanced via species diversity increase and percent cover increase.	No initial impact, but major, long-term, adverse impacts from habitat loss and degradation, with 1,543 acres of total habitat at TY-20.
Sargassum	Potential short-term, minor, adverse disruptions from vessel traffic.	No impact.
Emergent Marshes/ Mangroves	Short-term to long-term, minor (362 acres), adverse impacts from temporary or permanent fill during construction; long-term beneficial impacts from plantings and increased island longevity after restoration is complete.	No initial impact, but major, long-term, adverse impacts from habitat loss and degradation.
Soft Bottom	Short-term, minor, adverse impacts from dredging and fill activities during construction. Long-term beneficial impact from conversion of softbottom to hardbottom within the footprint of the New Harbor Island breakwaters.	No impact.
Water Column	Short-term, minor, adverse impacts from dredging and fill activities during construction. Long-term beneficial impact from conversion of softbottom to hardbottom within the footprint of the New Harbor Island breakwaters.	No impact.

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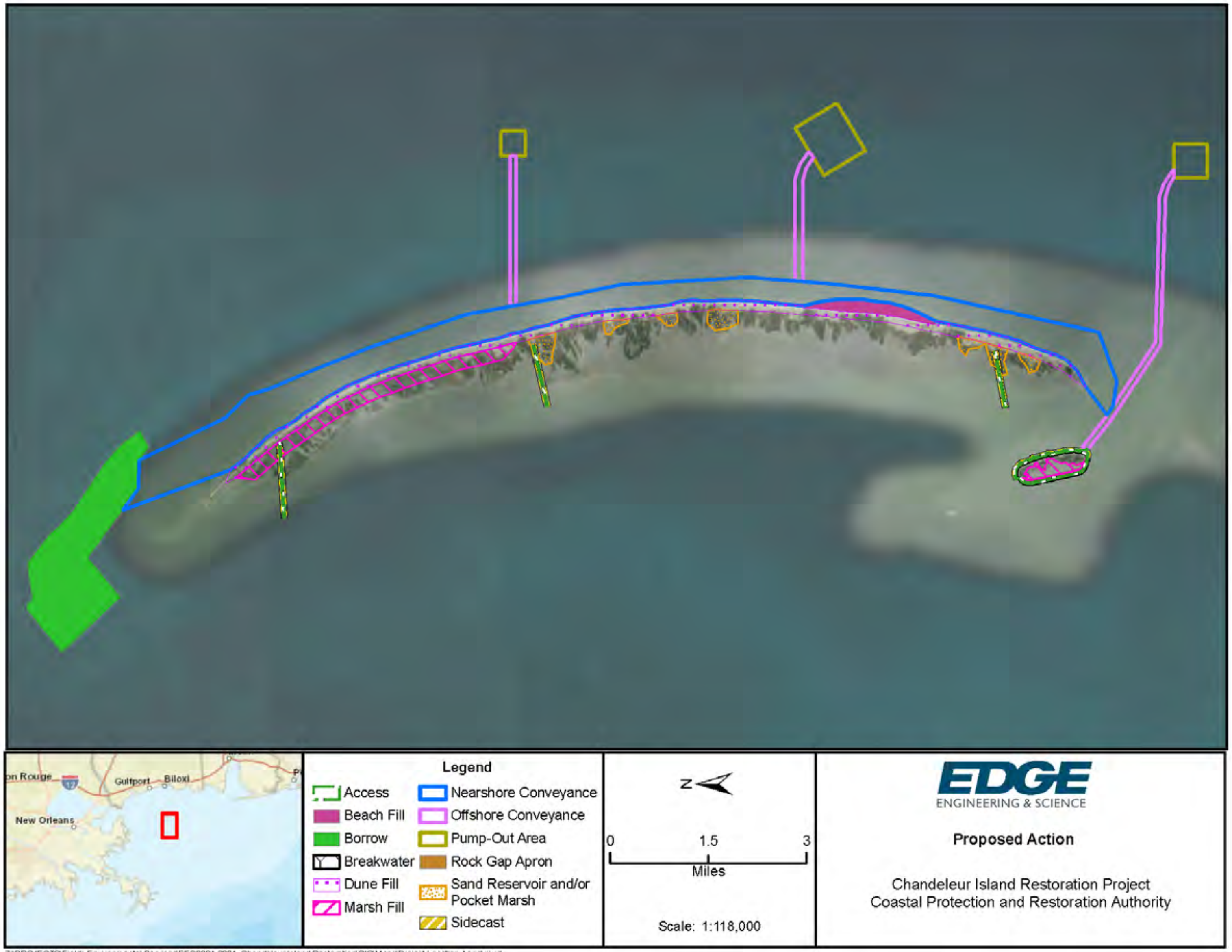
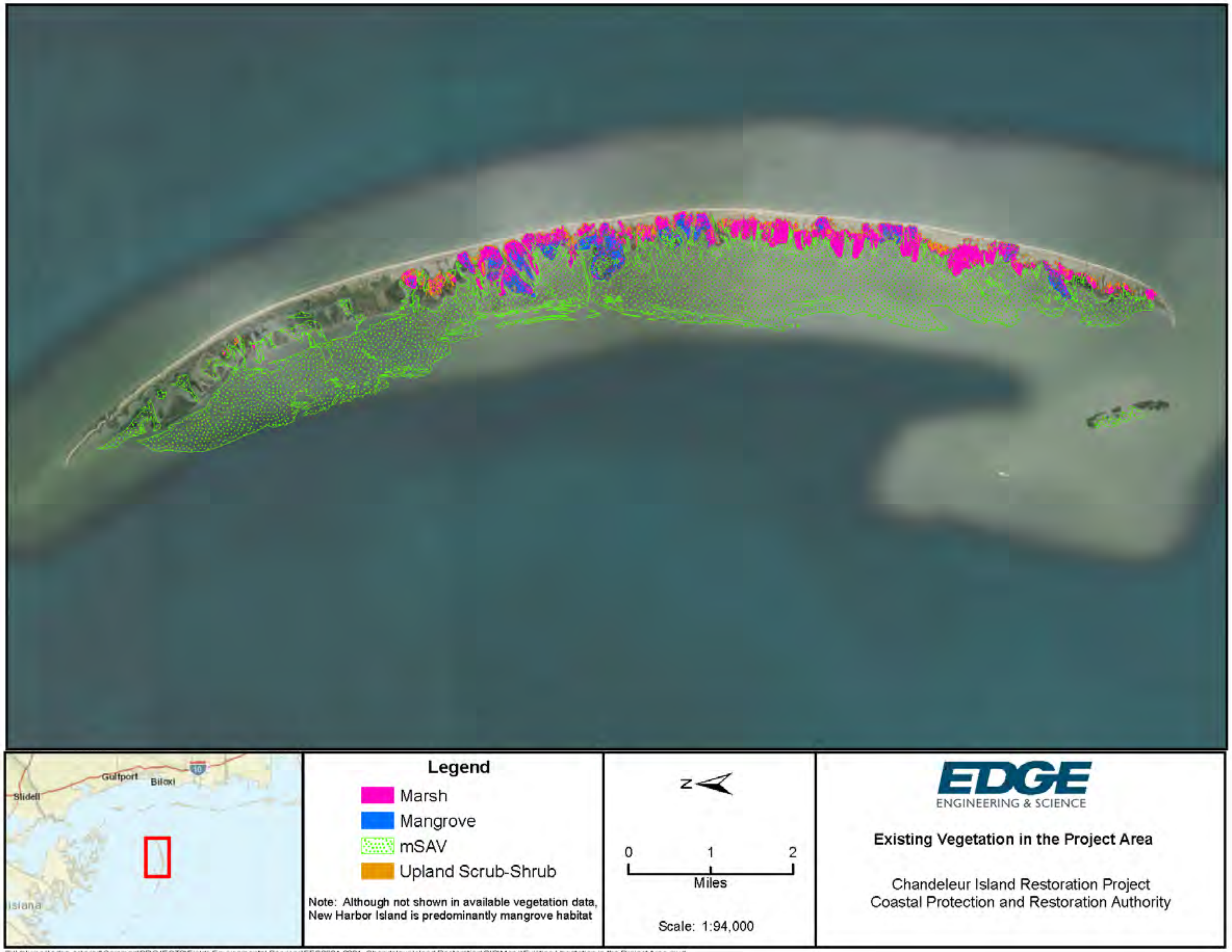
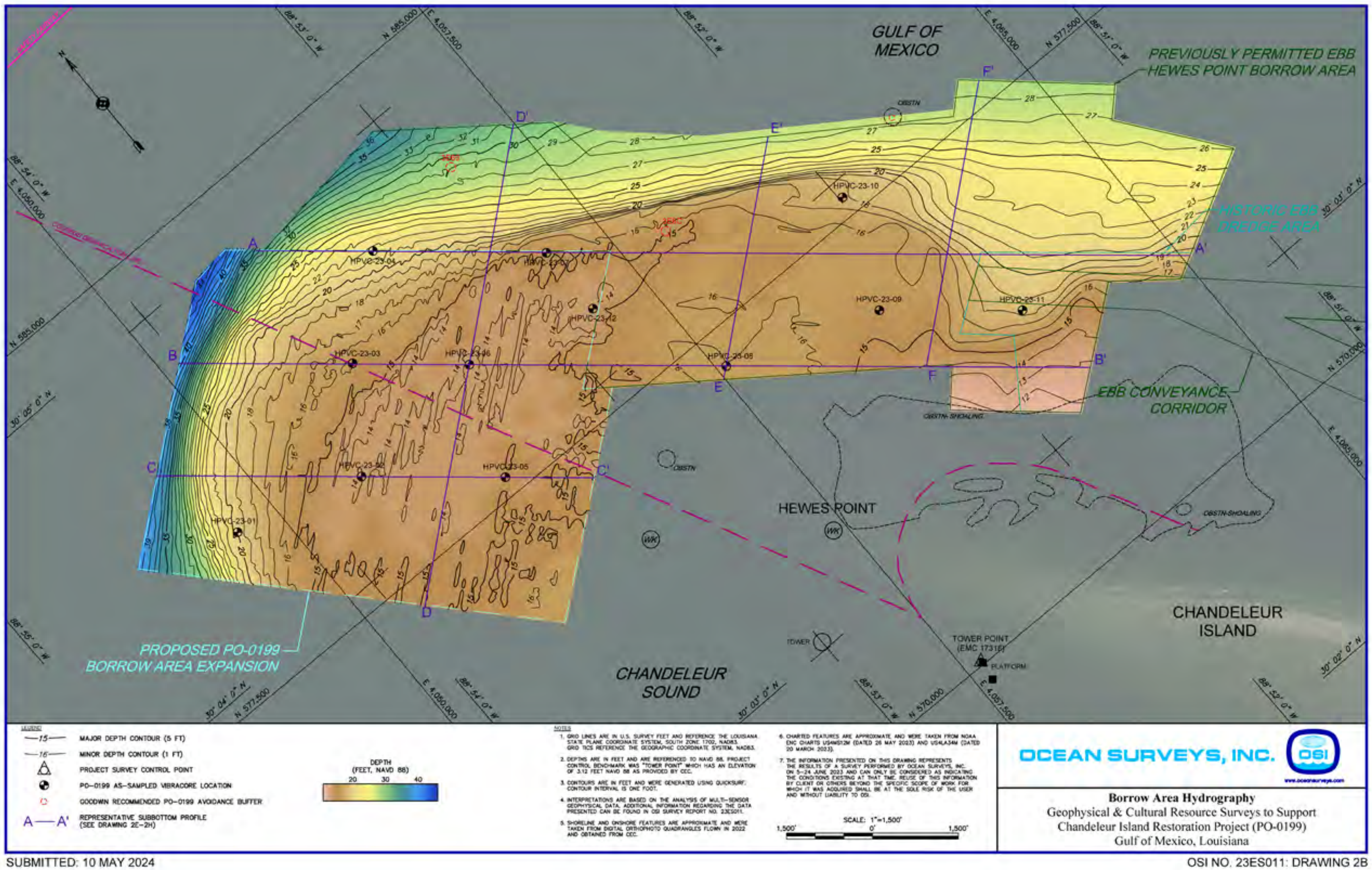
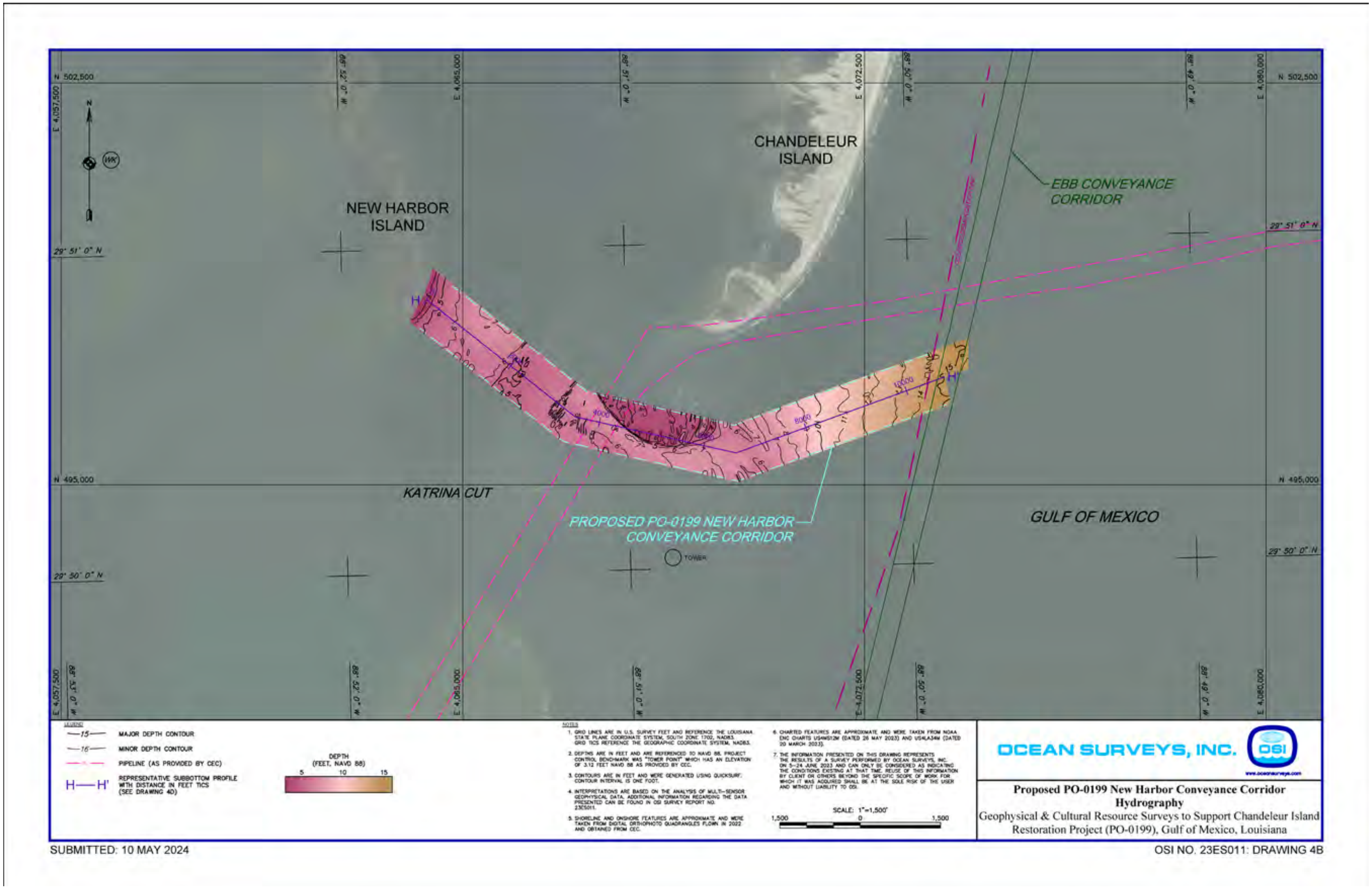
Attachment A
Figures


on Rouge
Gulfport
Biloxi
New Orleans
Legend
Access
Beach Fill
Borrow
Breakwater
Dune Fill
Marsh Fill
Nearshore Conveyance
Offshore Conveyance
Pump-Out Area
Rock Gap Apron
Sand Reservoir and/or Pocket Marsh
Sidecast
N
0
1.5
3
Miles
Scale: 1:118,000
EDGE
ENGINEERING & SCIENCE
Proposed Action
Chandeleur Island Restoration Project
Coastal Protection and Restoration Authority
Z:\PROJECTS\Fields Environmental Services\FEC2024-0001_Chandeleur Island Restoration\GIS\Maps\Project Location Aerial.mxd


Gulfport
Biloxi
Slidell
10
Legend
Marsh
Mangrove
mSAV
Upland Scrub-Shrub
Note: Although not shown in available vegetation data, New Harbor Island is predominantly mangrove habitat
N
0
1
2
Miles
Scale: 1:94,000
EDGE
ENGINEERING & SCIENCE
Existing Vegetation in the Project Area
Chandeleur Island Restoration Project
Coastal Protection and Restoration Authority


GULF OF MEXICO
PREVIOUSLY PERMITTED EBB HEWES POINT BORROW AREA
HISTORIC EBB DREDGE AREA
EBB CONVEYANCE CORRIDOR
HEWES POINT
CHANDELEUR ISLAND
CHANDELEUR SOUND
PROPOSED PO-0199 BORROW AREA EXPANSION
TOWER POINT (EMC 17316)
PLATFORM
HPVC-23-01
HPVC-23-02
HPVC-23-03
HPVC-23-04
HPVC-23-05
HPVC-23-06
HPVC-23-08
HPVC-23-09
HPVC-23-10
HPVC-23-11
HPVC-23-12
LEGEND
MAJOR DEPTH CONTOUR (5 FT)
MINOR DEPTH CONTOUR (1 FT)
PROJECT SURVEY CONTROL POINT
PO-0199 AS-SAMPLED VIBRACORE LOCATION
GOODWIN RECOMMENDED PO-0199 AVOIDANCE BUFFER
REPRESENTATIVE SUBBOTTOM PROFILE (SEE DRAWING 2E-2H)
DEPTH (FEET, NAVD 88)
20 30 40
NOTES
1. GRID LINES ARE IN U.S. SURVEY FEET AND REFERENCE THE LOUISIANA STATE PLANE COORDINATE SYSTEM, SOUTH ZONE 1702, NAD83. GRID TICS REFERENCE THE GEOGRAPHIC COORDINATE SYSTEM, NAD83.
2. DEPTHS ARE IN FEET AND ARE REFERENCED TO NAVD 88. PROJECT CONTROL BENCHMARK WAS "TOWER POINT" WHICH HAS AN ELEVATION OF 3.12 FEET NAVD 88 AS PROVIDED BY CEC.
3. CONTOURS ARE IN FEET AND WERE GENERATED USING QUICKSURF. CONTOUR INTERVAL IS ONE FOOT.
4. INTERPRETATIONS ARE BASED ON THE ANALYSIS OF MULTI-SENSOR GEOPHYSICAL DATA. ADDITIONAL INFORMATION REGARDING THE DATA PRESENTED CAN BE FOUND IN OSI SURVEY REPORT NO. 23ES011.
5. SHORELINE AND ONSHORE FEATURES ARE APPROXIMATE AND WERE TAKEN FROM DIGITAL ORTHOPHOTO QUADRANGLES FLOWN IN 2022 AND OBTAINED FROM CEC.
6. CHARTED FEATURES ARE APPROXIMATE AND WERE TAKEN FROM NOAA ENC CHARTS US4MS12M (DATED 26 MAY 2023) AND US4LA34M (DATED 20 MARCH 2023).
7. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 5-24 JUNE 2023 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.
SCALE: 1"=1,500'
OCEAN SURVEYS, INC.
Borrow Area Hydrography
Geophysical & Cultural Resource Surveys to Support
Chandeleur Island Restoration Project (PO-0199)
Gulf of Mexico, Louisiana
SUBMITTED: 10 MAY 2024
OSI NO. 23ES011: DRAWING 2B

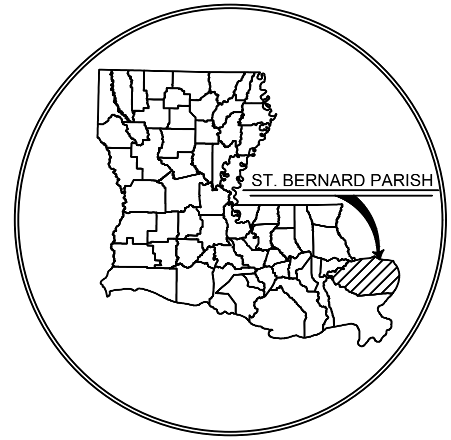

CHANDELEUR ISLAND
NEW HARBOR ISLAND
EBB CONVEYANCE CORRIDOR
KATRINA CUT
PROPOSED PO-0199 NEW HARBOR CONVEYANCE CORRIDOR
GULF OF MEXICO
TOWER
N 502,500
N 495,000
29° 51' 0" N
29° 50' 0" N
LEGEND
MAJOR DEPTH CONTOUR
MINOR DEPTH CONTOUR
PIPELINE (AS PROVIDED BY CEC)
REPRESENTATIVE SUBBOTTOM PROFILE WITH DISTANCE IN FEET TICS (SEE DRAWING 4D)
DEPTH (FEET, NAVD 88)
NOTES
1. GRID LINES ARE IN U.S. SURVEY FEET AND REFERENCE THE LOUISIANA STATE PLANE COORDINATE SYSTEM, SOUTH ZONE 1702, NAD83. GRID TICS REFERENCE THE GEOGRAPHIC COORDINATE SYSTEM, NAD83.
2. DEPTHS ARE IN FEET AND ARE REFERENCED TO NAVD 88. PROJECT CONTROL BENCHMARK WAS "TOWER POINT" WHICH HAS AN ELEVATION OF 3.12 FEET NAVD 88 AS PROVIDED BY CEC.
3. CONTOURS ARE IN FEET AND WERE GENERATED USING QUICKSURF. CONTOUR INTERVAL IS ONE FOOT.
4. INTERPRETATIONS ARE BASED ON THE ANALYSIS OF MULTI-SENSOR GEOPHYSICAL DATA. ADDITIONAL INFORMATION REGARDING THE DATA PRESENTED CAN BE FOUND IN OSI SURVEY REPORT NO. 23ES011.
5. SHORELINE AND ONSHORE FEATURES ARE APPROXIMATE AND WERE TAKEN FROM DIGITAL ORTHOPHOTO QUADRANGLES FLOWN IN 2022 AND OBTAINED FROM CEC.
6. CHARTED FEATURES ARE APPROXIMATE AND WERE TAKEN FROM NOAA ENC CHARTS US4MS12M (DATED 26 MAY 2023) AND US4LA34M (DATED 20 MARCH 2023).
7. THE INFORMATION PRESENTED ON THIS DRAWING REPRESENTS THE RESULTS OF A SURVEY PERFORMED BY OCEAN SURVEYS, INC. ON 5-24 JUNE 2023 AND CAN ONLY BE CONSIDERED AS INDICATING THE CONDITIONS EXISTING AT THAT TIME. REUSE OF THIS INFORMATION BY CLIENT OR OTHERS BEYOND THE SPECIFIC SCOPE OF WORK FOR WHICH IT WAS ACQUIRED SHALL BE AT THE SOLE RISK OF THE USER AND WITHOUT LIABILITY TO OSI.
SCALE: 1"=1,500'
OCEAN SURVEYS, INC.
Proposed PO-0199 New Harbor Conveyance Corridor
Hydrography
Geophysical & Cultural Resource Surveys to Support Chandeleur Island Restoration Project (PO-0199), Gulf of Mexico, Louisiana
SUBMITTED: 10 MAY 2024
OSI NO. 23ES011: DRAWING 4B

Attachment B
Engineering Drawings

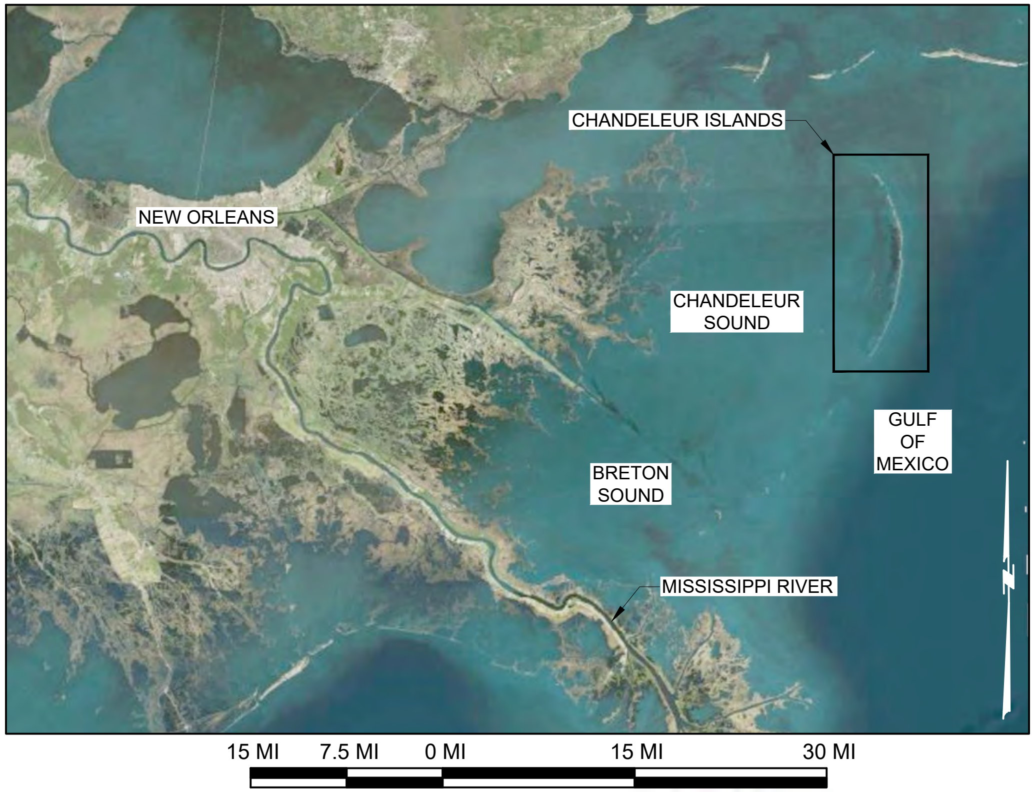
STATE OF LOUISIANA
COASTAL PROTECTION AND RESTORATION AUTHORITY

CHANDELEUR ISLAND RESTORATION PROJECT
STATE PROJECT NO. PO-0199

ST. BERNARD PARISH, LOUISIANA



INDEX TO SHEETS



NOTES:
1. FOR PERMITTING PURPOSES ONLY. NOT TO BE USED FOR CONSTRUCTION.
2. RETAIN ENTIRE SET AS ONE, INDIVIDUAL SHEETS SHOULD NOT BE REMOVED.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

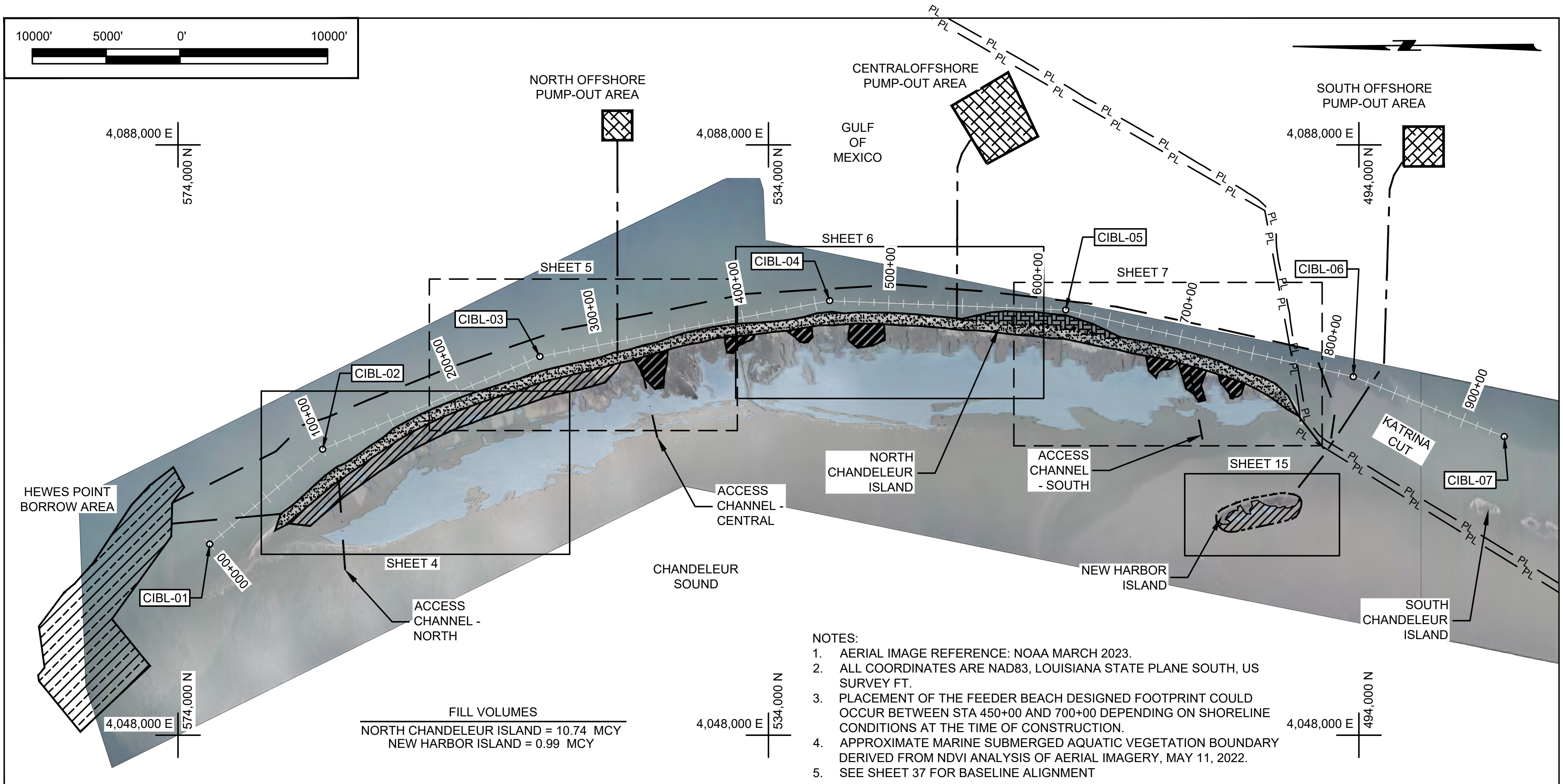
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

TITLE SHEET

DATE: NOVEMBER 2024

SHEET 1 OF 40



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. PLACEMENT OF THE FEEDER BEACH DESIGNED FOOTPRINT COULD OCCUR BETWEEN STA 450+00 AND 700+00 DEPENDING ON SHORELINE CONDITIONS AT THE TIME OF CONSTRUCTION.
4. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
5. SEE SHEET 37 FOR BASELINE ALIGNMENT

LEGEND

- BEACH/DUNE FILL AREA
- FEEDER BEACH FILL AREA
- MARSH FILL AREA
- BORROW AREA LIMITS
- SHORELINE BREAKWATER
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- SAND RESERVOIR FILL AREA
- PUMP-OUT AREA LIMITS
- DETACHED BREAKWATER
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- 100+00 FILL AREA BASELINE
- ACCESS CHANNEL ALIGNMENT
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- PL PIPELINE
- CIBL-01 BASELINE ALIGNMENT COORDINATE

BY	DESCRIPTION	DATE

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APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

PROJECT OVERVIEW

DATE: NOVEMBER 2024

SHEET 2 OF 40

GENERAL NOTES:

1. ANY EXCAVATED MATERIAL WILL BE, TO THE BEST OF KNOWLEDGE, FREE OF CONTAMINANTS AND/OR WILL BE DISPOSED OF IN AN APPROVED LANDFILL.
2. THE CONTRACTOR SHALL BECOME FAMILIAR WITH THE SITE, CONSTRUCTION PLANS, AND CONTRACT DOCUMENTS AND SHALL CONDUCT WORK IN STRICT ACCORDANCE WITH ALL PERMITS AND APPROVALS OBTAINED FOR THIS PROJECT. THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY ERRORS OR DISCREPANCIES IN THE PLANS PRIOR TO BIDDING.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING LOUISIANA ONE CALL SYSTEM (1-800-272-3020) A MINIMUM OF 48 HOURS PRIOR TO THE COMMENCEMENT OF ANY EXCAVATION (DIGGING, DREDGING, JETTING, ETC.) OR DEMOLITION ACTIVITY. THE CONTRACTOR SHALL ALSO NOTIFY PIPELINE AND UTILITY OPERATORS 72 HOURS PRIOR TO ANY EXCAVATION. ALL PIPELINES AND UNDERGROUND UTILITIES SHALL BE FIELD LOCATED AND MARKED.
4. THE CONTRACTOR SHALL WORK COOPERATIVELY WITH THE OWNER TO ADDRESS THE NOTIFICATION AND COORDINATION REQUIREMENTS WITH THE LANDOWNERS, UTILITY OPERATORS, AND PIPELINE COMPANIES.
5. THE WATER BOTTOM SHALL NOT BE DISTURBED DURING ACCESS TO THE PROPOSED WORK LOCATION, OR BY THE AUTHORIZED ACTIVITIES WHETHER IT BE BY DREDGING, WHEEL WASHING , PROPWASHING, JETTING, MUCKING, PLOWING, BULL DOZING OR ANY MEANS OF MOVING BOTTOM MATERIAL, EXCEPT AS DEPICTED ON THE PERMIT SHEETS. POWERED VESSELS SHALL BE OPERATED SO AS NOT TO DISTURB THE WATER BOTTOM OR SEAGRASS BEDS BY PROPELLER OR JET ACTION.
6. ALL LOGS, STUMPS, AND OTHER DEBRIS UNEARTHED DURING DREDGING SHALL BE REMOVED TO AN APPROVED OFFSITE DISPOSAL AREA.
7. THE CONTRACTOR MUST INSTALL AND MAINTAIN ANY SAFETY LIGHTS, SIGNS, AND SIGNALS PRESCRIBED BY THE U.S. COAST GUARD, THROUGH REGULATIONS OR OTHERWISE ON THE AUTHORIZED FACILITIES.
8. ANY DAMAGE TO EXISTING U.S. COAST GUARD (USCG) NAVIGATION AIDS OR PRIVATE NAVIGATION AIDS SHALL BE REPAIRED BY THE CONTRACTOR TO U.S. COAST GUARD STANDARDS AT THE EXPENSE OF THE CONTRACTOR.
9. SEDIMENT PIPELINES IN OPEN WATER AND/OR NAVIGABLE WATERS SHALL BE MARKED WITH BUOYS BY THE CONTRACTOR IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS AND USCG REGULATIONS. THE CONTRACTOR SHALL MAINTAIN BUOYS DURING CONSTRUCTION OR HAVE ADEQUATE NAVIGATIONAL EQUIPMENT ON THE DREDGE TO AVOID DREDGING IN RESTRICTED AREAS.
10. THE PROPOSED PROJECT AND ANY FUTURE MAINTENANCE WORK INVOLVING THE USE OF FLOATING CONSTRUCTION EQUIPMENT (BARGE MOUNTED CRANES, BARGE MOUNTED PILE DRIVING EQUIPMENT, FLOATING DREDGE EQUIPMENT, DREDGE DISCHARGE PIPELINES, ETC.) IN FEDERAL WATERS, SHALL NOTIFY THE USCG SO THAT A NOTICE TO MARINERS, IF REQUIRED, MAY BE PREPARED. NOTIFICATION, WITH A COPY OF THE PERMIT APPROVAL AND DRAWINGS, SHALL BE MAILED TO THE USCG, SECTOR NEW ORLEANS COMMAND CENTER, 201 HAMMOND HIGHWAY, METAIRIE, LOUISIANA 70005, 30 DAYS BEFORE COMMENCEMENT OF WORK.
11. THE OFFSHORE WORK AREAS SHALL CONSIST OF THE BORROW AREA, PUMP-OUT AREAS, AND CONVEYANCE CORRIDORS. THE INSHORE WORK AREA IS DEFINED BY A 50-FOOT OFFSET FROM THE OUTER LIMITS OF THE ACCESS CHANNELS AND TEMPORARY SIDECAST DISPOSAL AREAS, 200-FOOT OFFSET FROM THE TOE OF THE HYDRAULIC FILL TEMPLATE, AND 100-FOOT OFFSET FROM THE TOE OF ROCK STRUCTURES. THE CONTRACTOR SHALL BE REQUIRED TO CONFINE HIS/HER PLANT, EQUIPMENT, AND OPERATIONS OF PERSONNEL WITHIN THE LIMITS OF THE WORK AREA, AREAS PERMITTED BY LAW, ORDINANCES, PERMITS, AND THE REQUIREMENTS OF THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL NOT UNREASONABLY ENCUMBER THE PREMISES WITH PLANT OR EQUIPMENT.
12. THE CONTRACTOR SHALL FOLLOW CONVEYANCE CORRIDORS, ACCESS CHANNELS, AND / OR FILL TEMPLATES, AND SHALL NOT, AT ANY TIME, TRAVEL ON EXISTING MARSH, VEGETATED WETLANDS, OR SEAGRASS BEDS UNLESS SPECIFIED IN THE PERMIT OR THROUGH WRITTEN DIRECTION FROM ENGINEER.
13. THE CONTRACTOR SHALL ABIDE BY ALL ECOLOGICAL AND ENVIRONMENTAL BEST MANAGEMENT PRACTICES DEFINED IN THE PERMITS, FEDERAL AND STATE REGULATIONS, AND THE CONSTRUCTION DOCUMENTS.
14. AS-BUILT DRAWINGS AND/OR PLATS SHALL HAVE WRITTEN ON THEM THE DATE OF COMPLETION OF SAID ACTIVITIES AND SHALL BE SUBMITTED TO THE LOUISIANA DEPARTMENT OF NATURAL RESOURCES, OFFICE OF COASTAL MANAGEMENT, P.O. BOX 44487, BATON ROUGE, LA 70804-4487.
15. THIS DRAWING SET IS FOR PERMITTING PURPOSES ONLY AND IS NOT TO BE USED FOR CONSTRUCTION.

SURVEY NOTES:

1. ALL COORDINATES ARE NORTH AMERICAN DATUM OF 1983 (NAD 83 - GEOID18), LOUISIANA STATE PLANE, SOUTHERN ZONE, U.S. SURVEY FEET. ALL PROJECT COORDINATES AND ELEVATIONS ARE BASED ON NATIONAL GEODETIC SURVEY AND LOUISIANA DEPARTMENT OF NATURAL RESOURCES MONUMENTS.

MONUMENTS	ELEVATION	NORTHING	EASTING
CI-0178B	3.872'	505,754.39	4,072,974.00
CI-BM2	3.109'	536,344.97	4,074,755.33

2. ALL ELEVATIONS ARE IN NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88 - 2004.65), U.S. SURVEY FEET UNLESS OTHERWISE SPECIFIED.
3. HEWES POINT BORROW AREA, NORTH OFFSHORE PUMP-OUT AREA AND CONVEYANCE CORRIDOR, AND NEW HARBOR ISLAND EXTENSION OF THE NEARSHORE CONVEYANCE CORRIDOR SURVEYS PERFORMED BY OCEAN SURVEYS, INC. (OSI) FROM JUNE 5 - 24, 2023. NEARSHORE CONVEYANCE CORRIDOR AND THE CENTRAL AND SOUTH OFFSHORE PUMP-OUT AREAS AND CONVEYANCE CORRIDORS SURVEYS PERFORMED BY TIDEWATER ATLANTIC RESEARCH, INC. (TAR) FROM MAY 31 - SEPTEMBER 14, 2010.
4. HEWES POINT BORROW AREA AVOIDANCE AREAS RECOMMENDED BY GOODWIN AND ASSOCIATES (GOODWIN), 2023. NEARSHORE CONVEYANCE CORRIDOR AVOIDANCE AREAS RECOMMENDED BY TAR 2011. HEWES POINT BORROW AREA GEOTECHNICAL INVESTIGATIONS PERFORMED BY ATHENA TECHNOLOGIES, INC. (ATHENA) ON OCTOBER 6, 2023.
5. CHANDELEUR AND NEW HARBOR ISLAND TOPOGRAPHIC AND BATHYMETRIC SURVEYS PERFORMED BY EMC, INC. FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
6. OIL/GAS PIPELINE INFORMATION OBTAINED FROM THE BUREAU OF OCEAN ENERGY MANAGEMENT (HTTPS://WWW.DATA.BOEM.GOV).
7. INFORMATION SHOWN HERE IN REFLECTS CONDITIONS AS THEY EXISTED ON THE SURVEY DATE SHOWN AND CAN ONLY BE CONSIDERED INDICATIVE OF CONDITIONS AT THAT TIME.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

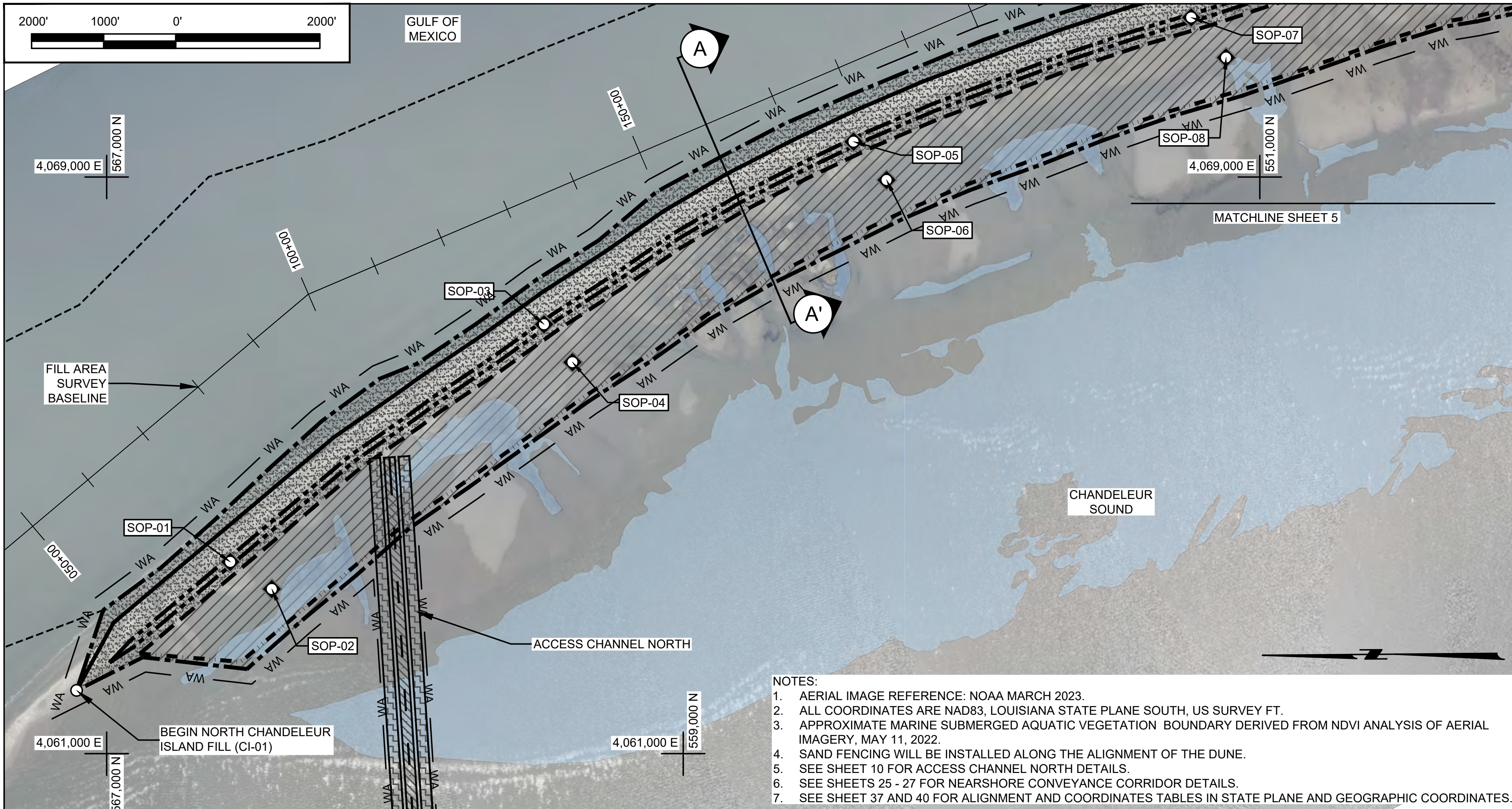
CHANDELEUR ISLAND RESTORATION PROJECT

GENERAL AND SURVEY NOTES

STATE PROJECT NUMBER: PO-0199

DATE: NOVEMBER 2024

FEDERAL PROJECT NUMBER:



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
4. SAND FENCING WILL BE INSTALLED ALONG THE ALIGNMENT OF THE DUNE.
5. SEE SHEET 10 FOR ACCESS CHANNEL NORTH DETAILS.
6. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 37 AND 40 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- BEACH FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/MARSH INTERFACE
- BEACH/DUNE FILL
- MARSH FILL
- WA — WORK AREA
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- SETTLEMENT AND OVERWASH MONITORING SYSTEM
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- 100+00 FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

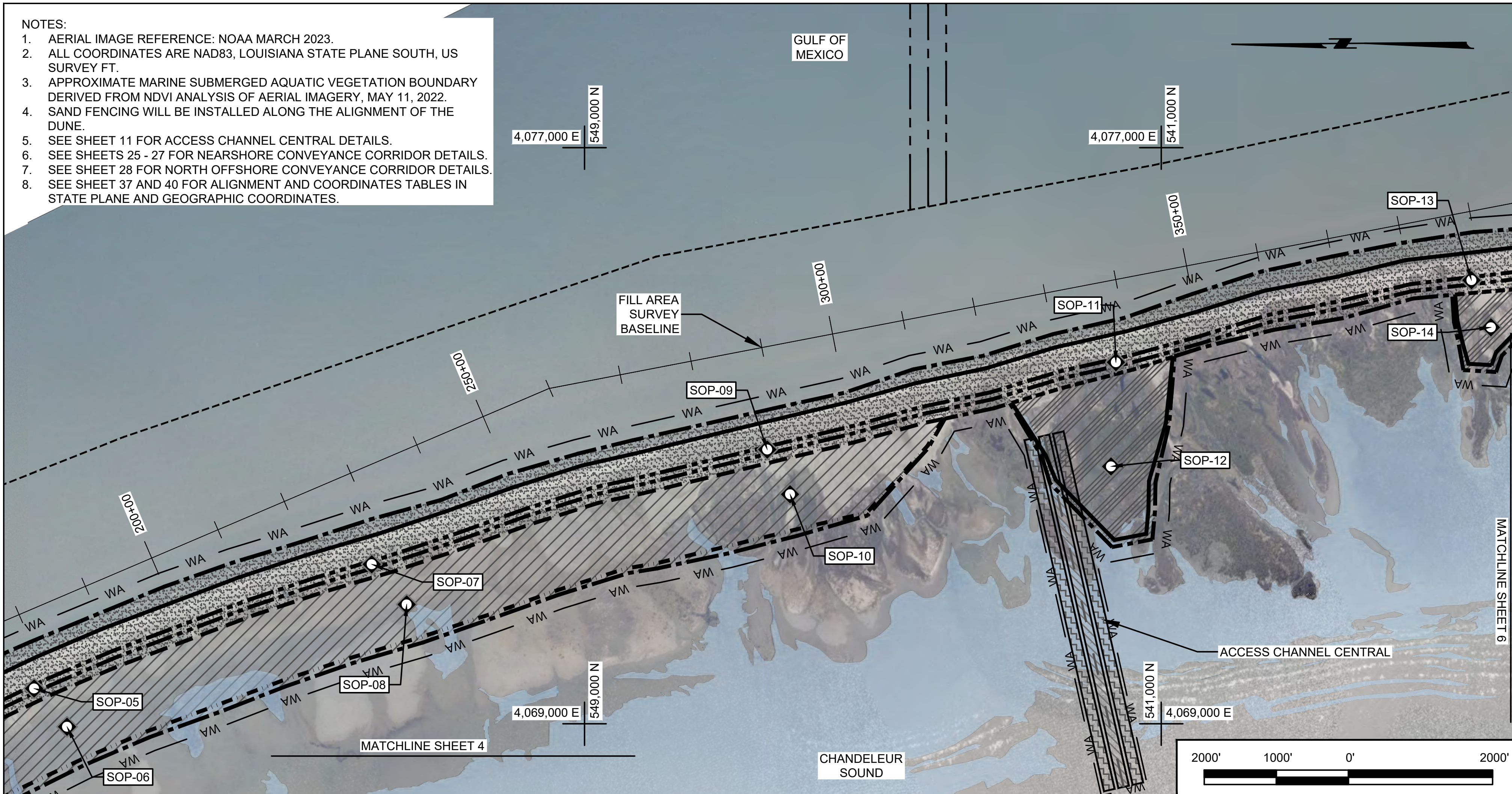
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NORTH CHANDELEUR ISLAND RESTORATION AREA PLAN VIEW

DATE: NOVEMBER 2024

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
4. SAND FENCING WILL BE INSTALLED ALONG THE ALIGNMENT OF THE DUNE.
5. SEE SHEET 11 FOR ACCESS CHANNEL CENTRAL DETAILS.
6. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 28 FOR NORTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 37 AND 40 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.



LEGEND

	FILL EXTENTS
	BEACH/SAND RESERVOIR FILL CREST
	DUNE FILL CREST
	MARSH FILL CREST
	DUNE/MARSH INTERFACE
	DUNE/SAND RESERVOIR INTERFACE
	BEACH/DUNE FILL
	MARSH FILL
	SAND RESERVOIR FILL
WA	WORK AREA
	ACCESS CHANNEL
	TEMPORARY SIDECAST DISPOSAL
	NEARSHORE CONVEYANCE CORRIDOR LIMITS
	OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
	SETTLEMENT AND OVERWASH MONITORING SYSTEM
	APPROX. MARINE SUBMERGED AQUATIC VEGETATION
100+00	FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
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150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

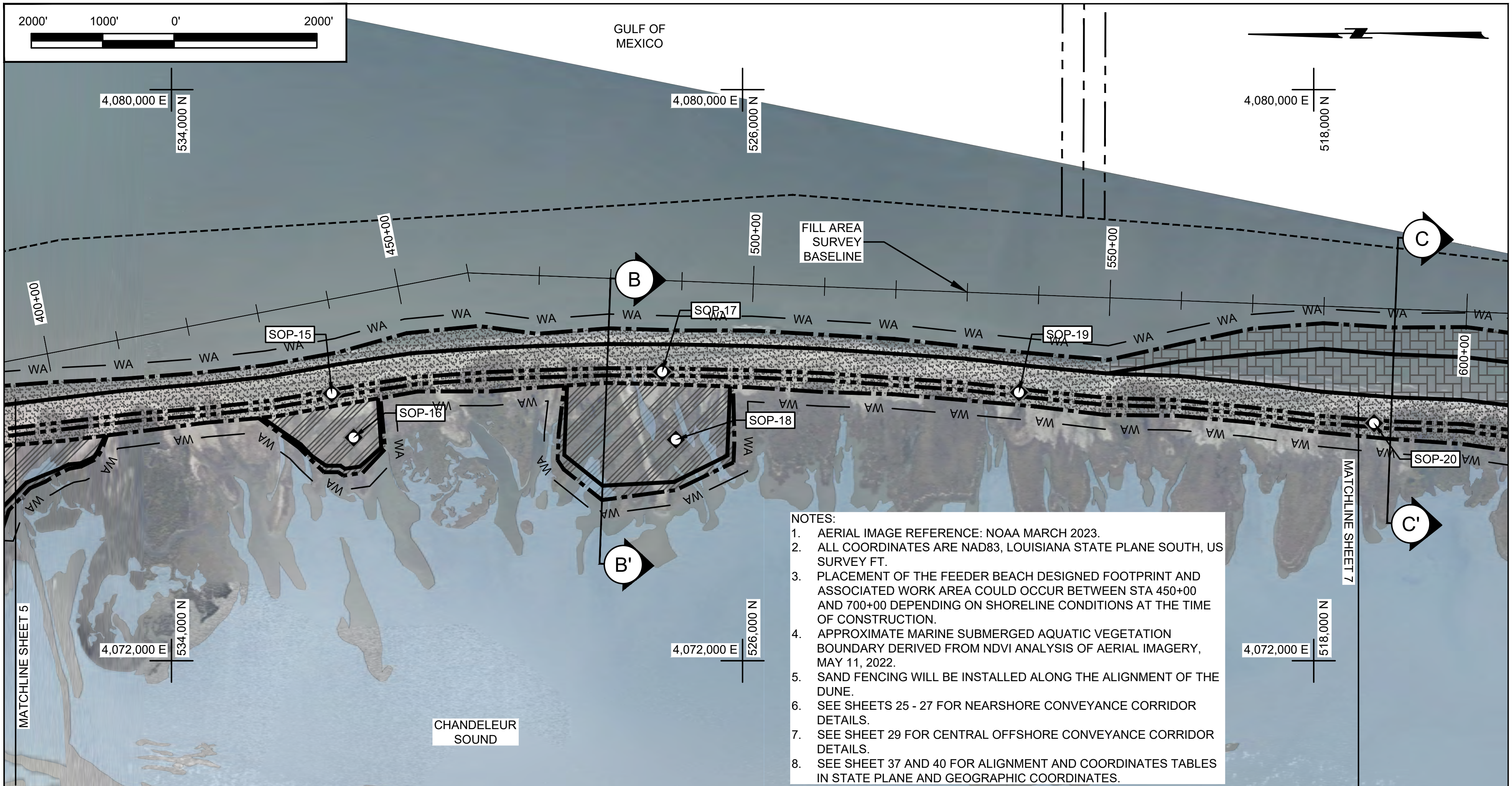
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NORTH CHANDELEUR ISLAND RESTORATION AREA PLAN VIEW

DATE: NOVEMBER 2024



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. PLACEMENT OF THE FEEDER BEACH DESIGNED FOOTPRINT AND ASSOCIATED WORK AREA COULD OCCUR BETWEEN STA 450+00 AND 700+00 DEPENDING ON SHORELINE CONDITIONS AT THE TIME OF CONSTRUCTION.
4. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
5. SAND FENCING WILL BE INSTALLED ALONG THE ALIGNMENT OF THE DUNE.
6. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 29 FOR CENTRAL OFFSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 37 AND 40 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- BEACH/SAND RESERVOIR FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/SAND RESERVOIR INTERFACE
- BEACH/DUNE FILL
- SAND RESERVOIR FILL
- FEEDER BEACH FILL
- WA — WORK AREA
- NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- SETTLEMENT AND OVERWASH MONITORING SYSTEM
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- 100+00 FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

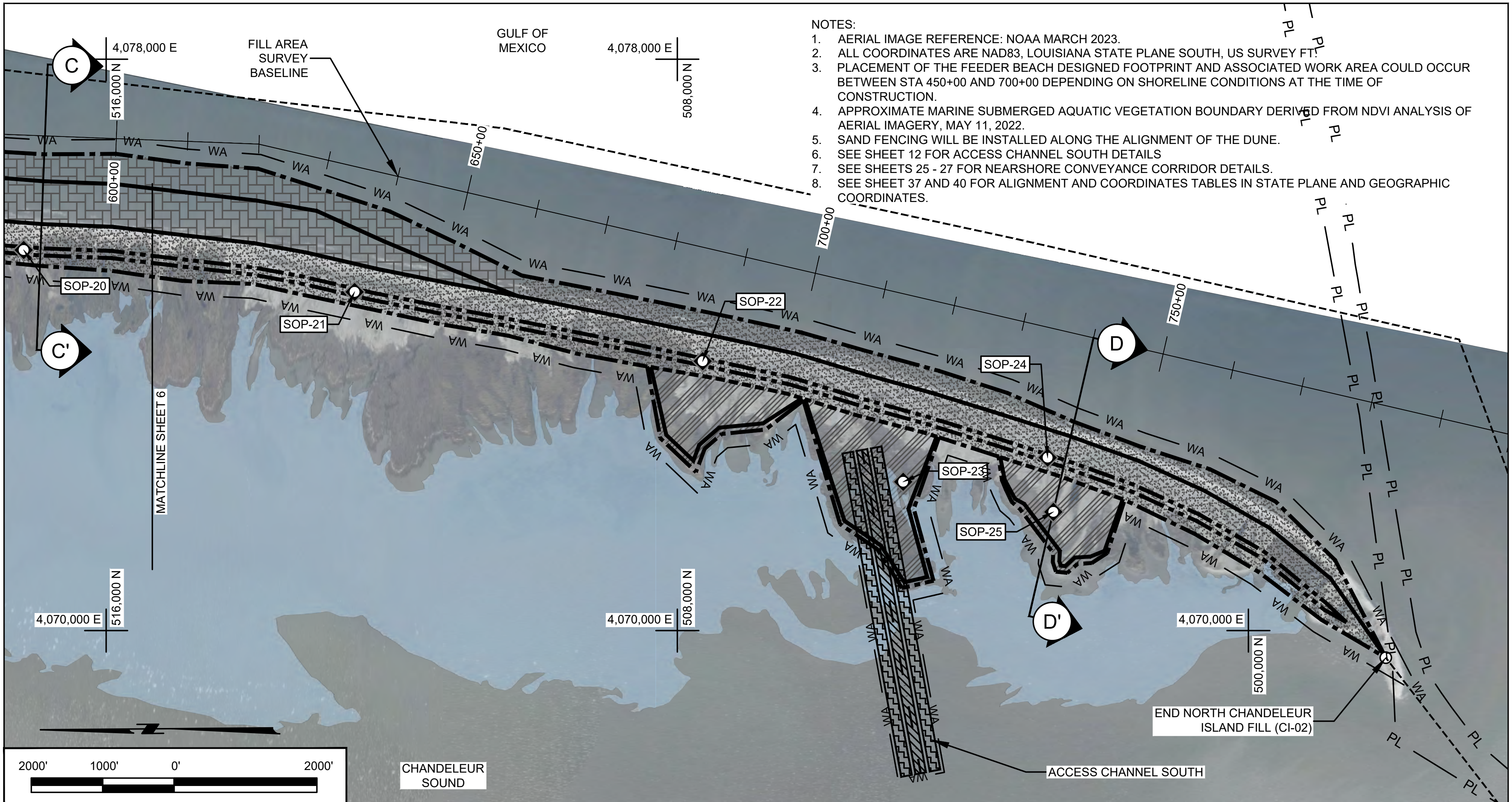
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NORTH CHANDELEUR ISLAND RESTORATION AREA PLAN VIEW

DATE: NOVEMBER 2024

SHEET 6 OF 40



NOTES:
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3. PLACEMENT OF THE FEEDER BEACH DESIGNED FOOTPRINT AND ASSOCIATED WORK AREA COULD OCCUR BETWEEN STA 450+00 AND 700+00 DEPENDING ON SHORELINE CONDITIONS AT THE TIME OF CONSTRUCTION.
4. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
5. SAND FENCING WILL BE INSTALLED ALONG THE ALIGNMENT OF THE DUNE.
6. SEE SHEET 12 FOR ACCESS CHANNEL SOUTH DETAILS
7. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 37 AND 40 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- BEACH/SAND RESERVOIR FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/SAND RESERVOIR INTERFACE
- BEACH/DUNE FILL
- SAND RESERVOIR FILL
- FEEDER BEACH FILL
- WA — WORK AREA
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- PL — PIPELINE
- SETTLEMENT AND OVERWASH MONITORING SYSTEM
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- 100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

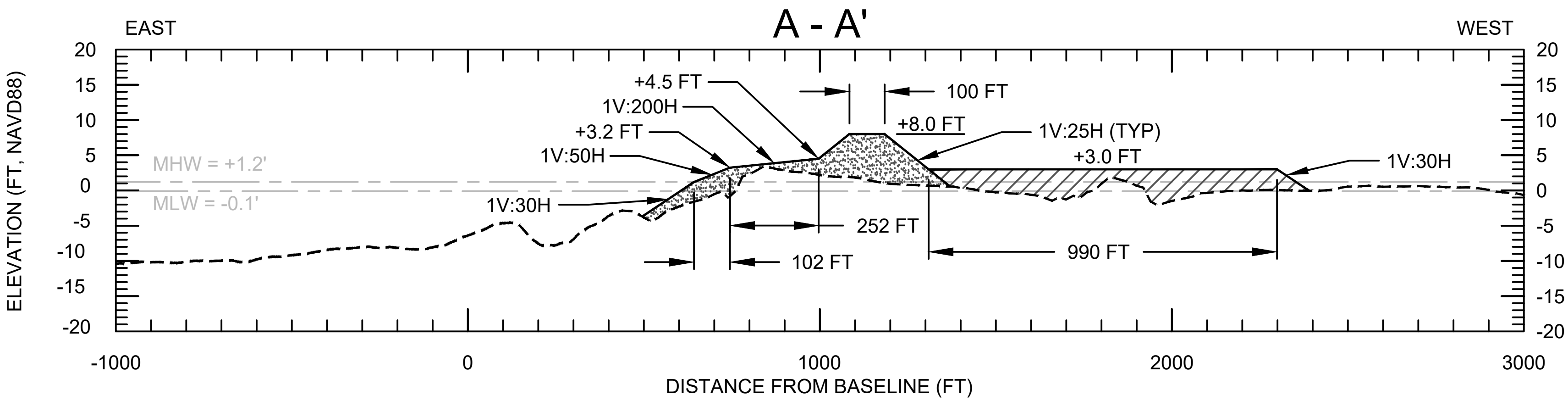
FEDERAL PROJECT NUMBER:

NORTH CHANDELEUR ISLAND RESTORATION AREA PLAN VIEW

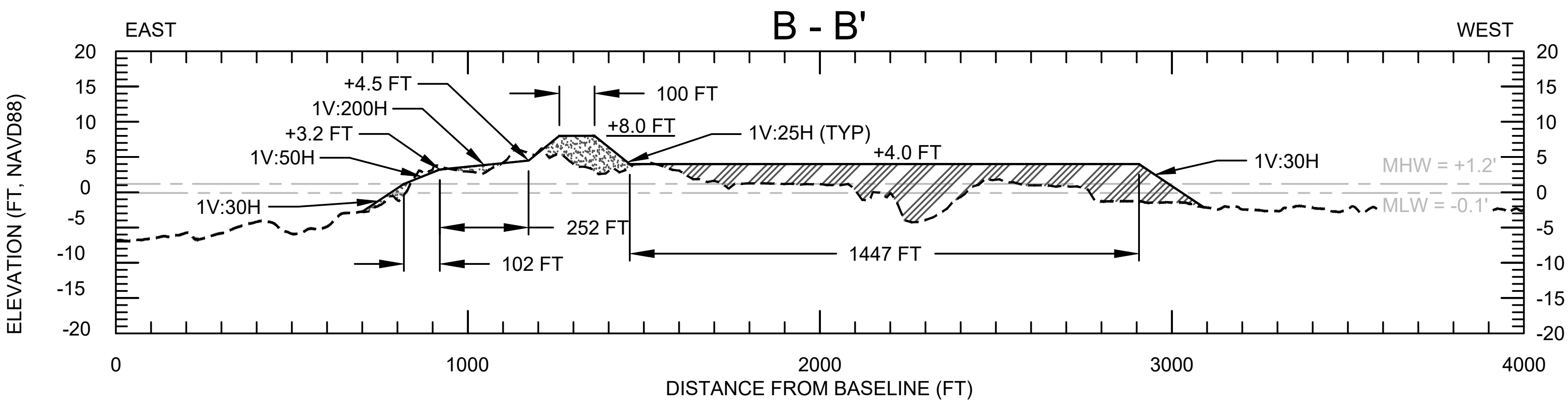
DATE: NOVEMBER 2024

SHEET 7 OF 40

A - A'



B - B'



NOTES:
1. SURVEY CONDUCTED BY EMC, INC. FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEET 37 FOR ALIGNMENTS.

SCALE:
H: 1" = 500'
V: 1" = 25'

DESIGN ELEMENTS:
1. DESIGN DIMENSIONS ARE MEASURED FROM THE CREST LINES OF THE RESPECTIVE FEATURES.
2. DUNE DESIGN ELEVATION = +8.0 FT NAVD88.
3. DUNE DESIGN SLOPE = 1V:25H.
4. BEACH DESIGN ELEVATION = +4.5 FT NAVD88 TO +3.2 FT NAVD88.
5. BEACH DESIGN SLOPES = 1V:200H TRANSITIONING TO 1V:50H AT +3.2 FT NAVD88 AND T0 1V:30H AT MHW.
6. MARSH DESIGN ELEVATION = +3.0 FT NAVD88.
7. MARSH DESIGN SLOPE = 1V:30H.
8. SAND RESERVOIR DESIGN ELEVATION = +4.0 FT NAVD88.
9. SAND RESERVOIR DESIGN SLOPE = 1V:30H.
10. A +1.0 FT VERTICAL CONSTRUCTION TOLERANCE IS INCLUDED TO ACCOUNT FOR CONSTRUCTION METHODS AND CONSOLIDATION / SETTLEMENT OF THE FILL.

LEGEND:
- EXISTING GRADE
- DESIGN
- BEACH/DUNE FILL
- MARSH FILL
- SAND RESERVOIR FILL

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

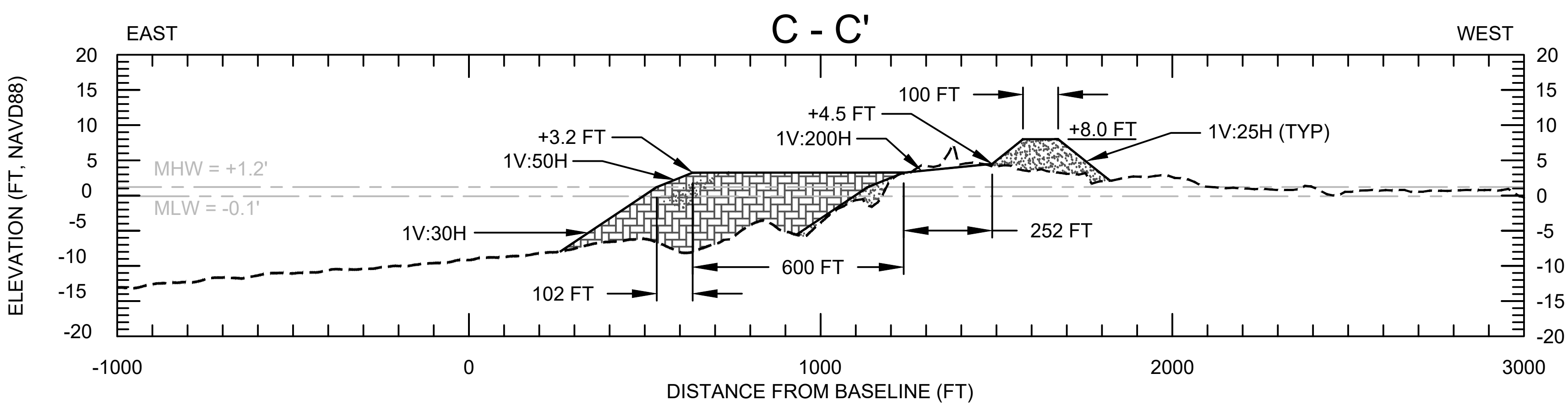
STATE PROJECT NUMBER: PO-0199

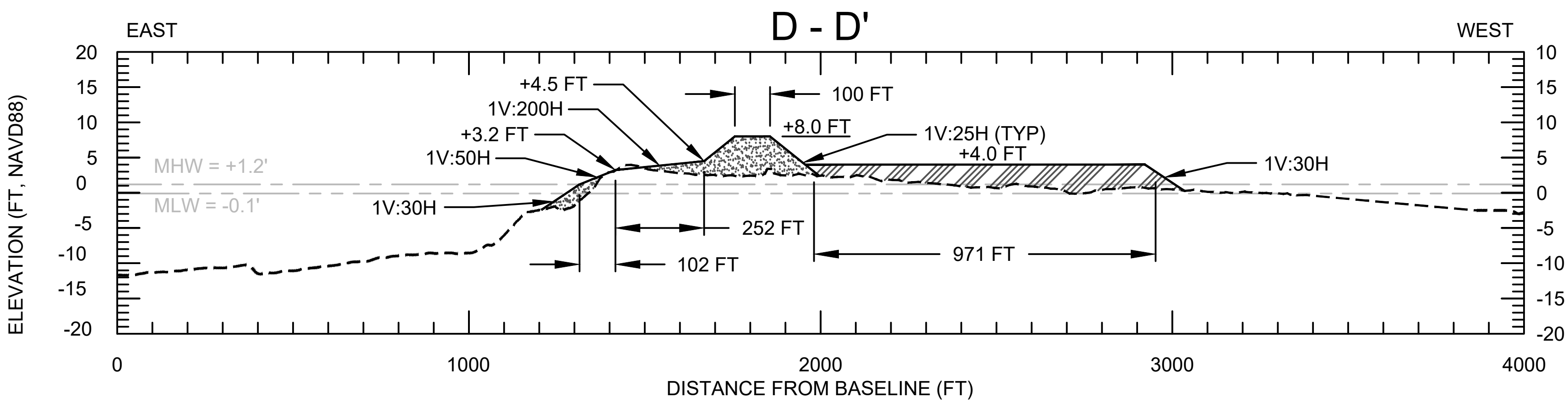
FEDERAL PROJECT NUMBER:

NORTH CHANDELEUR ISLAND RESTORATION AREA TYPICAL SECTIONS

DATE: NOVEMBER 2024

SHEET 8 OF 40





NOTES:
1. SURVEY CONDUCTED BY EMC, INC. FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEET 37 FOR ALIGNMENTS.

SCALE:
H: 1" = 500'
V: 1" = 25'

DESIGN ELEMENTS:
1. DESIGN DIMENSIONS ARE MEASURED FROM THE CREST LINES OF THE RESPECTIVE FEATURES.
2. DUNE DESIGN ELEVATION = +8.0 FT NAVD88.
3. DUNE DESIGN SLOPE = 1V:25H.
4. BEACH DESIGN ELEVATION = +4.5 FT NAVD88 TO +3.2 FT NAVD88.
5. BEACH DESIGN SLOPES = 1V:200H TRANSITIONING TO 1V:50H AT +3.2 FT NAVD88 AND T0 1V:30H AT MHW (EXCEPT AT FEEDER BEACH).
6. FEEDER BEACH DESIGN ELEVATION = +3.24 FT NAVD88.
7. FEEDER BEACH SLOPES = 1V:50H TRANSITIONING TO 1V:30H AT MHW.
8. SAND RESERVOIR DESIGN ELEVATION = +4.0 FT NAVD88.
9. SAND RESERVOIR DESIGN SLOPE = 1V:30H.
10. A +1.0 FT VERTICAL CONSTRUCTION TOLERANCE IS INCLUDED TO ACCOUNT FOR CONSTRUCTION METHODS AND CONSOLIDATION / SETTLEMENT OF THE FILL.

LEGEND:
- EXISTING GRADE
- DESIGN
- BEACH/DUNE FILL
- SAND RESERVOIR FILL
- FEEDER BEACH FILL

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

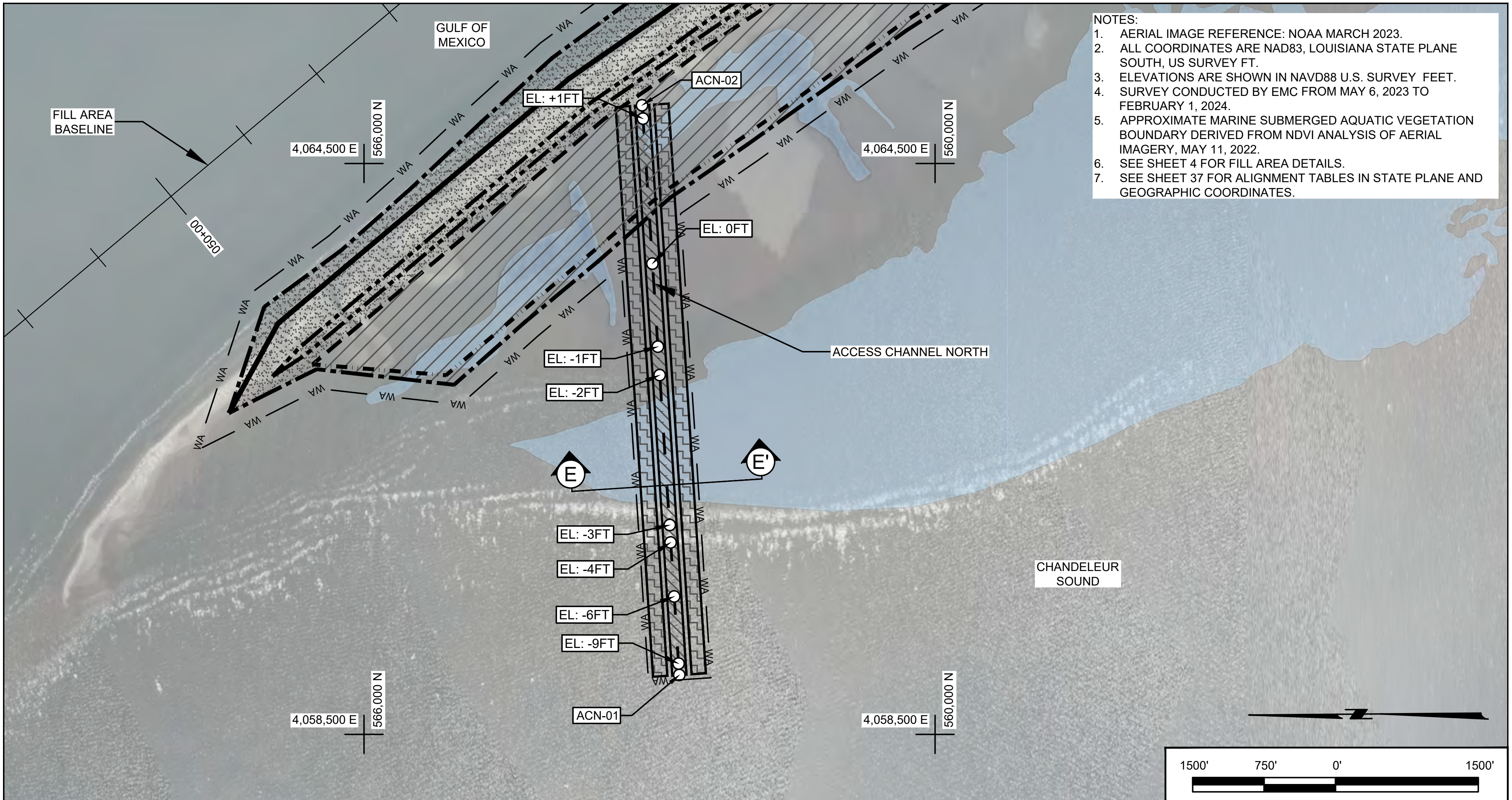
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NORTH CHANDELEUR ISLAND RESTORATION AREA TYPICAL SECTIONS

DATE: NOVEMBER 2024



NOTES:
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3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
4. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
5. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
6. SEE SHEET 4 FOR FILL AREA DETAILS.
7. SEE SHEET 37 FOR ALIGNMENT TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

FILL EXTENTS
BEACH FILL CREST
DUNE FILL CREST
MARSH FILL CREST
DUNE/MARSH INTERFACE
BEACH/DUNE FILL
MARSH FILL
ACCESS CHANNEL
TEMPORARY SIDECAST DISPOSAL
WA — WORK AREA
ACN-01 — ACCESS CHANNEL - NORTH ALIGNMENT COORDINATE
EL: -6FT — EXISTING GRADE ELEVATION
APPROX. MARINE SUBMERGED AQUATIC VEGETATION
100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

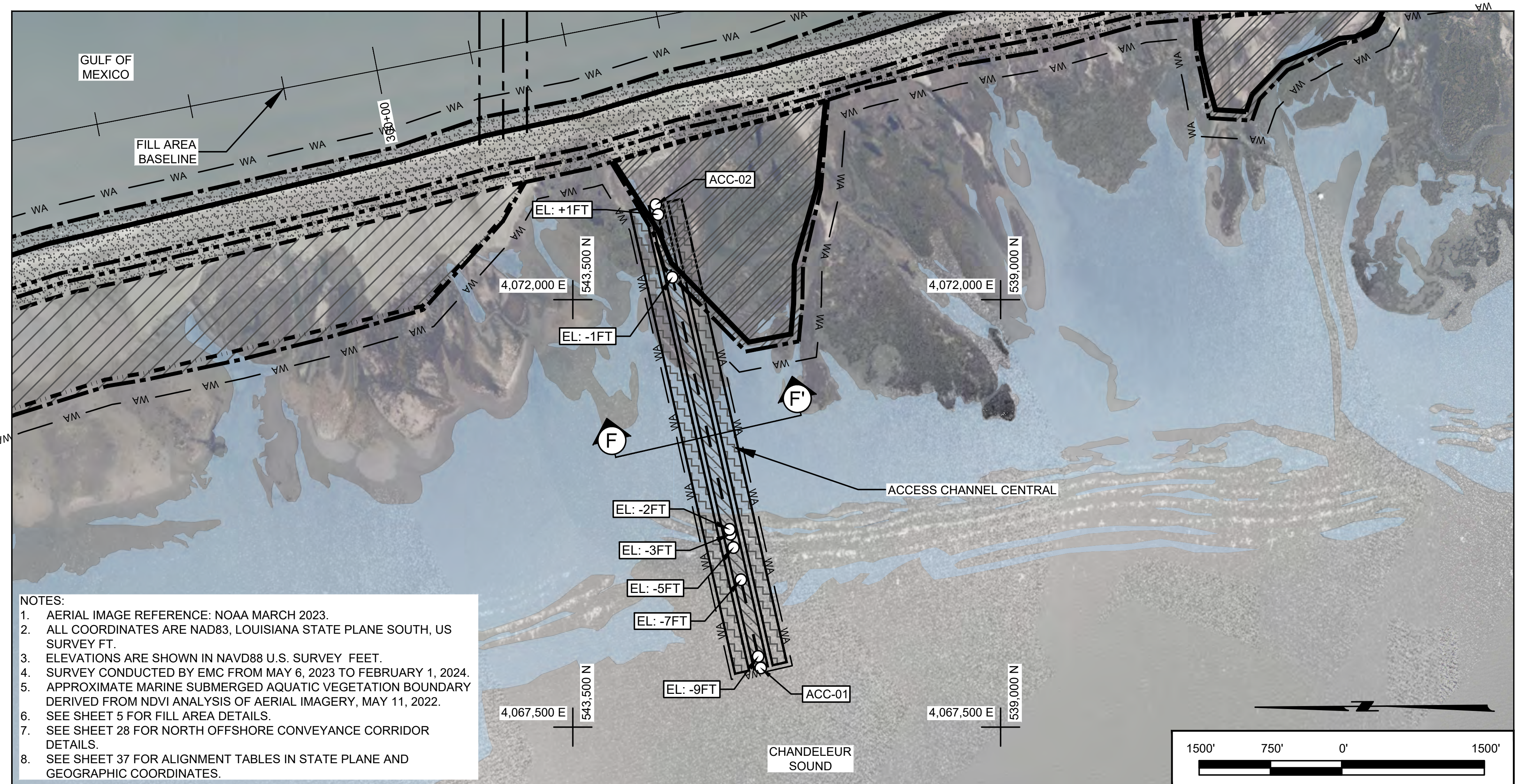
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL - NORTH PLAN VIEW

DATE: NOVEMBER 2024

SHEET 10 OF 40



NOTES:
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4. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
5. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
6. SEE SHEET 5 FOR FILL AREA DETAILS.
7. SEE SHEET 28 FOR NORTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 37 FOR ALIGNMENT TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- BEACH FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/SAND RESERVOIR INTERFACE
- WA — WORK AREA
- BEACH/DUNE FILL
- MARSH FILL
- SAND RESERVOIR FILL
- FEEDER BEACH FILL
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL
- ACC-01 — ACCESS CHANNEL - CENTRAL ALIGNMENT COORDINATE
- EL: -6FT — EXISTING GRADE ELEVATION
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- 100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL - CENTRAL PLAN VIEW

DATE: NOVEMBER 2024

NOTES:
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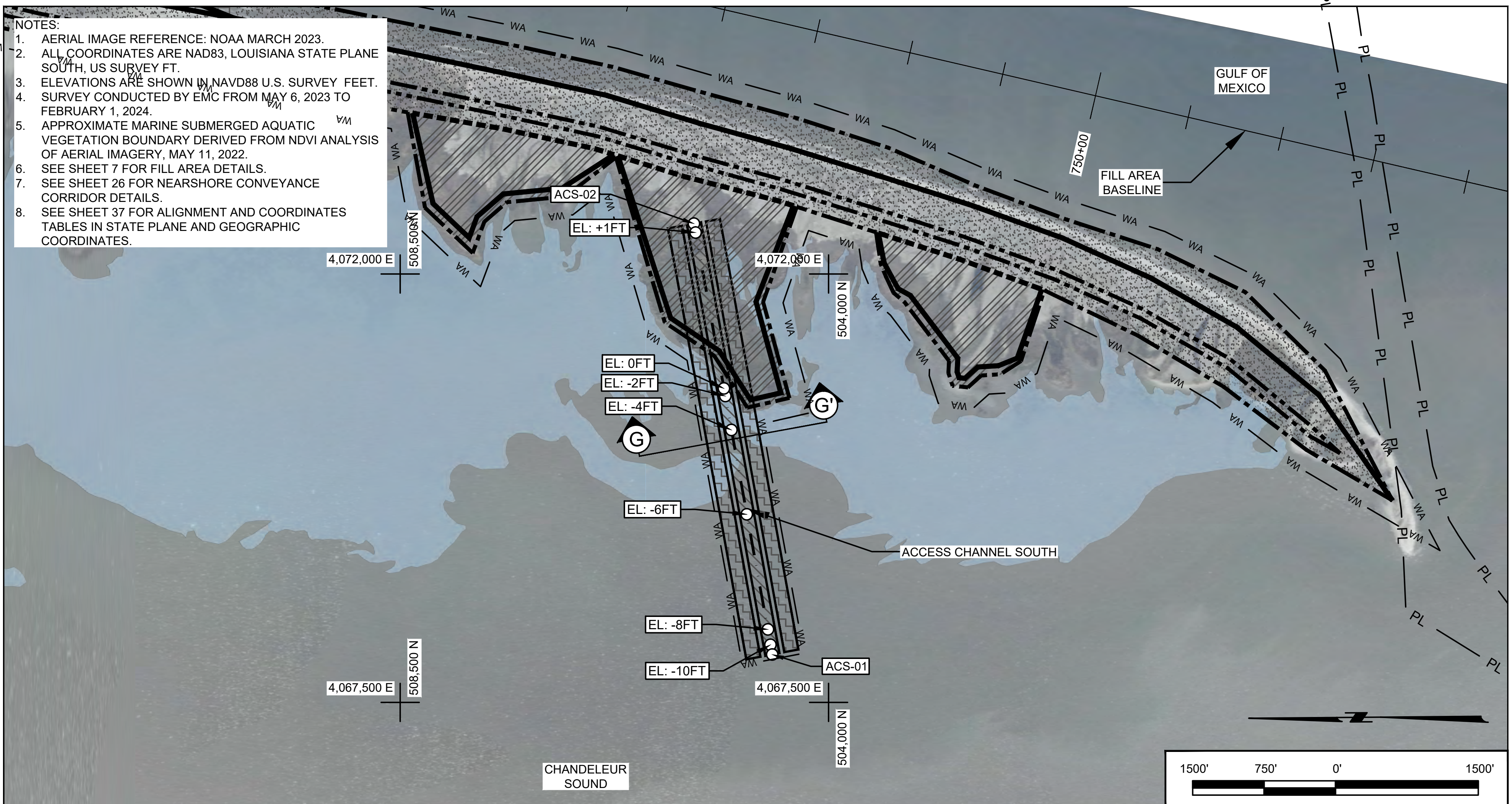
3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
4. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
5. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
6. SEE SHEET 7 FOR FILL AREA DETAILS.
7. SEE SHEET 26 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 37 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.



LEGEND

- FILL EXTENTS
- BEACH FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/SAND RESERVOIR INTERFACE
- WA — WORK AREA
- BEACH/DUNE FILL
- SAND RESERVOIR FILL
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL
- NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT
- ACS-01 — ACCESS CHANNEL - SOUTH ALIGNMENT COORDINATE
- EL: -6FT — EXISTING GRADE ELEVATION
- PL — PIPELINE
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- 100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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DESIGNED BY: BRETT BORNE, P.E.
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LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

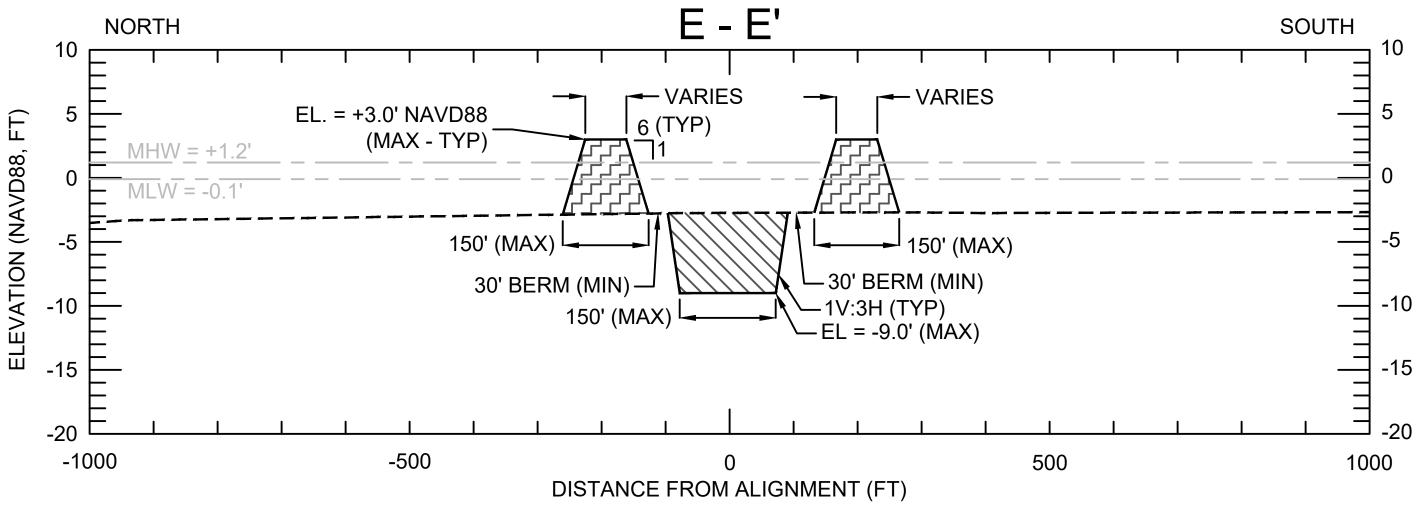
CHANDELEUR ISLAND RESTORATION PROJECT

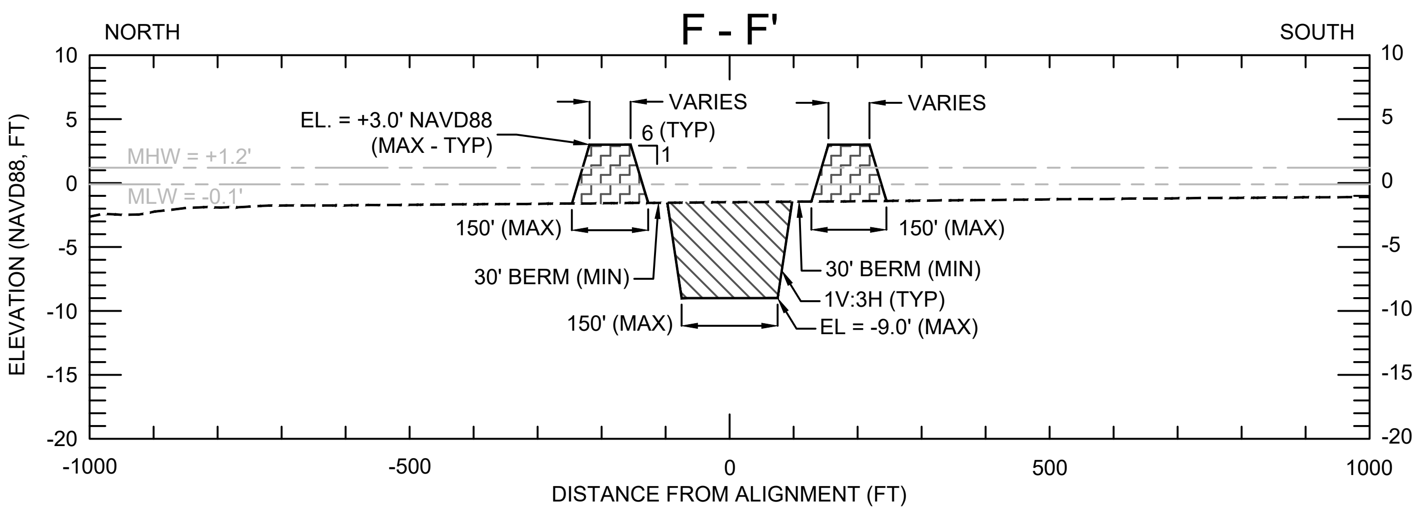
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL - SOUTH PLAN VIEW

DATE: NOVEMBER 2024





LEGEND:

- EXISTING GRADE
- DESIGN
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL

SCALE:
H: 1" = 300'
V: 1" = 15'

NOTES:
1. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

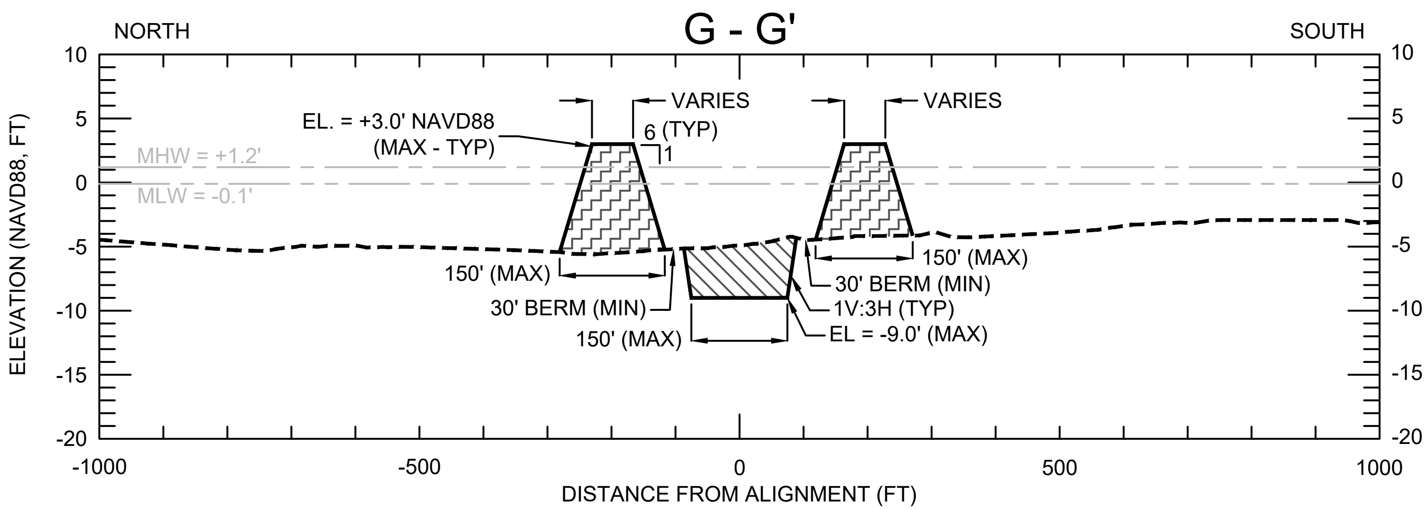
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL TYPICAL SECTIONS

DATE: NOVEMBER 2024

SHEET 13 OF 40



LEGEND:

- EXISTING GRADE
- DESIGN
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL

SCALE:
H: 1" = 300'
V: 1" = 15'

NOTES:
1. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

BY	DESCRIPTION	DATE

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LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
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CHANDELEUR ISLAND RESTORATION PROJECT

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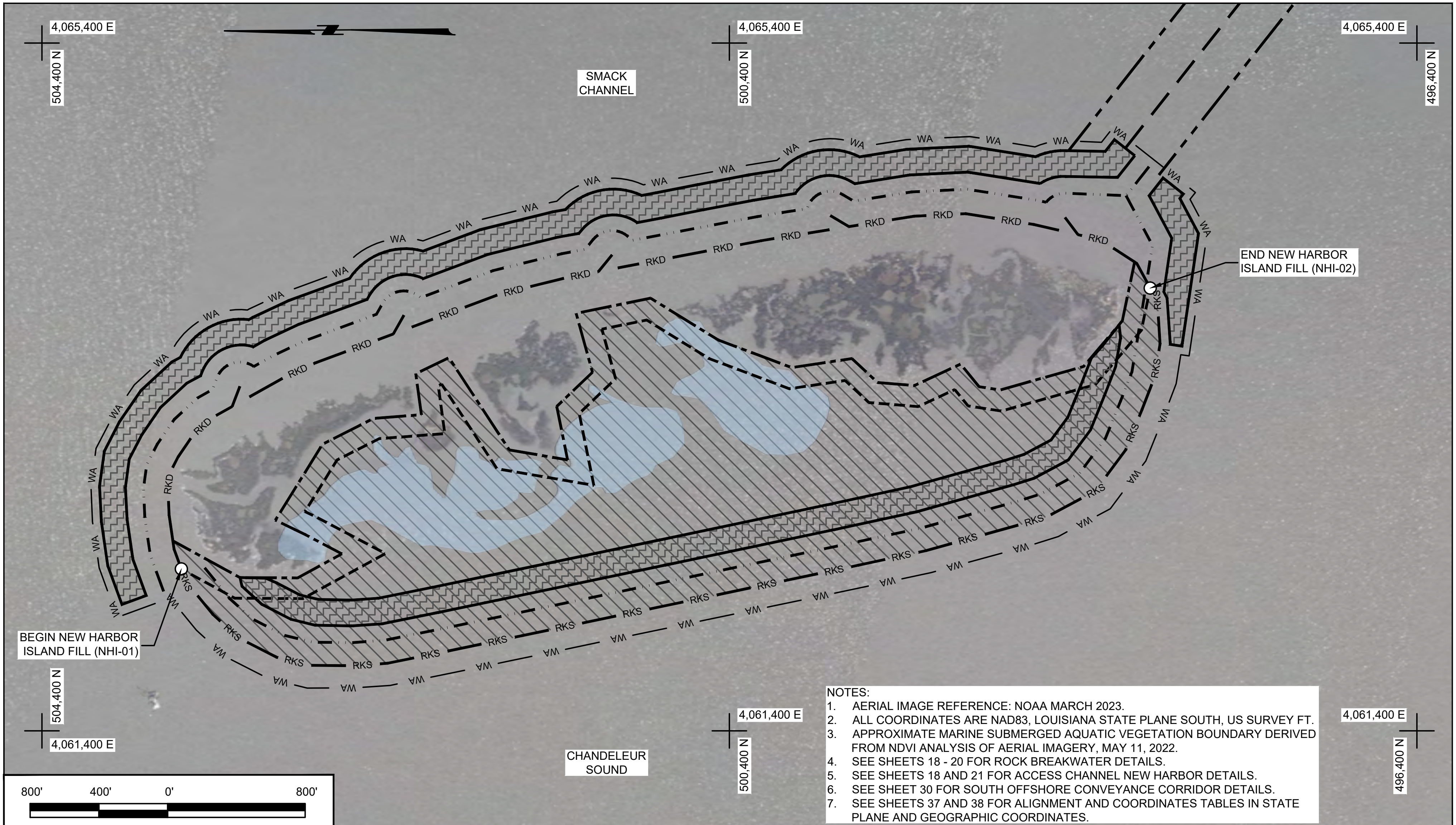
FEDERAL PROJECT NUMBER:

ACCESS CHANNEL TYPICAL SECTION

DATE: NOVEMBER 2024

SHEET 14 OF 40



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
4. SEE SHEETS 18 - 20 FOR ROCK BREAKWATER DETAILS.
5. SEE SHEETS 18 AND 21 FOR ACCESS CHANNEL NEW HARBOR DETAILS.
6. SEE SHEET 30 FOR SOUTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEETS 37 AND 38 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- MARSH FILL EXTENTS
- ACCESS CHANNEL ALIGNMENT
- RKD — DETACHED ROCK BREAKWATER ALIGNMENT
- RKS — SHORELINE ROCK BREAKWATER ALIGNMENT
- WA — WORK AREA
- TEMPORARY SIDECAST DISPOSAL AREA
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- SOUTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

BY	DESCRIPTION	DATE

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

CHANDELEUR ISLAND RESTORATION PROJECT

NEW HARBOR ISLAND RESTORATION AREA OVERVIEW

STATE PROJECT NUMBER: PO-0199

DATE: NOVEMBER 2024

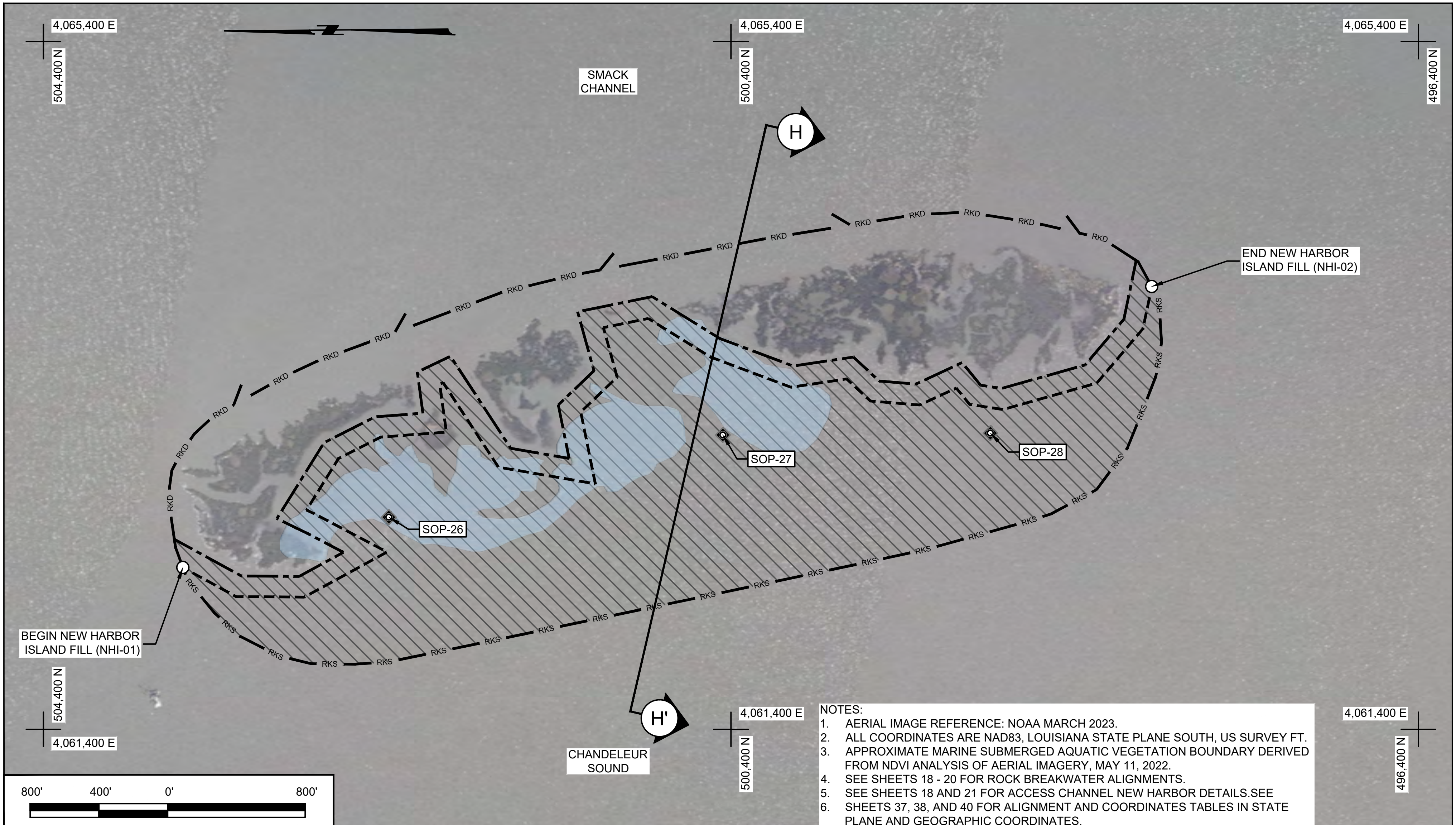
DRAWN BY: STEVE DARTEZ

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

APPROVED BY: MICHAEL T. POFF, P.E.

FEDERAL PROJECT NUMBER:

SHEET 15 OF 40



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
4. SEE SHEETS 18 - 20 FOR ROCK BREAKWATER ALIGNMENTS.
5. SEE SHEETS 18 AND 21 FOR ACCESS CHANNEL NEW HARBOR DETAILS.SEE
6. SHEETS 37, 38, AND 40 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- MARSH FILL CREST ALIGNMENT
- MARSH FILL
- RKD — DETACHED ROCK BREAKWATER ALIGNMENT
- RKS — SHORELINE ROCK BREAKWATER ALIGNMENT
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- SETTLEMENT AND OVERWASH MONITORING SYSTEM

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

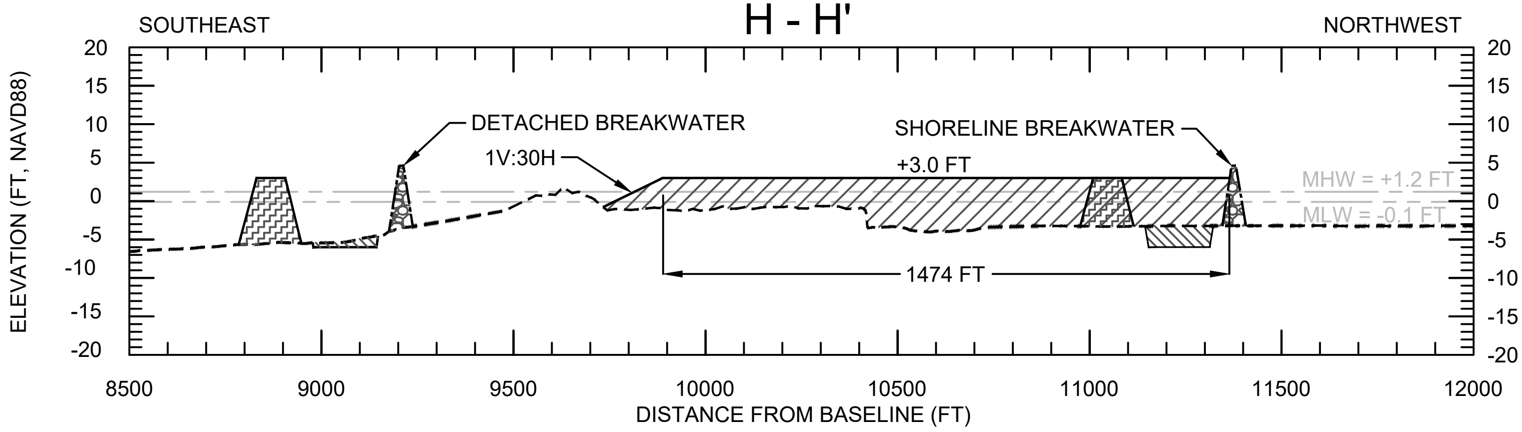
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NEW HARBOR ISLAND FILL AREA PLAN VIEW

DATE: NOVEMBER 2024

H - H'



NOTES:
1. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEETS 18 - 20 FOR ROCK BREAKWATER DETAILS
3. SEE SHEET 21 FOR ACCESS CHANNEL NEW HARBOR TYPICAL SECTION.
4. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

DESIGN ELEMENTS:
1. DESIGN DIMENSIONS ARE MEASURED FROM THE CREST LINES OF THE RESPECTIVE FEATURES.
2. MARSH DESIGN ELEVATION = +3.0 FT NAVD88.
3. MARSH DESIGN SLOPE = 1V:30H.
4. A +1.0 FT VERTICAL CONSTRUCTION TOLERANCE IS INCLUDED TO ACCOUNT FOR CONSTRUCTION METHODS AND CONSOLIDATION / SETTLEMENT OF THE FILL.

LEGEND:
- EXISTING GRADE
- DESIGN
- MARSH FILL
- ROCK BREAKWATER
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL

SCALE:
H: 1" = 500'
V: 1" = 25'

BY	DESCRIPTION	DATE

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

CHANDELEUR ISLAND RESTORATION PROJECT

NEW HARBOR ISLAND FILL AREA TYPICAL SECTION

STATE PROJECT NUMBER: PO-0199

DATE: NOVEMBER 2024

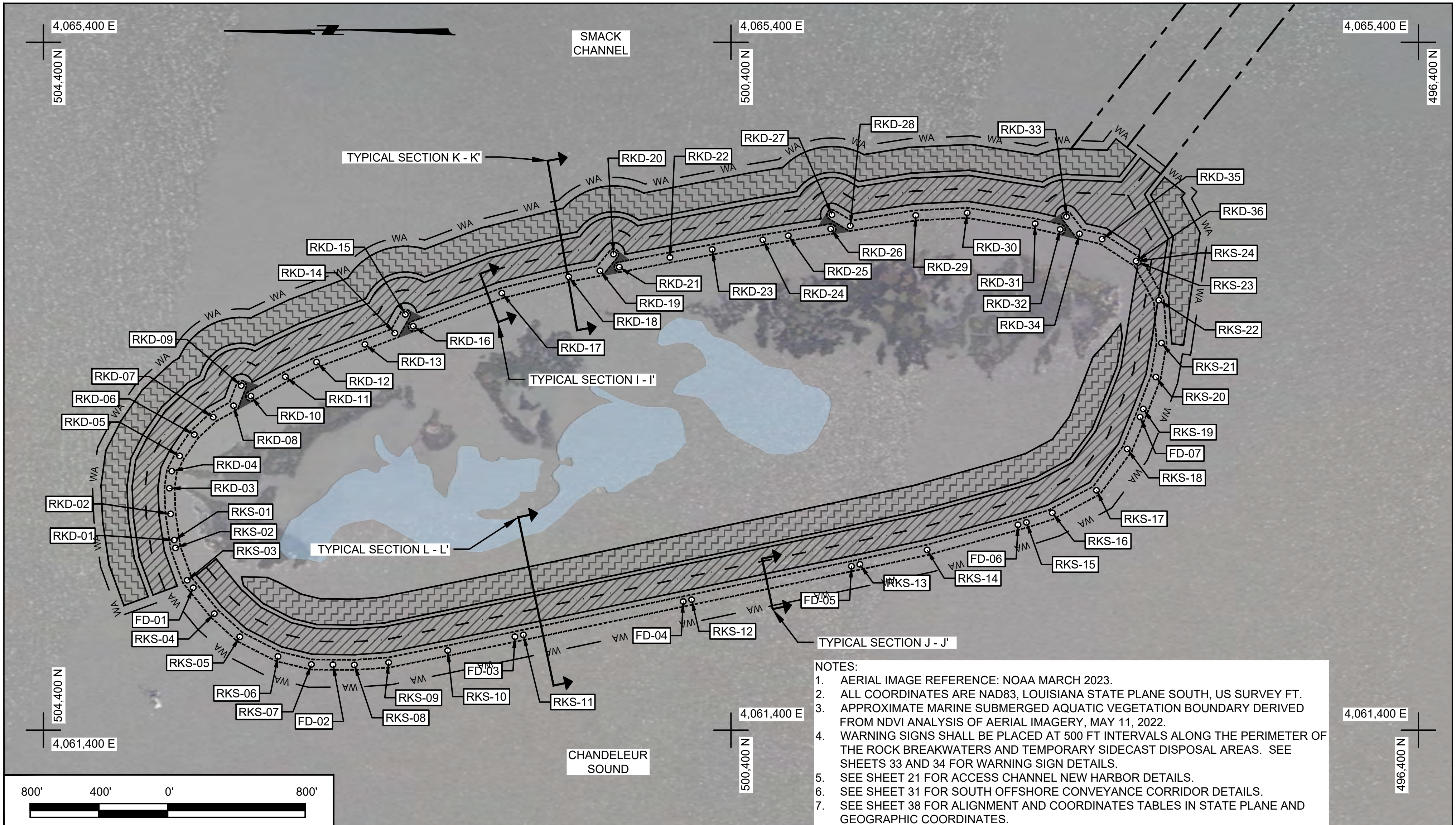
DRAWN BY: STEVE DARTEZ

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

APPROVED BY: MICHAEL T. POFF, P.E.

FEDERAL PROJECT NUMBER:

SHEET 17 OF 40



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
4. WARNING SIGNS SHALL BE PLACED AT 500 FT INTERVALS ALONG THE PERIMETER OF THE ROCK BREAKWATERS AND TEMPORARY SIDECAST DISPOSAL AREAS. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.
5. SEE SHEET 21 FOR ACCESS CHANNEL NEW HARBOR DETAILS.
6. SEE SHEET 31 FOR SOUTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 38 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- ROCK BREAKWATER CREST AND TOE
- ROCK BREAKWATER FISH DIP
- ROCK GAP CORE STONE
- — WA — WORK AREA
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- SOUTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- RKS-01 ROCK BREAKWATER - SHORELINE ALIGNMENT COORDINATE
- RKD-01 ROCK BREAKWATER - DETACHED ALIGNMENT COORDINATE
- FD-01 ROCK BREAKWATER FISH DIP LOCATION COORDINATE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

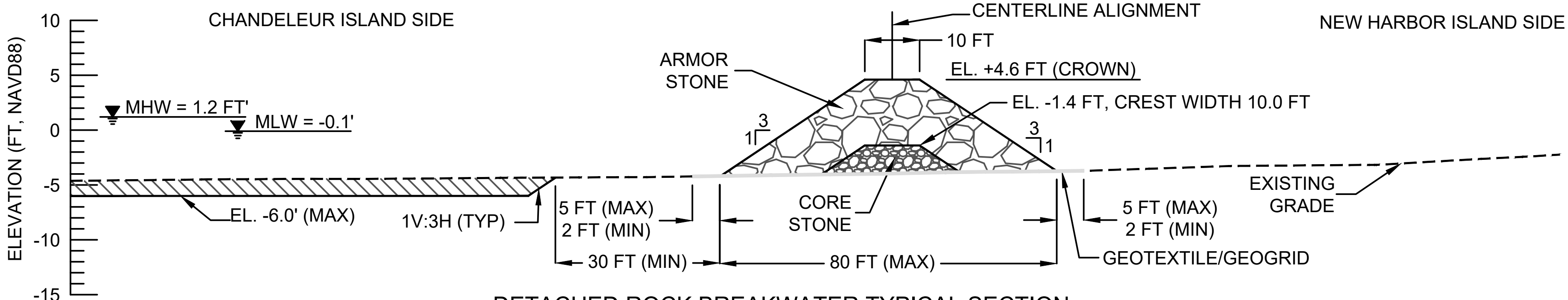
FEDERAL PROJECT NUMBER:

NEW HARBOR ISLAND ROCK BREAKWATER AND ACCESS CHANNEL PLAN VIEW

DATE: NOVEMBER 2024

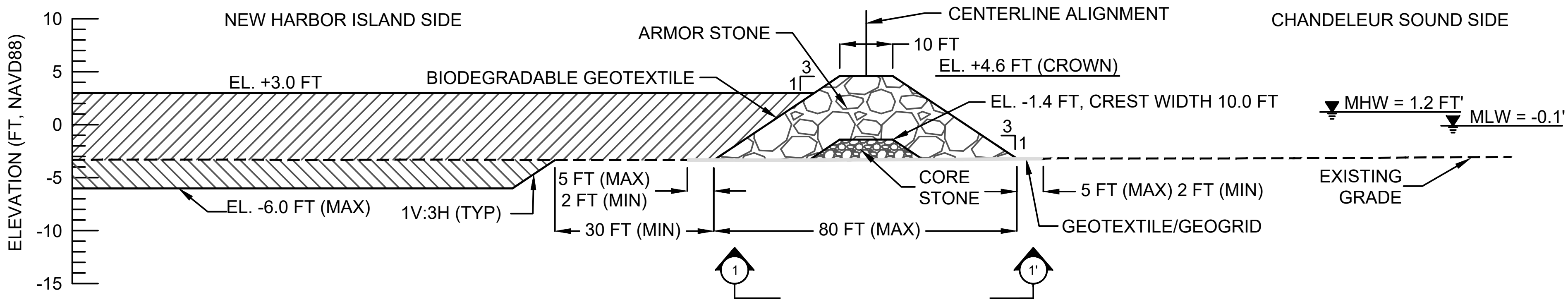
SHEET 18 OF 40

I -I'



DETACHED ROCK BREAKWATER TYPICAL SECTION

J -J'



SHORELINE ROCK BREAKWATER TYPICAL SECTION

NOTES:
1. SECTIONS ARE VIEWED AS LOOKING SOUTH.
2. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
3. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

DESIGN ELEMENTS:
1. DESIGN DIMENSIONS ARE MEASURED FROM THE CREST LINES OF THE RESPECTIVE FEATURES.
2. BREAKWATER DESIGN ELEVATION = +4.6 FT NAVD88.
4. BREAKWATER DESIGN SLOPES = 1V:3H.
5. A +1.0 FT VERTICAL CONSTRUCTION TOLERANCE IS INCLUDED TO ACCOUNT FOR CONSTRUCTION METHODS AND CONSOLIDATION / SETTLEMENT OF THE FILL.

LEGEND:
- EXISTING GRADE
- DESIGN
- ARMOR STONE
- CORE STONE
- MARSH FILL
- ACCESS CHANNEL

SCALE:
H: 1" = 30'
V: 1" = 15'

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

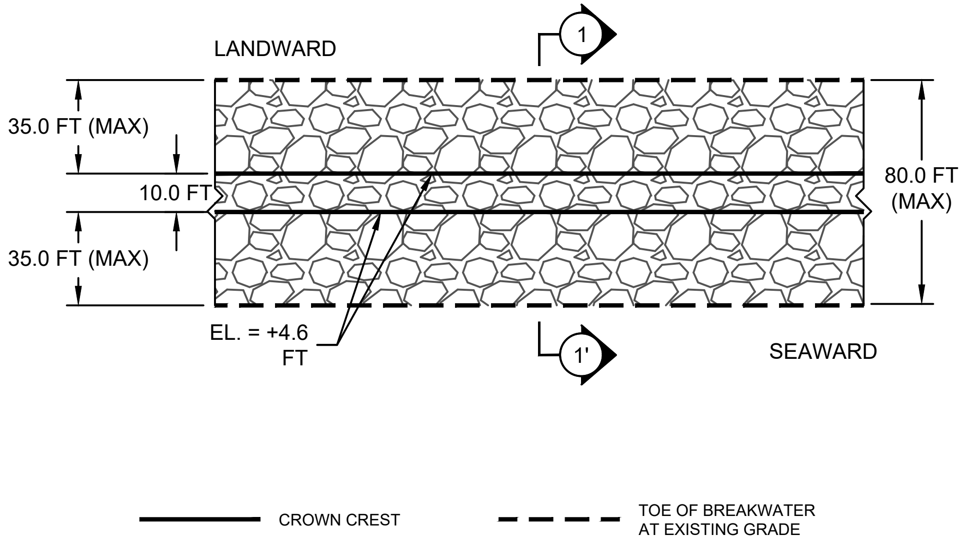
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

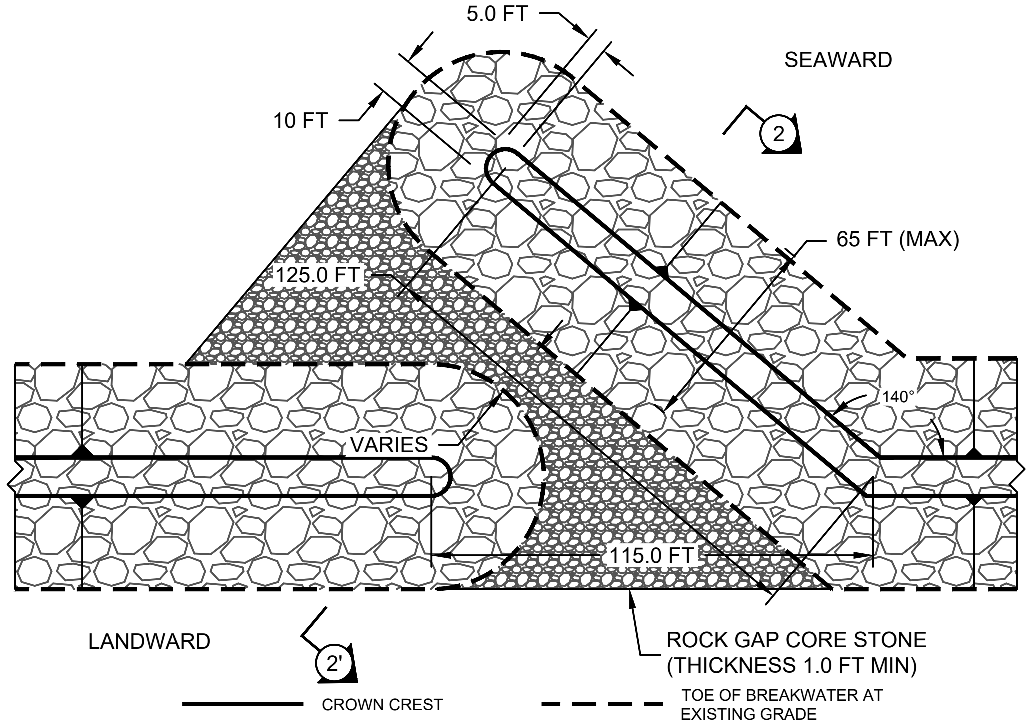
NEW HARBOR ISLAND ROCK BREAKWATER TYPICAL SECTIONS

DATE: NOVEMBER 2024



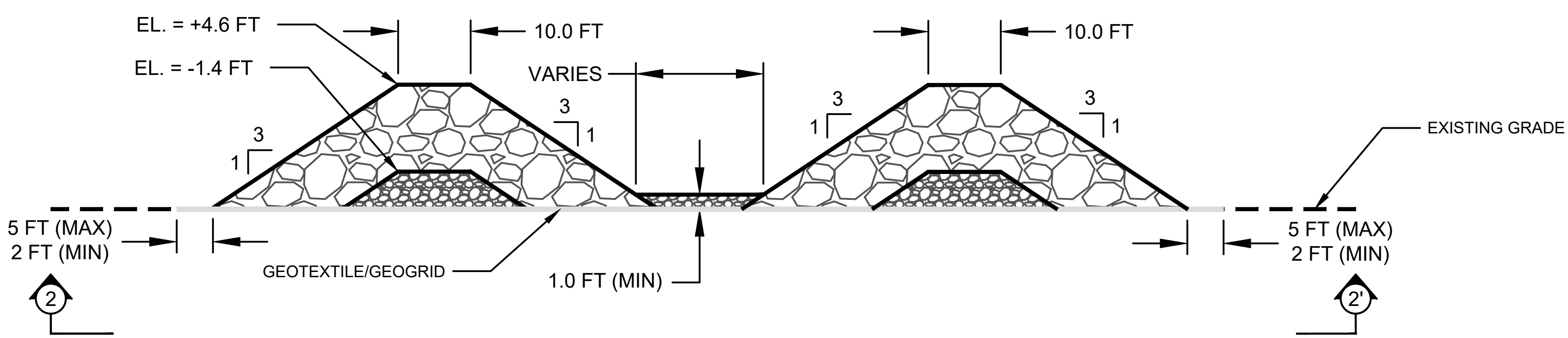
SHORELINE ROCK BREAKWATER TYPICAL SECTION PLAN VIEW

SCALE: AS SHOWN



DETACHED ROCK BREAKWATER TYPICAL PLAN VIEW

SCALE: AS SHOWN



DETACHED ROCK BREAKWATER GAP TYPICAL SECTION

SCALE: AS SHOWN

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
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DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

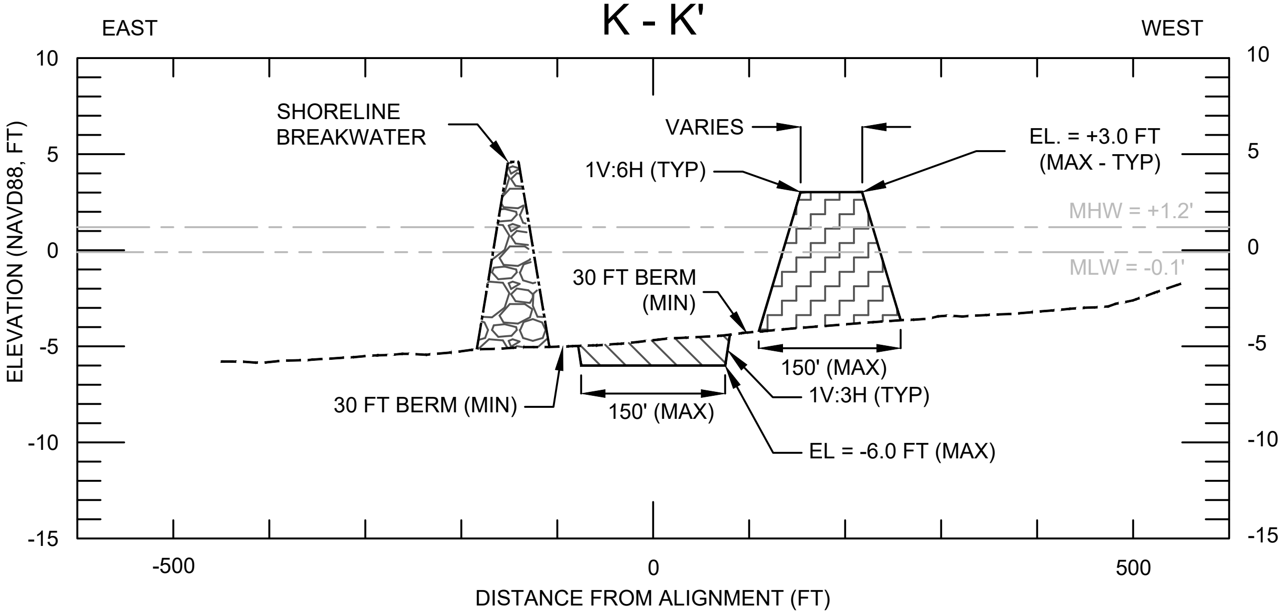
FEDERAL PROJECT NUMBER:

NEW HARBOR ISLAND ROCK BREAKWATER DETAILS

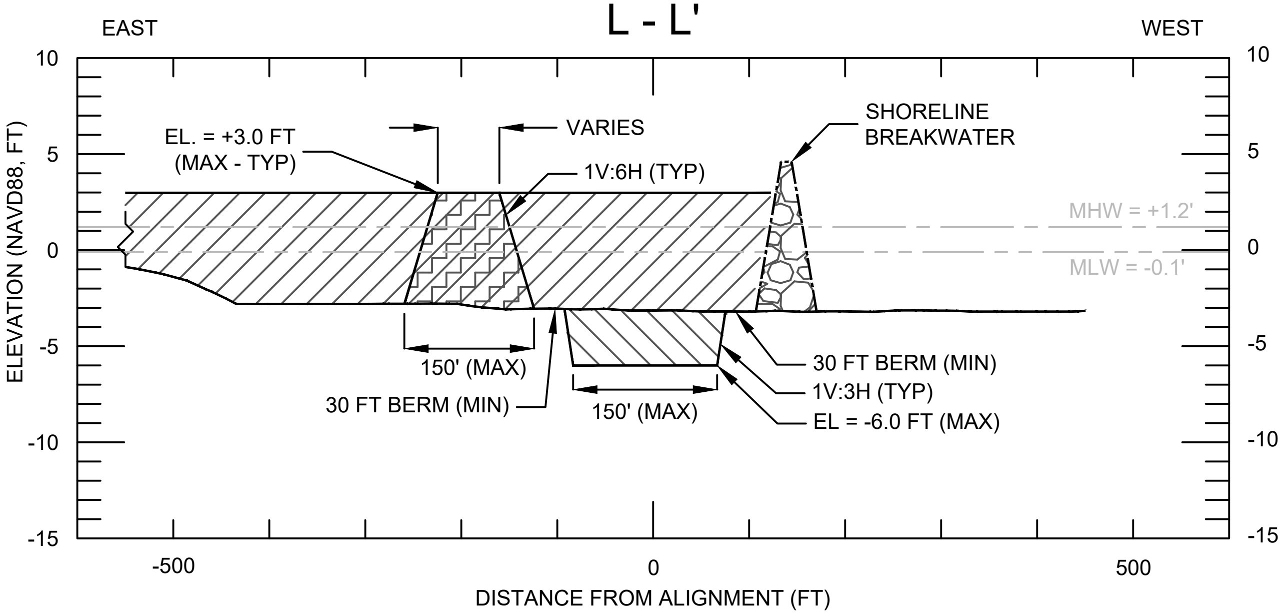
DATE: NOVEMBER 2024

SHEET 20 OF 40

K - K'



L - L'



NOTES:
1. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. TEMPORARY SIDECAST DISPOSAL AREAS TO BE DEGRADE BACK TO EXISTING CONDITIONS AND SPOIL PLACED IN THE ACCESS CHANNEL PRIOR TO MARSH FILL PLACEMENT.
3. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

SCALE:
H: 1" = 200'
V: 1" = 10'

LEGEND:
- EXISTING GRADE
- DESIGN
- MARSH FILL
- ROCK BREAKWATER
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

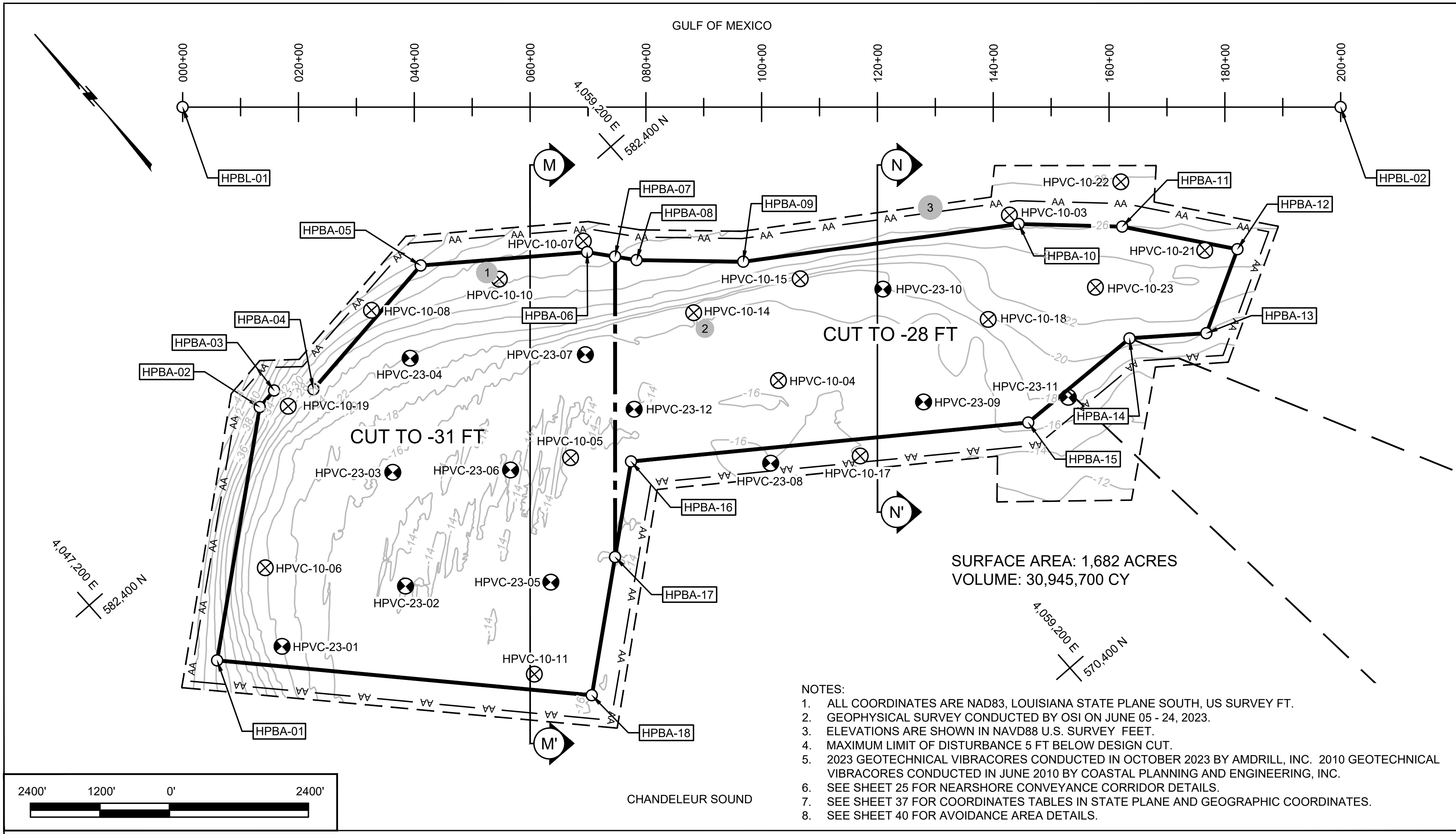
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL - NEW HARBOR

TYPICAL SECTION

DATE: NOVEMBER 2024



NOTES:

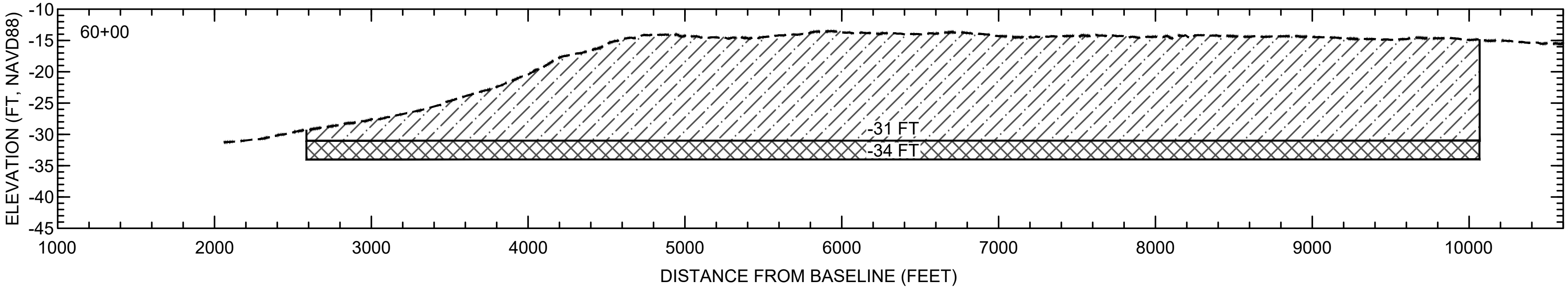
1. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
2. GEOPHYSICAL SURVEY CONDUCTED BY OSI ON JUNE 05 - 24, 2023.
3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
4. MAXIMUM LIMIT OF DISTURBANCE 5 FT BELOW DESIGN CUT.
5. 2023 GEOTECHNICAL VIBRACORES CONDUCTED IN OCTOBER 2023 BY AMDRILL, INC. 2010 GEOTECHNICAL VIBRACORES CONDUCTED IN JUNE 2010 BY COASTAL PLANNING AND ENGINEERING, INC.
6. SEE SHEET 25 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 37 FOR COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.
8. SEE SHEET 40 FOR AVOIDANCE AREA DETAILS.

LEGEND

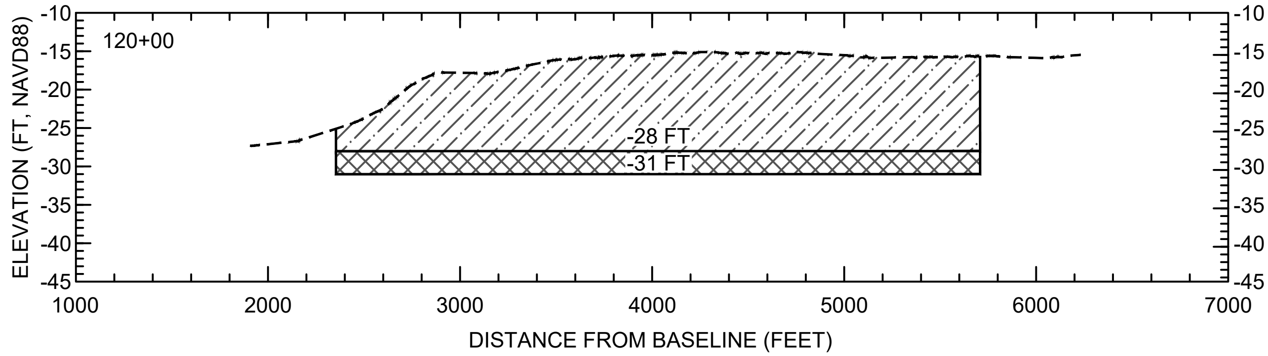
- DESIGN CUT TOE
- DESIGN CUT STEP
- GEOPHYSICAL SURVEY LIMITS
- -14 BATHYMETRIC CONTOUR (OSI, 2023)
- AA ALLOWABLE ANCHOR AREA (400 FT OFFSET FROM DESIGN CUT)
- 1 AVOIDANCE AREA (GOODWIN, 2023)
- HPVC-23-04 2023 GEOTECHNICAL VIBRACORE (AMDRILL, 2023)
- HPVC-10-08 2010 GEOTECHNICAL VIBRACORE (CPE, 2010)
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- HPBA-01 BORROW AREA ALIGNMENT COORDINATE
- BORROW AREA BASELINE

COASTAL ENGINEERING CONSULTANTS, INC. PH: (225) 523-7403 1211 N. RANGE AVE, STE. E DENHAM SPRINGS, LA 70726	LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY 150 TERRACE AVENUE BATON ROUGE, LA 70802	CHANDELEUR ISLAND RESTORATION PROJECT	HEWES POINT BORROW AREA PLAN VIEW
		STATE PROJECT NUMBER: PO-0199	DATE: NOVEMBER 2024
DRAWN BY: STEVE DARTEZ	DESIGNED BY: BRETT BORNE, P.E. LICENSE NUMBER: 42158	APPROVED BY: MICHAEL T. POFF, P.E.	FEDERAL PROJECT NUMBER:

M - M'



N - N'



LEGEND:

- EXISTING GRADE
- DESIGN
- DESIGN CUT
- ALLOWABLE DISTURBANCE

SCALE:
H: 1" = 500'
V: 1" = 25'

NOTES:
1. GEOPHYSICAL SURVEY CONDUCTED BY OSI ON JUNE 05 - 24, 2023.
2. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
3. MEAN HIGH WATER = +1.2 FT NAVD88, MEAN LOW WATER = -0.1 FT NAVD88.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

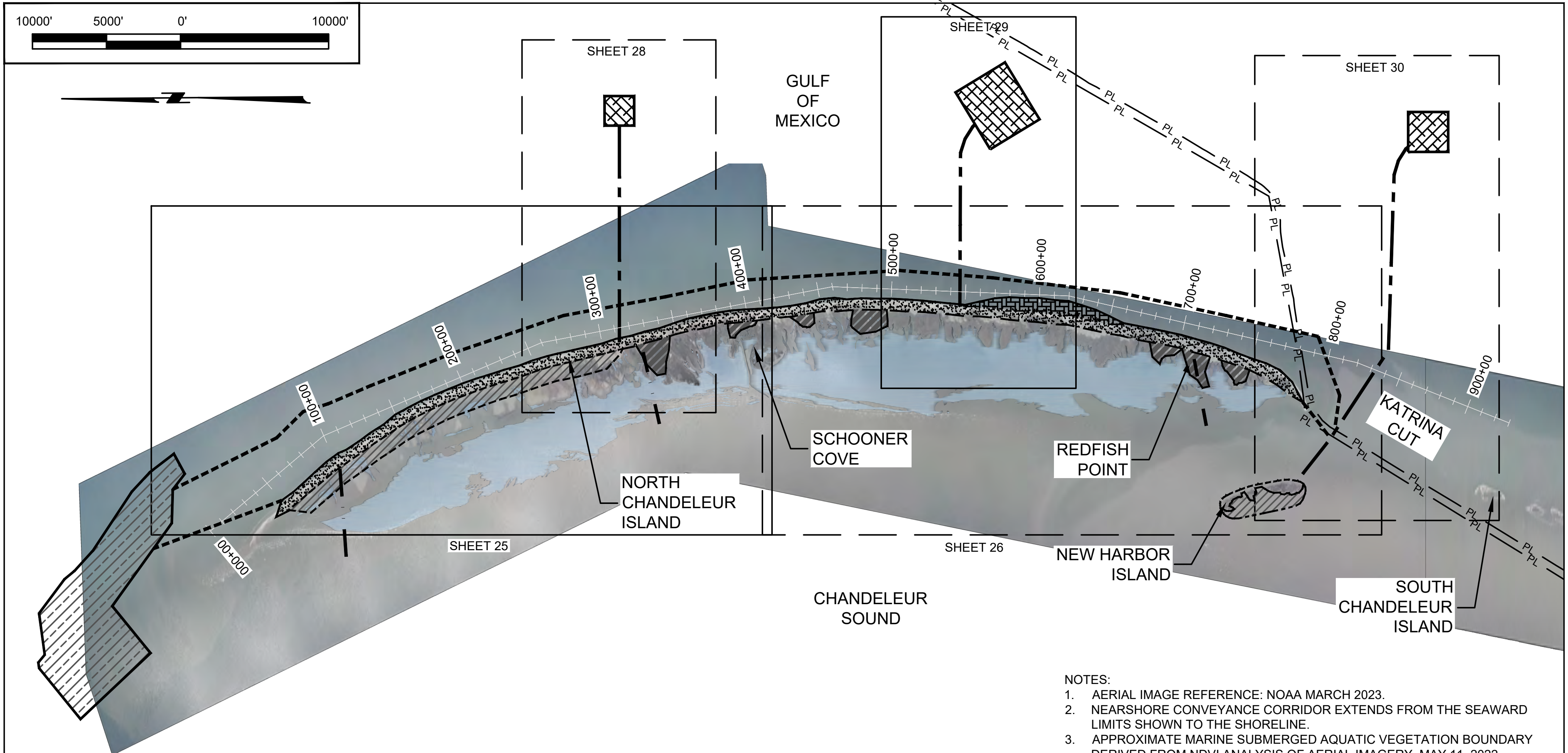
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

HEWES POINT BORROW AREA TYPICAL SECTIONS

DATE: NOVEMBER 2024



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

LEGEND

- BEACH/DUNE FILL AREA
- MARSH FILL AREA
- SAND RESERVOIR FILL AREA
- FEEDER BEACH FILL AREA
- BORROW AREA LIMITS
- PUMP-OUT AREA LIMITS
- ACCESS CHANNEL ALIGNMENT
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- PL — PIPELINE
- 100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: BEVIN BARRINGER, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

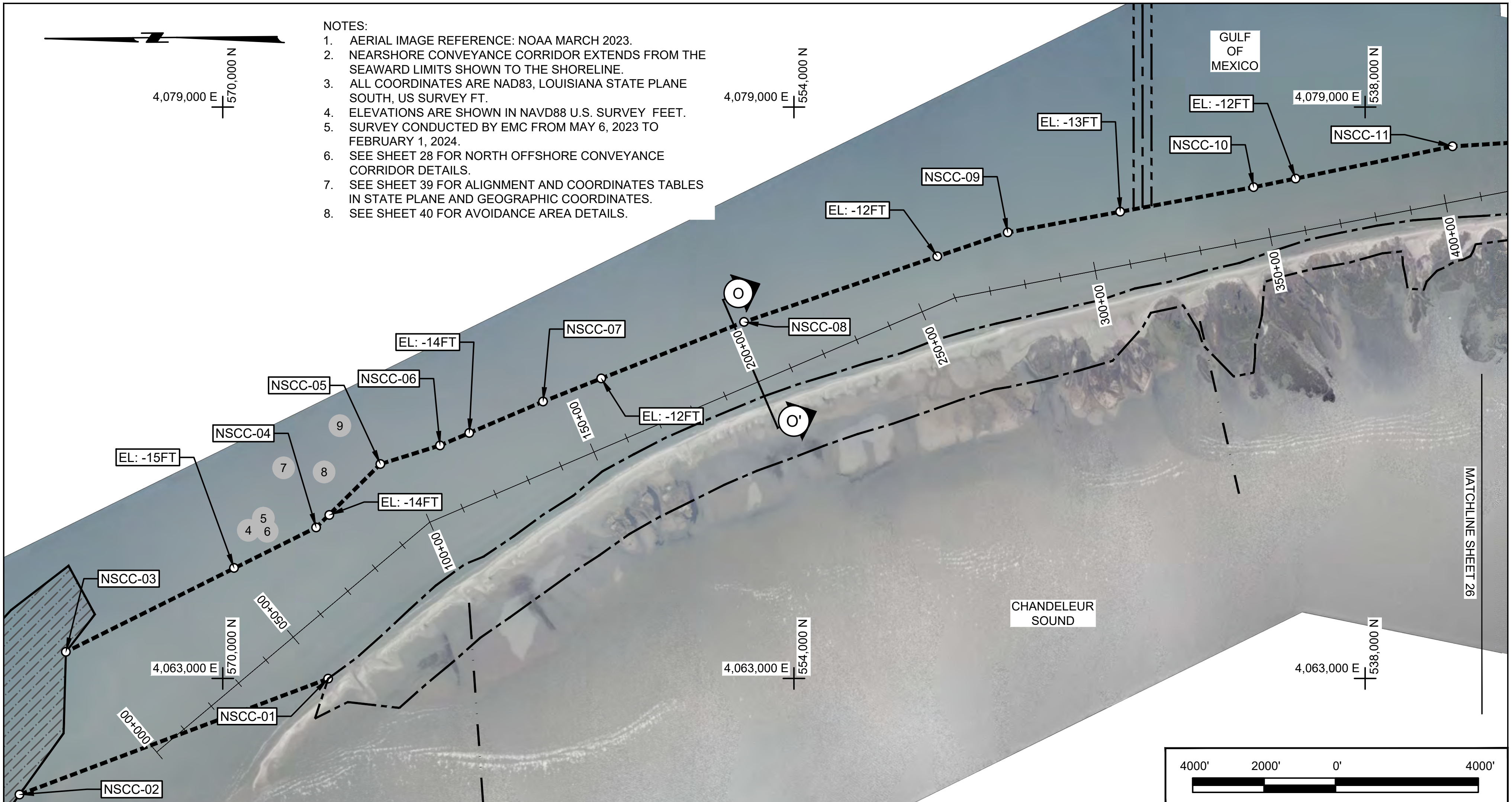
FEDERAL PROJECT NUMBER:

PUMP-OUT AREA AND CONVEYANCE CORRIDOR OVERVIEW

DATE: OCTOBER 2024

NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
3. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
4. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
5. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
6. SEE SHEET 28 FOR NORTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.
8. SEE SHEET 40 FOR AVOIDANCE AREA DETAILS.



LEGEND

- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT/LIMITS
- NSCC-01 — NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE
- EL: -16FT — EXISTING GRADE ELEVATION (FT, NAVD88)
- FILL EXTENTS
- ACCESS CHANNEL
- BORROW AREA
- 4 — AVOIDANCE AREA (TAR 2011)
- 100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

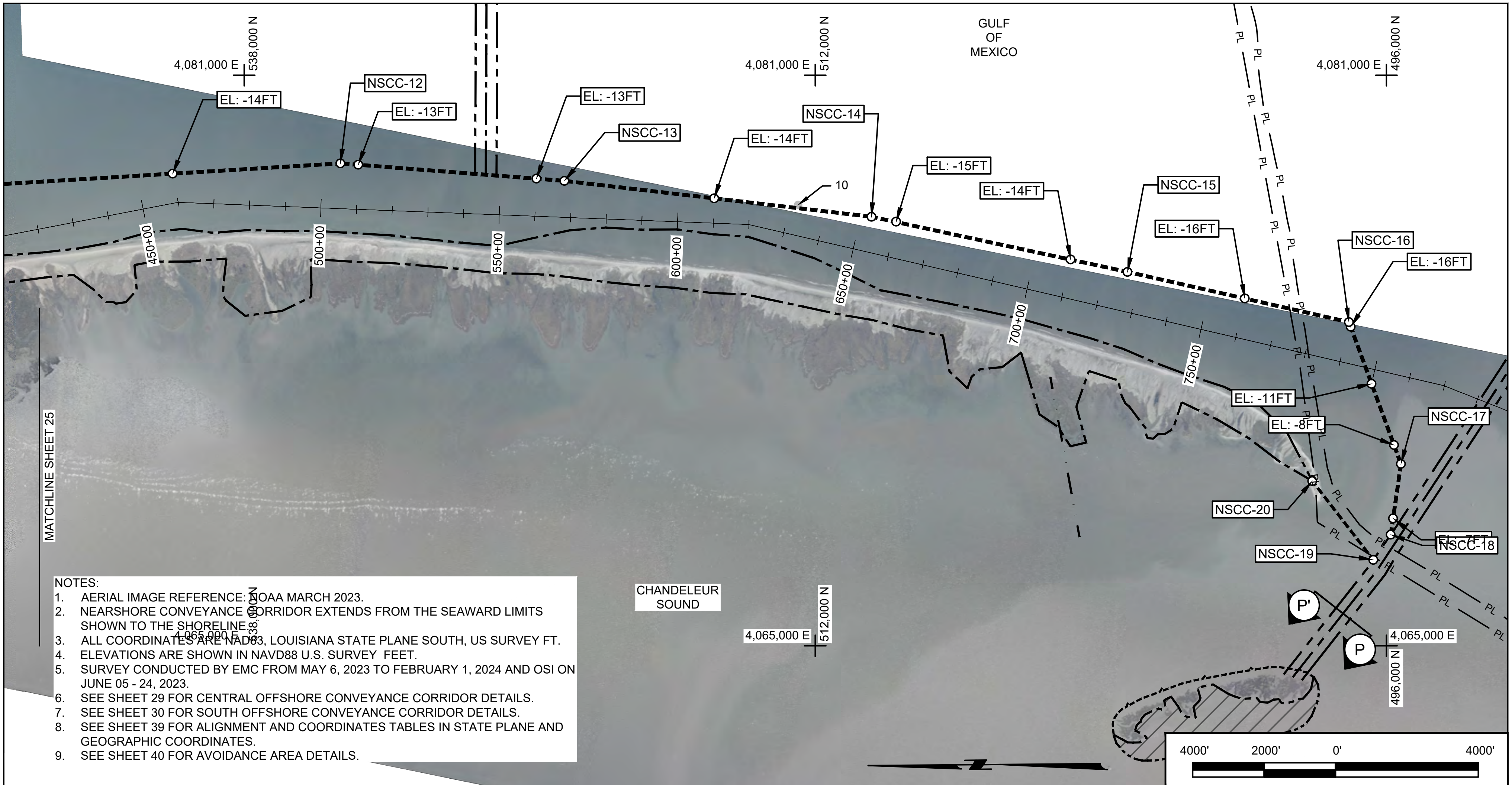
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NEARSHORE CONVEYANCE CORRIDOR PLAN VIEW

DATE: NOVEMBER 2024

SHEET 25 OF 40



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
3. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
4. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
5. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024 AND OSI ON JUNE 05 - 24, 2023.
6. SEE SHEET 29 FOR CENTRAL OFFSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 30 FOR SOUTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.
9. SEE SHEET 40 FOR AVOIDANCE AREA DETAILS.

LEGEND

- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT/LIMITS
- NSCC-01 — NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE
- EL: -16FT — EXISTING GRADE ELEVATION (FT, NAVD88)
- FILL EXTENTS
- ACCESS CHANNEL
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- 10 — AVOIDANCE AREA (TAR 2011)
- PL — PIPELINE
- 100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

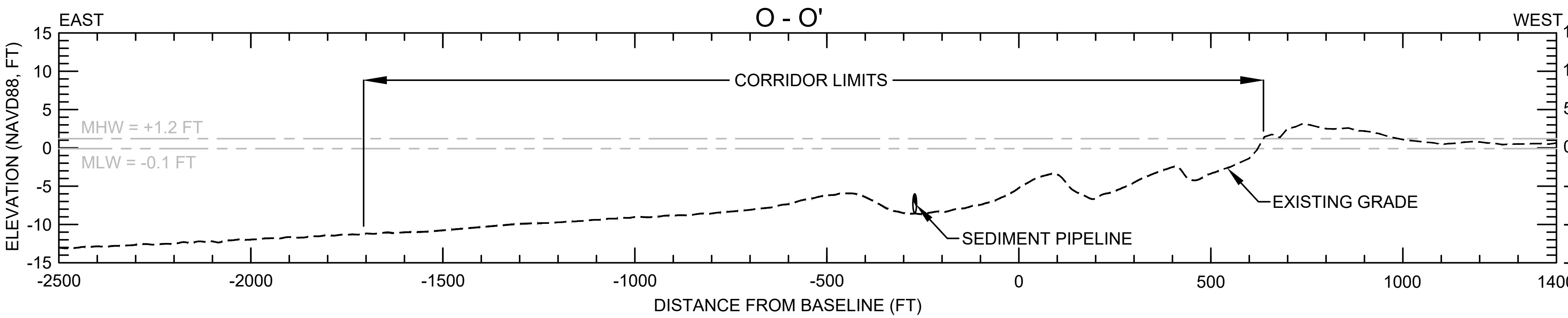
STATE PROJECT NUMBER: PO-0199

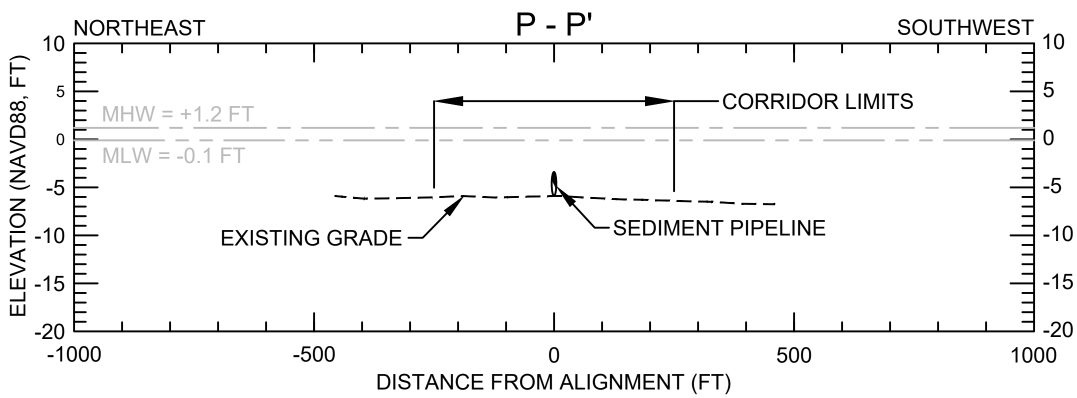
FEDERAL PROJECT NUMBER:

NEARSHORE CONVEYANCE CORRIDOR PLAN VIEW

DATE: NOVEMBER 2024

SHEET 26 OF 40





SCALE:
H: 1" = 400'
V: 1" = 20'

NOTES:
1. SURVEY CONDUCTED BY EMC, INC. FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEDIMENT PIPELINE INSTALLATION DETAILS ARE THE SAME FOR THE OFFSHORE CONVEYANCE CORRIDORS SHOWN ON SHEETS 28 - 30.
3. SEE SHEET 39 FOR ALIGNMENTS.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

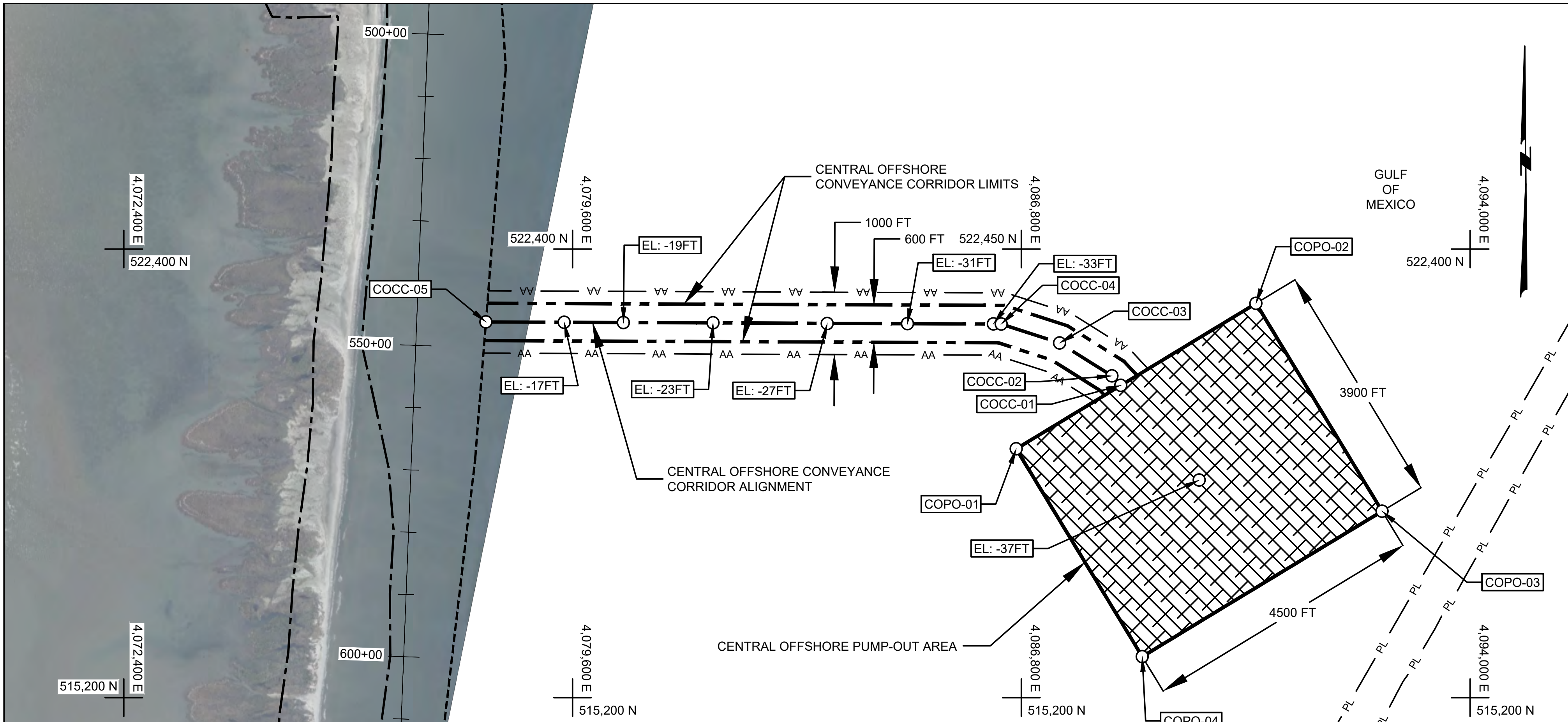
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NEARSHORE CONVEYANCE CORRIDOR TYPICAL SECTIONS

DATE: NOVEMBER 2024



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL ANCHORING WITHIN THE PUMP-OUT AREA SHALL BE CONDUCTED WITHIN THE PUMP-OUT AREA LIMITS.
3. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
4. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
5. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
6. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
7. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- CENTRAL OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- CENTRAL OFFSHORE PUMP-OUT AREA
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- COPO-01 — CENTRAL OFFSHORE PUMP-OUT AREA COORDINATE
- COCC-01 — CENTRAL OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE
- EL: -16FT — EXISTING GRADE ELEVATION(FT, NAVD88)
- AA — ANCHORAGE AREA
- FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
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DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

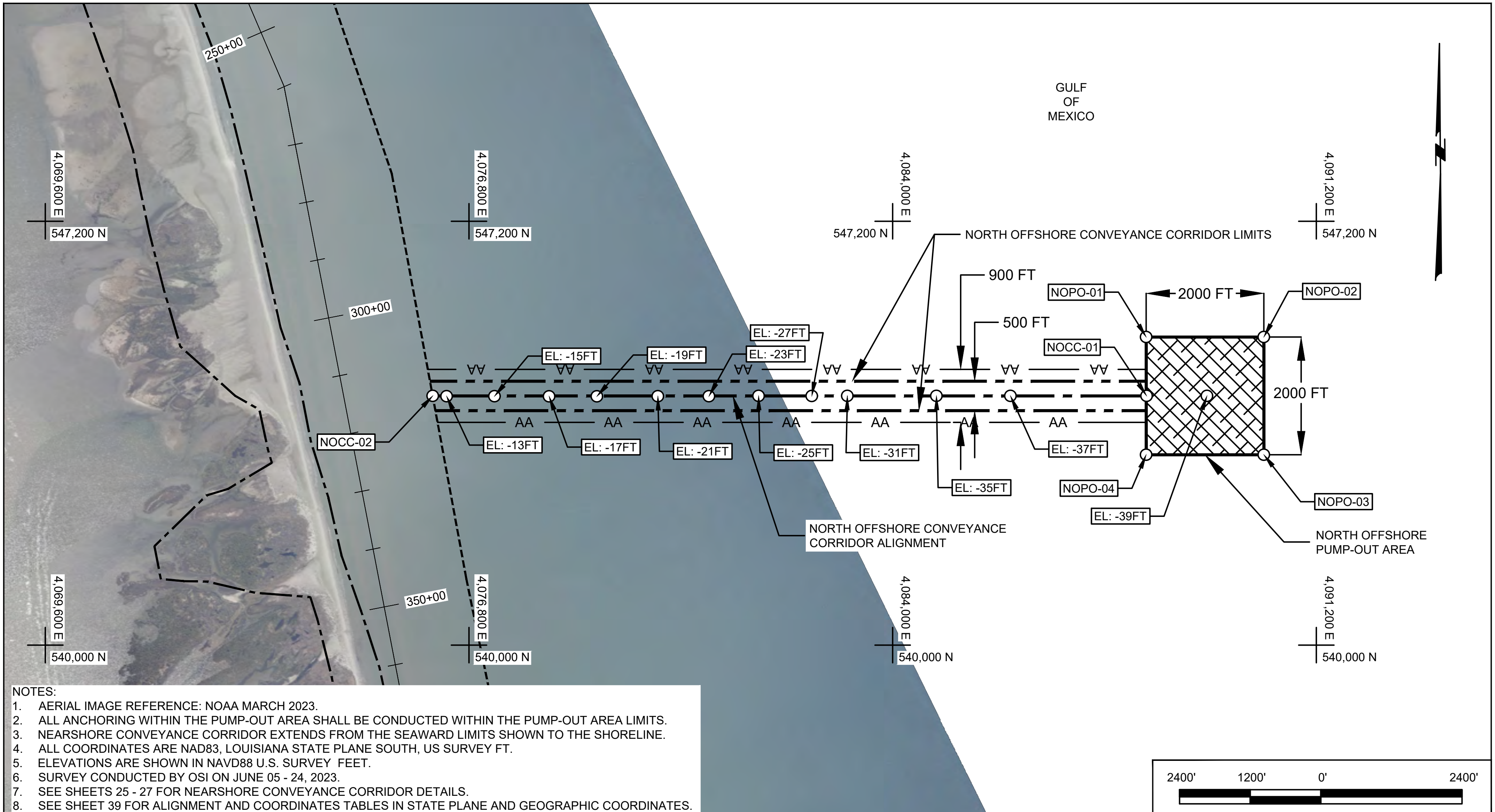
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

CENTRAL OFFSHORE PUMP-OUT AREA AND CONVEYANCE CORRIDOR PLAN VIEW

DATE: NOVEMBER 2024

SHEET 29 OF 40



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL ANCHORING WITHIN THE PUMP-OUT AREA SHALL BE CONDUCTED WITHIN THE PUMP-OUT AREA LIMITS.
3. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
4. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
5. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
6. SURVEY CONDUCTED BY OSI ON JUNE 05 - 24, 2023.
7. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

FILL EXTENTS

NORTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

NORTH OFFSHORE PUMP-OUT AREA

NEARSHORE CONVEYANCE CORRIDOR LIMITS

NOPO-01 — NORTH OFFSHORE PUMP-OUT AREA COORDINATE

NOCC-01 — NORTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE

EL: -16FT — EXISTING GRADE ELEVATION(FT, NAVD88)

AA — ANCHORAGE AREA

FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
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DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

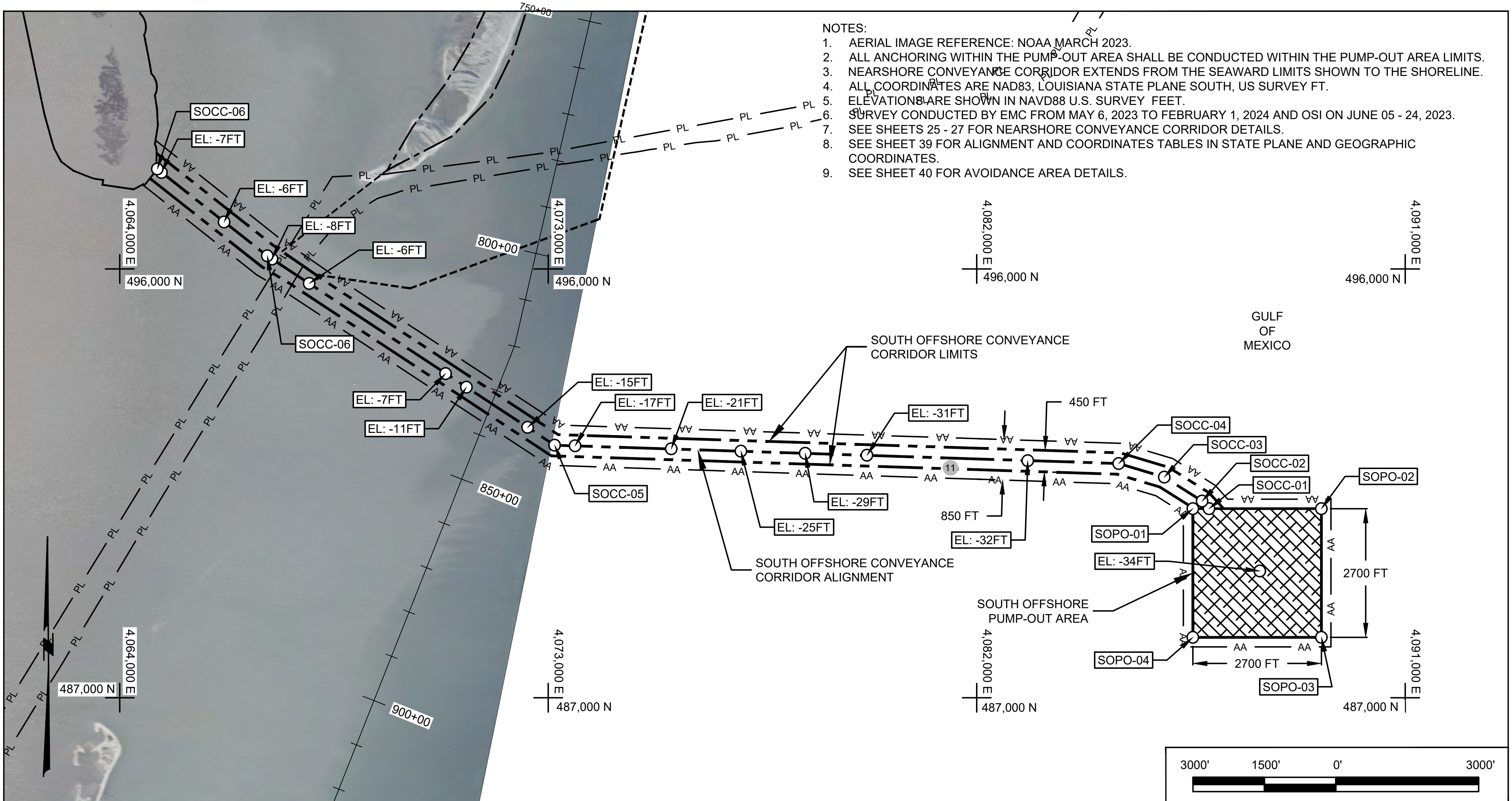
FEDERAL PROJECT NUMBER:

NORTH OFFSHORE PUMP-OUT AREA AND CONVEYANCE CORRIDOR PLAN VIEW

DATE: NOVEMBER 2024

SHEET 28 OF 40

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL ANCHORING WITHIN THE PUMP-OUT AREA SHALL BE CONDUCTED WITHIN THE PUMP-OUT AREA LIMITS.
3. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
4. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
5. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
6. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024 AND OSI ON JUNE 05 - 24, 2023.
7. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.
9. SEE SHEET 40 FOR AVOIDANCE AREA DETAILS.



LEGEND

- FILL EXTENTS
- NEW HARBOR ISLAND WORK AREA
- SOUTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- SOUTH OFFSHORE PUMP-OUT AREA
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- SOPO-01 — SOUTH OFFSHORE PUMP-OUT AREA COORDINATE
- SOCC-01 — SOUTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE
- EL: -16FT — EXISTING GRADE ELEVATION(FT, NAVD88)
- AA — ANCHORAGE AREA
- PL — PIPELINE
- 11 — AVOIDANCE AREA (TAR 2011)
- FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

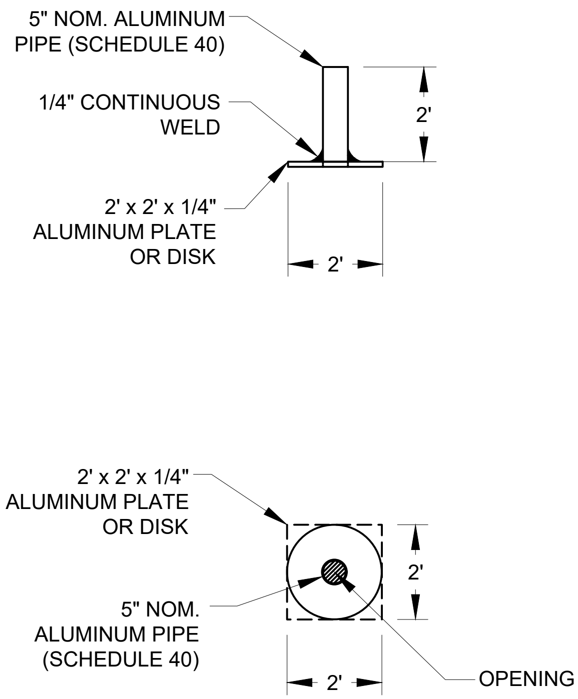
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

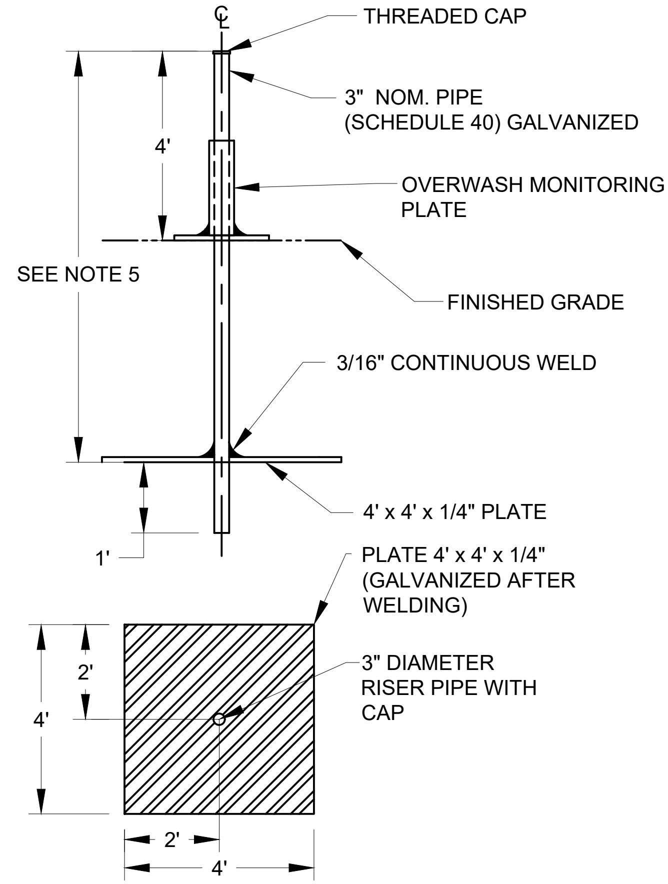
SOUTH OFFSHORE PUMP-OUT AREA AND CONVEYANCE CORRIDOR PLAN VIEW

DATE: NOVEMBER 2024

SHEET 30 OF 40



OVERWASH MONITORING PLATE
(NOT TO SCALE)



SETTLEMENT PLATE
(NOT TO SCALE)

SETTLEMENT AND OVERWASH MONITORING SYSTEM NOTES:

1. SETTLEMENT PLATES SHALL BE CONSTRUCTED USING ASTM A36 STEEL AND HOT- DIPPED GALVANIZED AFTER FABRICATION.
2. ALL SETTLEMENT PLATES SHALL BE SURVEYED WITHIN A DAY OF INSTALLATION AND WEEKLY THROUGHOUT THE DURATION OF THE PROJECT.
3. ALL SETTLEMENT PLATES MUST BE INSTALLED AND MAINTAINED WITHIN 10.5 DEGREES OF VERTICAL.
4. ALL SETTLEMENT PLATES SHALL BE MARKED WITH SURVEY FLAGGING.
5. LENGTH OF THE SETTLEMENT PLATE RISER PIPE SHALL BE SUCH THAT THE ELEVATION OF THE TOP CAP BE NO LESS THAN 4 FEET ABOVE MAXIMUM FINAL DESIGN GRADE FOR ITS LOCATION.
6. OVERWASH MONITORING PLATES SHALL BE FABRICATED USING 6061-TS GRADE ALUMINUM PER SPECIFICATION TS-16.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
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DESIGNED BY: BRETT BORNE, P.E.
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LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

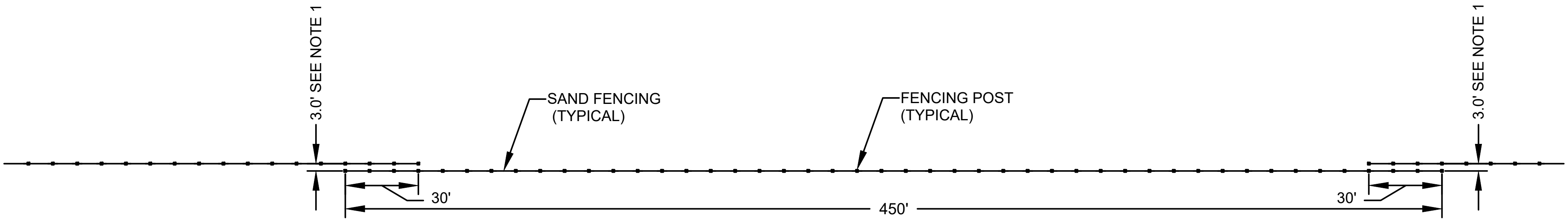
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

SETTLEMENT AND OVERWASH MONITORING DETAILS

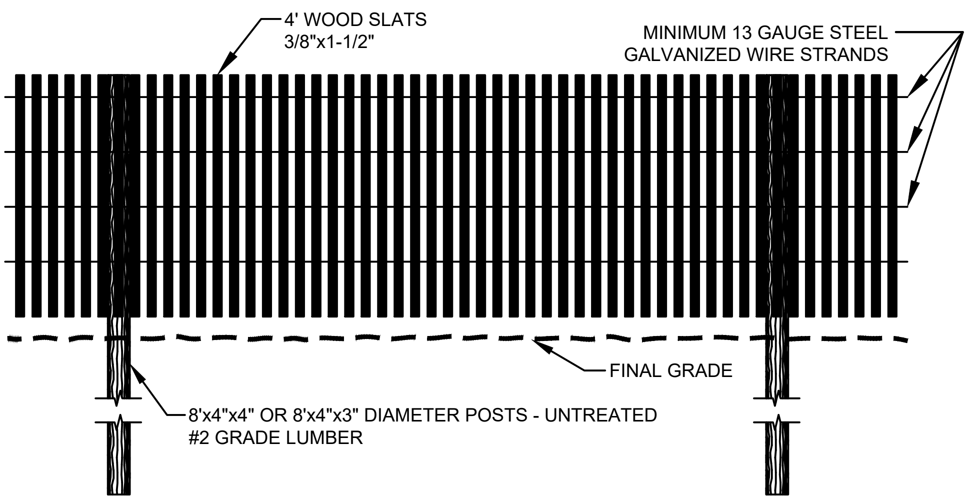
DATE: NOVEMBER 2024

SHEET 31 OF 40

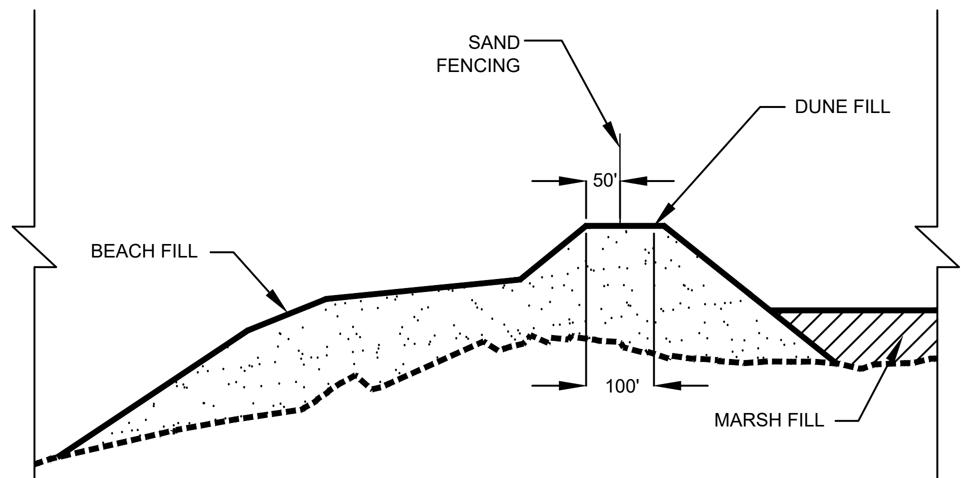


NOTES:
1. THE DISTANCE BETWEEN FENCES SHALL BE INCREASED FROM 3.0' TO 8.0' AT EVERY FIFTH GAP TO ALLOW ALL-TERRAIN VEHICLE ACCESS.

FENCING GAPPING DIMENSIONS
NOT TO SCALE



FENCING DETAIL
NOT TO SCALE



FENCING SECTION TYPICAL
NOT TO SCALE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

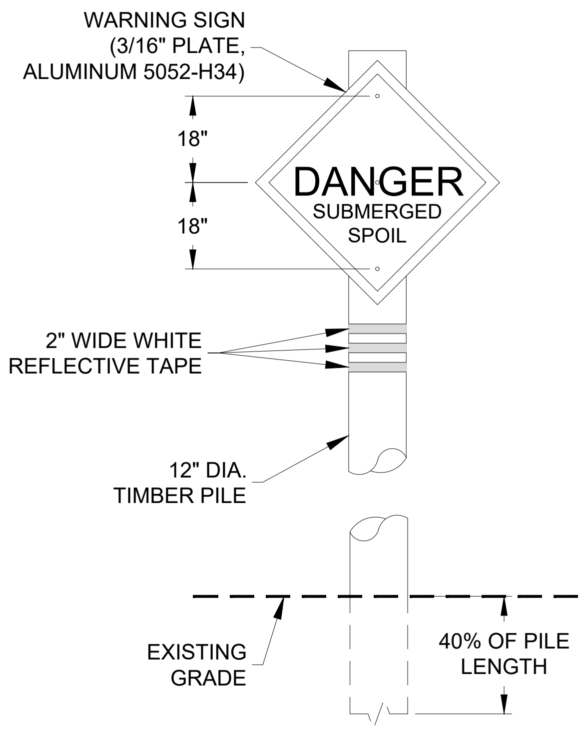
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

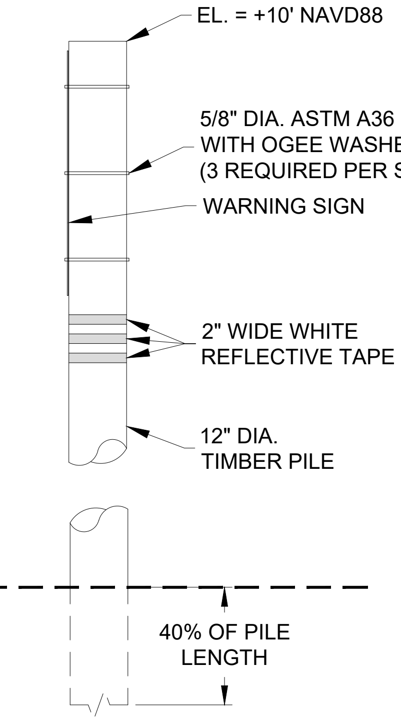
SAND FENCING DETAILS

DATE: NOVEMBER 2024

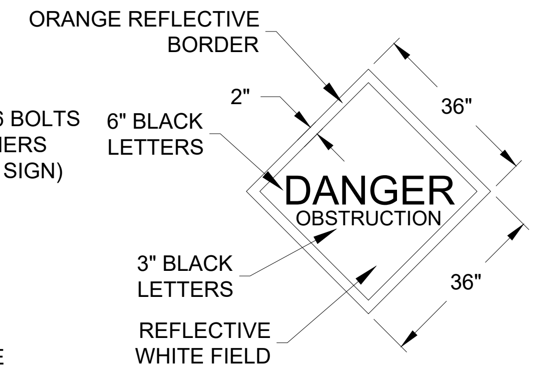
SHEET 32 OF 40



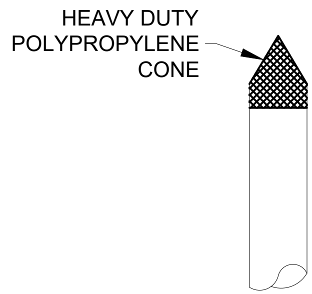
SIGN DETAIL



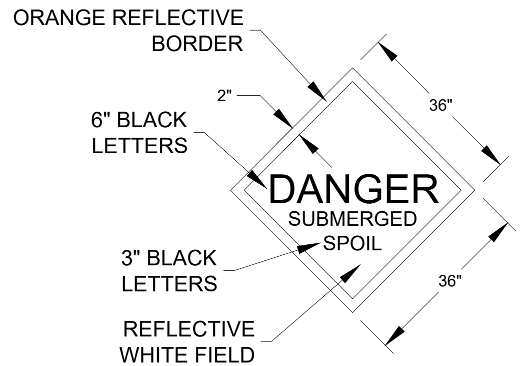
POST DETAIL



ROCK BREAKWATER SIGN DIMENSION
AND LETTERING DETAIL



TYPICAL TIMBER PILE
CAP



ROCK BREAKWATER SIGN DIMENSION
AND LETTERING DETAIL

NOTES:
1. WARNING SIGNS SHALL BE INSTALLED AS REQUIRED BY U.S. COAST GUARD.
2. WARNING SIGNS MUST MEET U.S. COAST GUARD STANDARDS.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
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1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

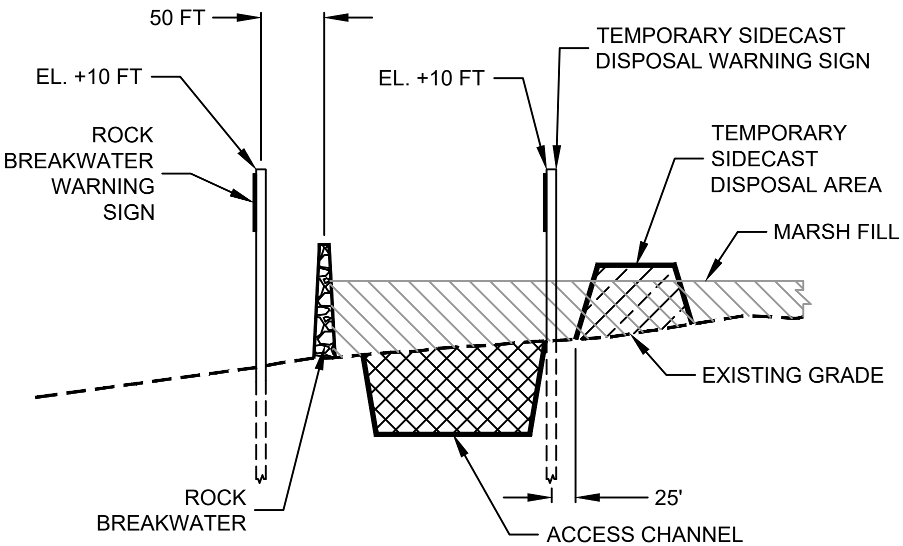
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

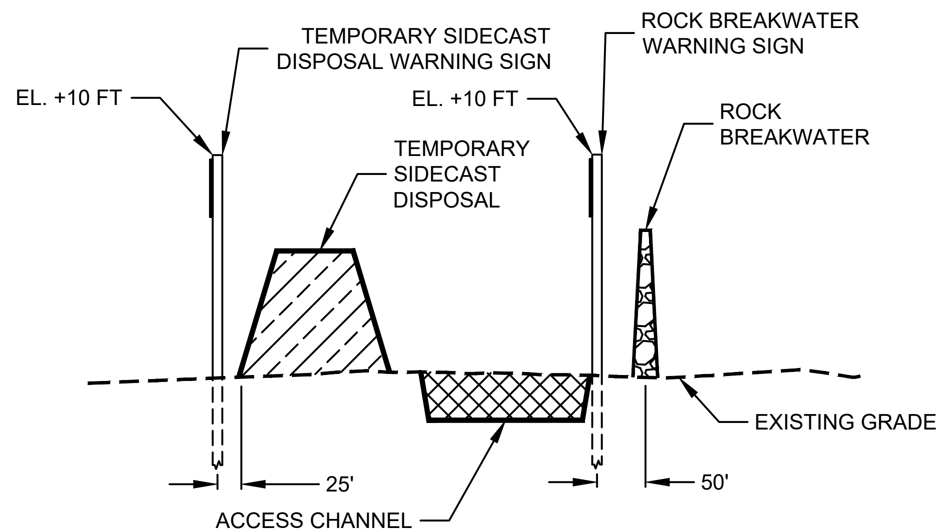
WARNING SIGN CONSTRUCTION DETAILS

DATE: NOVEMBER 2024

SHEET 33 OF 40



SHORELINE ROCK BREAKWATER
SIGN DETAIL
(NOT TO SCALE)



DETACHED ROCK BREAKWATER
SIGN DETAIL
(NOT TO SCALE)

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

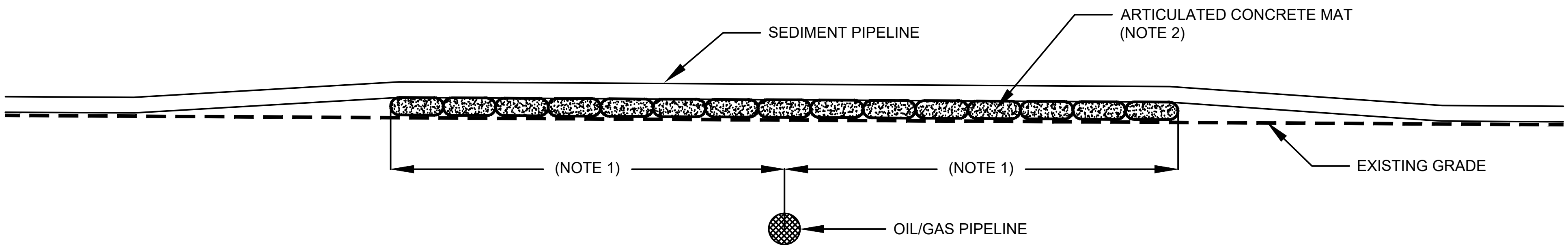
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

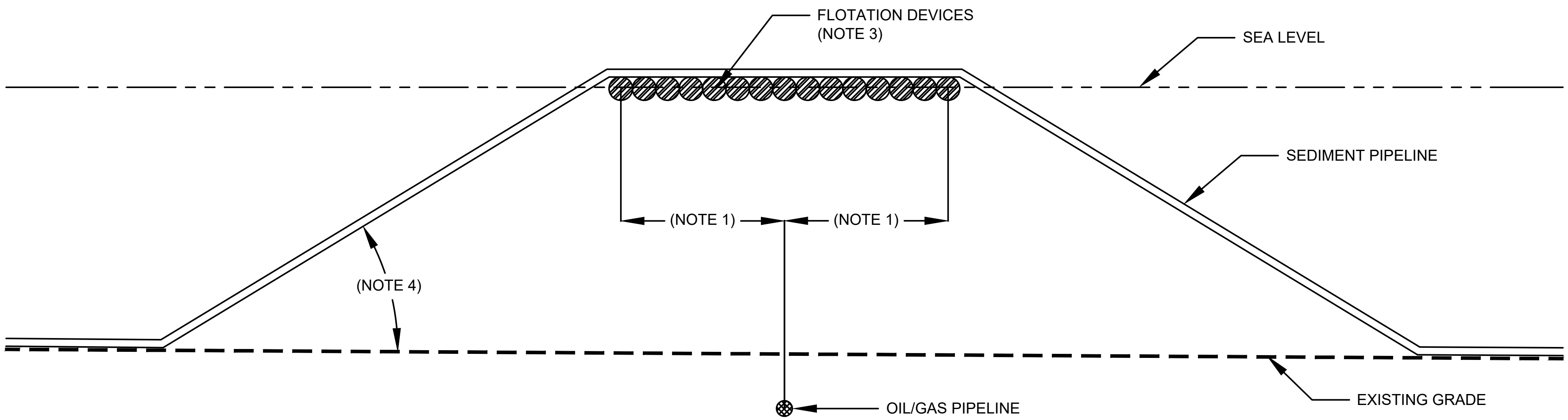
WARNING SIGN PLACEMENT DETAILS

DATE: NOVEMBER 2024

SHEET 34 OF 40



OPTIONAL ARTICULATED CONCRETE MAT PROTECTION CROSSING
(NOT TO SCALE)



OPTIONAL FLOTATION CROSSING
(NOT TO SCALE)

NOTES:

1. MEANS AND METHODS OF SEDIMENT PIPELINE CROSSING OF AN OIL/GAS PIPELINE SHALL BE COORDINATED BY THE CONSTRUCTION CONTRACTOR WITH THE OIL/GAS PIPELINE OPERATOR.
2. ARTICULATED CONCRETE MAT CONSTRUCTION AND COVERAGE AREA SHALL BE COORDINATED BY THE CONSTRUCTION CONTRACTOR WITH THE OIL/GAS PIPELINE OPERATOR.
3. FLOTATION DEVICE CONSTRUCTION AND PLACEMENT SHALL BE DETERMINED BY INDUSTRY STANDARDS FOR SEDIMENT PIPELINE SUPPORT AND CONSTRUCTION CONTRACTOR STANDARD EQUIPMENT.
4. ANGLE OF SEDIMENT PIPELINE DEPARTURE FROM EXISTING GRADE SHALL BE DETERMINED BY INDUSTRY STANDARDS FOR SEDIMENT PIPELINE SUPPORT AND CONSTRUCTION CONTRACTOR EQUIPMENT.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

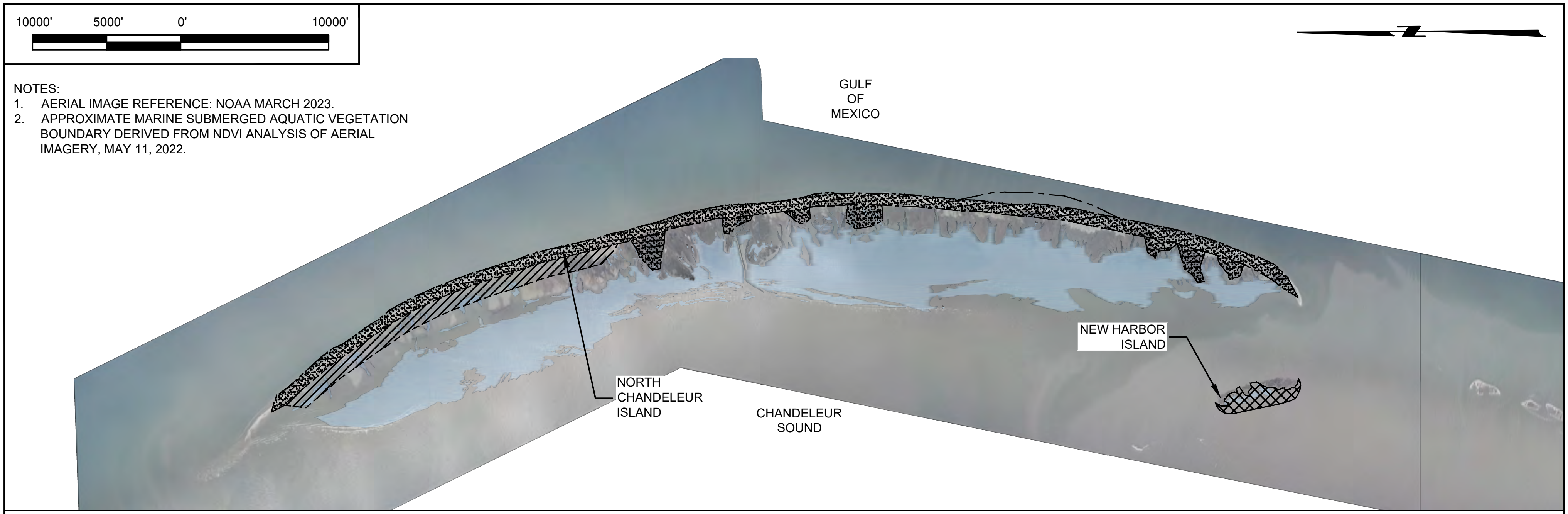
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

OPTIONAL SEDIMENT PIPELINE CROSSING TYPICAL DETAILS

DATE: NOVEMBER 2024

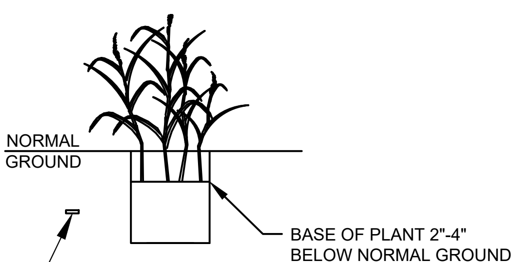
NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.



LEGEND

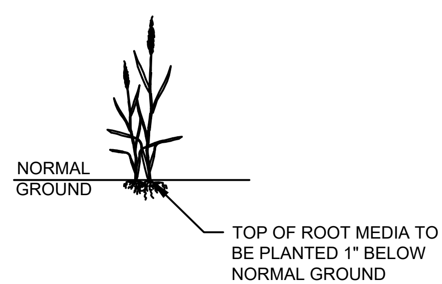
- BEACH/DUNE FILL PLANTING (PANICUM AMARUM)
- MARSH FILL PLANTING (SPARTINA ALTERNIFLORA)
- NEW HARBOR ISLAND PLANTING (AVICENNIA GERMINANS)
- MARINE SUBMERGED AQUATIC VEGETATION AREA (SEE NOTE 4)

NOTES:
1. PANICUM AMARUM PLANTS SHALL BE PLANTED ON SEVEN (7) FOOT CENTERS WITH ROWS TEN (10) FOOT APART.
2. SPARTINA ALTERNIFLORA PLANTS SHALL BE PLANTED ON THREE (3) FOOT CENTERS WITH ROWS THREE (3) FOOT APART.
3. AVICENNIA GERMINANS SHALL BE PLANTED ON EIGHT (8) FOOT CENTERS WITH ROWS EIGHT (8) FOOT APART.
4. SPECIES OF SEAGRASS THAT COULD BE PLANTED ARE THALASSIA TESTUDINUM, SYRINGODIUM FILIFORME, HALOPHILA ENGELMANNII, HALODULE BEAUDETTEI, AND RUPPIA MARITIMA.
5. SPECIES OF PLANTS AND SPACING ARE SUBJECT TO CHANGE DUE TO SITE CONDITIONS AND / OR CONSTRUCTION VARIABLES.

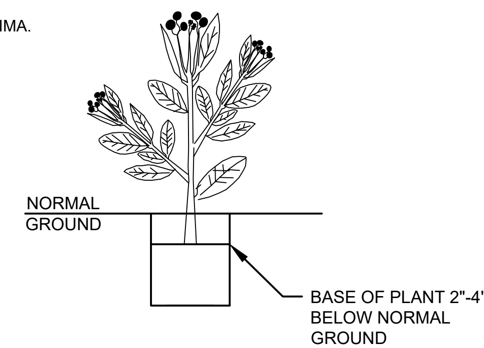


FERTILIZER TABLET TO BE PLACED WITHIN 2"-4" OF ROOTBALL EDGE, 3" BELOW NORMAL GROUND AS SPECIFIED

TYPICAL DETAIL A
PANICUM AMARUM
4" CONTAINER



TYPICAL DETAIL B
SPARTINA ALTERNIFLORA
PLUG



TYPICAL DETAIL C
AVICENNIA GERMINANS
GALLON CONTAINER

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

VEGETATIVE PLANTING DETAILS

DATE: NOVEMBER 2024

HEWES POINT BORROW AREA BOUNDARY				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
HPBA-01	580,626.71	4,048,229.40	30° 04' 27.37" N	88° 54' 25.05" W
HPBA-02	583,426.56	4,051,675.20	30° 04' 54.36" N	88° 53' 45.16" W
HPBA-03	583,477.79	4,052,050.62	30° 04' 54.79" N	88° 53' 40.87" W
HPBA-04	583,045.24	4,052,572.18	30° 04' 50.40" N	88° 53' 35.04" W
HPBA-05	583,427.92	4,055,377.81	30° 04' 53.59" N	88° 53' 03.02" W
HPBA-06	581,702.67	4,057,689.47	30° 04' 36.03" N	88° 52' 27.14" W
HPBA-07	581,325.90	4,057,999.26	30° 04' 32.23" N	88° 52' 33.70" W
HPBA-08	581,034.76	4,058,238.64	30° 04' 29.30" N	88° 52' 31.05" W
HPBA-09	579,796.65	4,059,604.51	30° 04' 16.76" N	88° 52' 15.81" W
HPBA-10	577,144.45	4,063,606.22	30° 03' 49.65" N	88° 51' 30.93" W
HPBA-11	575,927.81	4,064,917.53	30° 03' 37.33" N	88° 51' 16.31" W
HPBA-12	574,320.17	4,066,153.61	30° 03' 21.16" N	88° 51' 02.64" W
HPBA-13	573,585.20	4,064,792.56	30° 03' 14.17" N	88° 51' 18.31" W
HPBA-14	574,394.61	4,063,733.97	30° 03' 22.41" N	88° 51' 30.15" W
HPBA-15	574,458.27	4,061,462.08	30° 03' 23.53" N	88° 51' 55.98" W
HPBA-16	578,484.74	4,055,868.48	30° 04' 04.56" N	88° 52' 58.64" W
HPBA-17	577,427.19	4,054,568.51	30° 03' 54.37" N	88° 53' 13.69" W
HPBA-18	575,898.65	4,052,689.57	30° 03' 39.64" N	88° 53' 35.44" W

HEWES POINT BORROW AREA BASELINE ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
HPBL-01	588,200.00	4,054,100.00	30° 05' 41.09" N	88° 53' 16.41" W
HPBL-02	574,987.69	4,069,114.49	30° 03' 27.13" N	88° 50' 28.79" W

CHANDELEUR ISLAND RESTORATION AREA EXTENTS				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
CI-01	567,417.32	4,061,877.71	30° 02' 13.75" N	88° 51' 52.98" W
CI-02	498,075.82	4,069,620.16	29° 50' 45.82" N	88° 50' 42.04" W

NEW HARBOR ISLAND RESTORATION AREA EXTENTS				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
NHI-01	503,187.71	4,062,137.24	29° 51' 38.01" N	88° 52' 05.75" W
NHI-02	498,068.43	4,063,439.83	29° 50' 47.07" N	88° 51' 52.21" W

CHANDELEUR ISLAND RESTORATION AREA BASELINE ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
CIBL-01	571,852.61	4,060,935.79	30° 02' 57.85" N	88° 52' 02.61" W
CIBL-02	564,201.48	4,067,374.74	30° 01' 40.75" N	88° 50' 51.25" W
CIBL-03	549,487.10	4,073,658.62	29° 59' 13.77" N	88° 49' 43.43" W
CIBL-04	529,846.87	4,077,435.05	29° 55' 58.57" N	88° 49' 05.40" W
CIBL-05	513,859.05	4,076,810.86	29° 53' 20.47" N	88° 49' 16.48" W
CIBL-06	494,376.76	4,072,289.74	29° 50' 08.63" N	88° 50' 12.65" W
CIBL-07	484,152.16	4,068,232.97	29° 48' 28.31" N	88° 51' 01.22" W

ACCESS CHANNEL - NORTH ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
ACN-01	562,687.13	4,059,123.81	30° 01' 27.53" N	88° 52' 25.46" W
ACN-01	563,077.78	4,065,111.08	30° 01' 30.11" N	88° 51' 17.27" W

ACCESS CHANNEL - CENTRAL ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
ACC-01	541,522.11	4,068,123.51	29° 57' 56.13" N	88° 50' 48.33" W
ACC-01	542,625.61	4,073,000.22	29° 58' 06.00" N	88° 49' 52.62" W

ACCESS CHANNEL - SOUTH ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
ACS-01	504,590.66	4,068,002.39	29° 51' 50.64" N	88° 50' 58.81" W
ACS-01	505,420.67	4,072,526.90	29° 51' 57.89" N	88° 50' 07.22" W

ROCK BREAKWATER - SHORELINE ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
RKS-01	503,638.37	4,062,505.15	29° 51' 42.39" N	88° 52' 01.46" W
RKS-02	503,631.64	4,062,458.75	29° 51' 42.34" N	88° 52' 01.99" W
RKS-03	503,563.05	4,062,270.88	29° 51' 41.70" N	88° 52' 04.14" W
RKS-04	503,405.25	4,062,077.13	29° 51' 40.18" N	88° 52' 06.38" W
RKS-05	503,257.61	4,061,942.22	29° 51' 38.75" N	88° 52' 07.95" W
RKS-06	503,035.03	4,061,828.38	29° 51' 36.57" N	88° 52' 09.29" W
RKS-07	502,840.59	4,061,781.52	29° 51' 34.65" N	88° 52' 09.87" W
RKS-08	502,590.61	4,061,779.12	29° 51' 32.18" N	88° 52' 09.96" W
RKS-09	502,391.08	4,061,792.94	29° 51' 30.20" N	88° 52' 09.85" W
RKS-10	502,047.99	4,061,862.13	29° 51' 26.79" N	88° 52' 09.15" W
RKS-11	501,607.40	4,061,953.70	29° 51' 22.41" N	88° 52' 08.22" W
RKS-12	500,628.52	4,062,158.11	29° 51' 12.68" N	88° 52' 06.14" W
RKS-13	499,649.82	4,062,363.41	29° 51' 02.95" N	88° 52' 04.04" W
RKS-14	499,258.76	4,062,447.51	29° 50' 59.06" N	88° 52' 03.18" W
RKS-15	498,680.52	4,062,607.63	29° 50' 53.30" N	88° 52' 01.51" W
RKS-16	498,529.52	4,062,662.92	29° 50' 51.80" N	88° 52' 00.92" W
RKS-17	498,272.81	4,062,794.11	29° 50' 49.23" N	88° 51' 59.49" W
RKS-18	498,094.01	4,063,035.00	29° 50' 47.41" N	88° 51' 56.80" W
RKS-19	498,000.17	4,063,266.72	29° 50' 46.43" N	88° 51' 54.19" W
RKS-20	497,927.78	4,063,453.16	29° 50' 45.67" N	88° 51' 52.09" W
RKS-21	497,894.50	4,063,650.38	29° 50' 45.30" N	88° 51' 49.86" W
RKS-22	497,910.40	4,063,899.87	29° 50' 45.41" N	88° 51' 47.03" W
RKS-23	498,030.45	4,064,119.16	29° 50' 46.55" N	88° 51' 44.51" W
RKS-24	498,042.35	4,064,126.88	29° 50' 46.66" N	88° 51' 44.42" W

ROCK BREAKWATER - FISH DIP LOCATION				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
FD-01	503,528.02	4,062,227.86	29° 51' 41.36" N	88° 52' 04.64" W
FD-02	502,715.11	4,061,780.32	29° 51' 33.41" N	88° 52' 09.92" W
FS-03	501,656.88	4,061,943.29	29° 51' 22.90" N	88° 52' 08.32" W
FS-04	500,677.48	4,062,147.88	29° 51' 13.17" N	88° 52' 06.24" W
FS-05	499,698.68	4,062,353.16	29° 51' 03.43" N	88° 52' 04.15" W
FS-06	498,729.87	4,062,593.96	29° 50' 53.79" N	88° 52' 01.65" W
FS-07	498,019.02	4,063,220.18	29° 50' 46.63" N	88° 51' 54.72" W

ROCK BREAKWATER - DETACHED ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
RKD-01	503,638.37	4,062,505.15	29° 51' 42.39" N	88° 52' 01.46" W
RKD-02	503,660.32	4,062,656.68	29° 51' 42.58" N	88° 51' 59.73" W
RKD-03	503,666.64	4,062,806.55	29° 51' 42.61" N	88° 51' 58.03" W
RKD-04	503,652.96	4,062,905.61	29° 51' 42.45" N	88° 51' 56.91" W
RKD-05	503,607.06	4,062,994.45	29° 51' 41.98" N	88° 51' 55.91" W
RKD-06	503,522.18	4,063,118.13	29° 51' 41.11" N	88° 51' 54.53" W
RKD-07	503,411.99	4,063,219.90	29° 51' 40.00" N	88° 51' 53.40" W
RKD-08	503,293.04	4,063,286.36	29° 51' 38.81" N	88° 51' 52.67" W
RKD-09	503,248.65	4,063,403.21	29° 51' 38.35" N	88° 51' 51.36" W
RKD-10	503,192.65	4,063,342.46	29° 51' 37.80" N	88° 51' 52.06" W
RKD-11	502,991.87	4,063,454.66	29° 51' 35.79" N	88° 51' 50.84" W
RKD-12	502,810.76	4,063,539.50	29° 51' 33.98" N	88° 51' 49.92" W
RKD-13	502,529.28	4,063,643.28	29° 51' 31.17" N	88° 51' 48.81" W
RKD-14	502,355.56	4,063,708.21	29° 51' 29.44" N	88° 51' 48.11" W
RKD-15	502,294.00	4,063,817.00	29° 51' 28.81" N	88° 51' 46.89" W
RKD-16	502,247.84	4,063,748.48	29° 51' 28.37" N	88° 51' 47.68" W
RKD-17	501,732.66	4,063,941.05	29° 51' 23.23" N	88° 51' 45.62" W
RKD-18	501,344.20	4,064,036.44	29° 51' 19.36" N	88° 51' 44.63" W
RKD-19	501,161.96	4,064,071.04	29° 51' 17.55" N	88° 51' 44.29" W
RKD-20	501,082.87	4,064,167.84	29° 51' 16.75" N	88° 51' 43.21" W
RKD-21	501,048.97	4,064,092.49	29° 51' 16.43" N	88° 51' 44.07" W
RKD-22	500,754.24	4,064,148.45	29° 51' 13.50" N	88° 51' 43.51" W
RKD-23	500,508.61	4,064,195.00	29° 51' 11.06" N	88° 51' 43.04" W
RKD-24	500,213.85	4,064,250.82	29° 51' 08.13" N	88° 51' 42.48" W
RKD-25	500,065.81	4,064,274.99	29° 51' 06.66" N	88° 51' 42.24" W
RKD-26	499,818.93	4,064,314.38	29° 51' 04.21" N	88° 51' 41.85" W
RKD-27	499,812.59	4,064,396.75	29° 51' 04.13" N	88° 51' 40.92" W
RKD-28	499,705.37	4,064,332.49	29° 51' 03.08" N	88° 51' 41.67" W
RKD-29	499,324.70	4,064,393.23	29° 50' 59.30" N	88° 51' 41.08" W
RKD-30	499,025.05	4,064,407.74	29° 50' 56.33" N	88° 51' 40.99" W
RKD-31	498,629.97	4,064,345.21	29° 50' 52.43" N	88° 51' 41.79" W
RKD-32	498,483.82	4,064,311.45	29° 50' 50.99" N	88° 51' 42.21" W
RKD-33	498,446.98	4,064,385.41	29° 50' 50.61" N	88° 51' 41.38" W
RKD-34	498,371.77	4,064,285.57	29° 50' 49.89" N	88° 51' 42.53" W
RKD-35	498,240.20	4,064,255.18	29° 50' 48.59" N	88° 51' 42.91" W
RKD-36	498,042.35	4,064,126.88	29° 50' 46.66" N	88° 51' 44.42" W

BY	DESCRIPTION	DATE
SD	WEST BELLE RECOVERY PROJECT "TE-176" MODIFICATION TO TE-118 EAST TIMBALIER ISLAND RESTORATION	02/ 2023

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

ALIGNMENT AND COORDINATE TABLES

STATE PROJECT NUMBER: PO-0199

DATE: NOVEMBER 2024

FEDERAL PROJECT NUMBER:

NEARSHORE CONVEYANCE CORRIDOR LIMITS

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
NSCC-01	567,048.15	4,062,992.09	30° 02' 09.86" N	88° 51' 40.40" W
NSCC-02	575,693.44	4,059,746.17	30° 03' 36.12" N	88° 52' 15.20" W
NSCC-03	574,394.40	4,063,741.35	30° 03' 22.41" N	88° 51' 30.07" W
NSCC-04	567,383.43	4,067,225.11	30° 02' 12.27" N	88° 50' 52.16" W
NSCC-05	565,583.53	4,069,002.80	30° 01' 54.08" N	88° 50' 32.39" W
NSCC-06	563,914.72	4,069,523.00	30° 01' 37.45" N	88° 50' 26.88" W
NSCC-07	561,027.15	4,070,752.20	30° 01' 08.61" N	88° 50' 13.62" W
NSCC-08	555,396.35	4,072,981.95	30° 00' 12.40" N	88° 49' 49.66" W
NSCC-09	548,008.60	4,075,487.55	29° 58' 58.74" N	88° 49' 23.01" W
NSCC-10	541,120.90	4,076,755.85	29° 57' 50.30" N	88° 49' 10.31" W
NSCC-11	535,550.20	4,077,899.25	29° 56' 54.92" N	88° 48' 58.70" W
NSCC-12	525,300.55	4,078,527.73	29° 55' 13.34" N	88° 48' 54.12" W
NSCC-13	519,027.30	4,078,037.05	29° 54' 11.36" N	88° 49' 01.26" W
NSCC-14	510,424.05	4,077,031.35	29° 52' 46.43" N	88° 49' 14.83" W
NSCC-15	503,253.38	4,075,484.28	29° 51' 35.80" N	88° 49' 34.18" W
NSCC-16	497,049.11	4,074,076.21	29° 50' 34.70" N	88° 49' 51.71" W
NSCC-17	495,592.98	4,070,098.22	29° 50' 21.14" N	88° 50' 37.23" W
NSCC-18	495,879.61	4,068,116.93	29° 50' 24.40" N	88° 50' 59.65" W
NSCC-19	496,367.75	4,067,409.06	29° 50' 29.39" N	88° 51' 07.56" W
NSCC-20	498,075.82	4,069,620.16	29° 50' 45.82" N	88° 50' 42.04" W

NORTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
NOCC-01	544,233.11	4,088,316.56	29° 58' 18.57" N	88° 46' 58.12" W
NOCC-02	544,233.06	4,076,182.78	29° 58' 21.22" N	88° 49' 16.05" W

NORTH OFFSHORE PUMP-OUT AREA BOUNDARY

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
NOPO-01	545,233.11	4,088,309.13	29° 58' 28.47" N	88° 46' 57.95" W
NOPO-02	545,233.11	4,090,309.13	29° 58' 28.03" N	88° 46' 35.21" W
NOPO-03	543,233.11	4,090,309.13	29° 58' 08.23" N	88° 46' 35.72" W
NOPO-04	543,233.11	4,088,309.13	29° 58' 08.67" N	88° 46' 58.46" W

CENTRAL OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
COCC-01	520,211.48	4,088,396.82	29° 54' 20.81" N	88° 47' 03.28" W
COCC-02	520,363.89	4,088,254.38	29° 54' 22.35" N	88° 47' 04.86" W
COCC-03	520,892.17	4,087,414.58	29° 54' 27.76" N	88° 47' 14.27" W
COCC-04	521,195.60	4,086,477.40	29° 54' 30.97" N	88° 47' 24.84" W
COCC-05	521,299.21	4,078,209.28	29° 54' 33.11" N	88° 48' 58.76" W

CENTRAL OFFSHORE PUMP-OUT AREA BOUNDARY

PI NUMBER	NORTHING	EASTING	LATITUDE	LONGITUDE
COPO-01	519,192.79	4,086,717.70	29° 54' 11.10" N	88° 47' 22.61" W
COPO-02	521,526.90	4,090,565.03	29° 54' 33.35" N	88° 46' 38.32" W
COPO-03	518,192.55	4,092,587.92	29° 53' 59.90" N	88° 46' 16.18" W
COPO-04	515,858.44	4,088,740.59	29° 53' 37.65" N	88° 47' 00.48" W

SOUTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

PI NUMBER	NORTHING	EASTING	LATITUDE	LONGITUDE
SOCC-01	490,968.33	4,086,881.41	29° 49' 31.72" N	88° 47' 27.87" W
SOCC-02	491,126.78	4,086,736.81	29° 49' 33.32" N	88° 47' 29.47" W
SOCC-03	491,629.56	4,085,939.79	29° 49' 38.47" N	88° 47' 38.39" W
SOCC-04	491,915.91	4,084,984.02	29° 49' 41.52" N	88° 47' 49.17" W
SOCC-05	492,300.25	4,073,134.99	29° 49' 47.90" N	88° 50' 03.57" W
SOCC-06	498,096.64	4,064,788.76	29° 50' 47.06" N	88° 51' 36.89" W

SOUTH OFFSHORE PUMP-OUT AREA BOUNDARY

PI NUMBER	NORTHING	EASTING	LATITUDE	LONGITUDE
SOPO-01	490,968.33	4,086,540.65	29° 49' 31.80" N	88° 47' 31.73" W
SOPO-02	490,968.33	4,089,240.65	29° 49' 21.20" N	88° 47' 01.09" W
SOPO-03	488,268.33	4,089,240.65	29° 49' 04.48" N	88° 47' 01.77" W
SOPO-04	488,268.33	4,086,540.65	29° 49' 05.08" N	88° 47' 32.41" W

BY	DESCRIPTION	DATE
SD	WEST BELLE RECOVERY PROJECT "TE-176" MODIFICATION TO TE-118 EAST TIMBALIER ISLAND RESTORATION	02/ 2023

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APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ALIGNMENT AND COORDINATE TABLES

DATE: NOVEMBER 2024

AVOIDANCE AREA DETAILS					
NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE	RADIUS (FT)
1	582,580.61	4,056,155.58	30° 04' 45.04" N	88° 52' 54.38" W	175
2	579,364.42	4,058,341.09	30° 04' 12.75" N	88° 52' 30.29" W	150
3	578,368.00	4,062,648.00	30° 04' 01.97" N	88° 51' 41.53" W	200
4	569,282.50	4,067,144.60	30° 02' 31.09" N	88° 50' 52.61" W	300
5	568,858.90	4,067,484.90	30° 02' 26.82" N	88° 50' 48.84" W	300
6	568,753.00	4,067,120.20	30° 02' 25.85" N	88° 50' 53.02" W	300
7	568,295.10	4,068,895.40	30° 02' 20.94" N	88° 50' 32.94" W	300
8	567,161.40	4,068,779.50	30° 02' 09.74" N	88° 50' 34.54" W	300
9	566,716.60	4,070,075.00	30° 02' 05.06" N	88° 50' 19.91" W	300
10	512,476.63	4,077,363.50	29° 53' 06.67" N	88° 49' 10.54" W	100
11	491,823.80	4,081,450.20	29° 49' 41.38" N	88° 48' 29.30" W	150

SETTLEMENT AND OVERWASH MONITORING SYSTEM LOCATION									
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE	PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
SOP-01	565,284.69	4,063,659.89	30° 01' 52.27" N	88° 51' 33.23" W	SOP-15	531,753.82	4,075,744.55	29° 56' 17.81" N	88° 49' 24.14" W
SOP-02	564,707.76	4,063,283.33	30° 01' 46.64" N	88° 51' 37.66" W	SOP-16	531,448.28	4,075,127.73	29° 56' 14.92" N	88° 49' 31.22" W
SOP-03	560,931.16	4,066,956.64	30° 01' 08.47" N	88° 50' 56.81" W	SOP-17	527,126.32	4,076,049.40	29° 55' 31.95" N	88° 49' 21.82" W
SOP-04	560,535.77	4,066,430.60	30° 01' 04.67" N	88° 51' 02.89" W	SOP-18	526,933.44	4,075,097.99	29° 55' 30.24" N	88° 49' 32.68" W
SOP-05	556,635.83	4,069,490.04	30° 00' 25.42" N	88° 50' 29.06" W	SOP-19	522,128.04	4,075,759.20	29° 54' 42.54" N	88° 49' 26.36" W
SOP-06	556,178.62	4,068,958.86	30° 00' 21.01" N	88° 50' 35.21" W	SOP-20	517,154.50	4,075,329.07	29° 53' 53.41" N	88° 49' 32.49" W
SOP-07	551,951.78	4,071,214.80	29° 59' 38.69" N	88° 50' 10.61" W	SOP-21	512,519.97	4,074,741.18	29° 53' 07.67" N	88° 49' 40.32" W
SOP-08	551,467.08	4,070,657.28	29° 59' 34.01" N	88° 50' 17.07" W	SOP-22	507,644.03	4,073,771.43	29° 52' 19.62" N	88° 49' 52.54" W
SOP-09	546,465.35	4,072,808.20	29° 58' 44.05" N	88° 49' 53.85" W	SOP-23	504,835.66	4,072,082.96	29° 51' 52.19" N	88° 50' 12.41" W
SOP-10	546,148.75	4,072,186.57	29° 58' 41.05" N	88° 50' 01.00" W	SOP-24	502,812.94	4,072,422.46	29° 51' 32.10" N	88° 50' 09.06" W
SOP-11	541,627.62	4,074,021.39	29° 57' 55.90" N	88° 49' 41.26" W	SOP-25	502,732.69	4,071,661.32	29° 51' 31.47" N	88° 50' 17.72" W
SOP-12	541,695.51	4,072,574.26	29° 57' 56.89" N	88° 49' 57.70" W	SOP-26	502,390.40	4,062,633.98	29° 51' 30.02" N	88° 52' 00.30" W
SOP-13	536,695.40	4,075,159.81	29° 57' 06.84" N	88° 49' 29.55" W	SOP-27	500,446.95	4,063,112.27	29° 51' 10.68" N	88° 51' 55.35" W
SOP-14	536,425.66	4,074,505.32	29° 57' 04.32" N	88° 49' 37.06" W	SOP-28	498,890.32	4,063,122.72	29° 50' 55.27" N	88° 51' 55.61" W

Attachment C
Species Life History Tables

Attachment C-1

Life Histories for GMFMC Managed Fishes Identified in Ecoregion 3 in the Gulf of America

Attachment C-1: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 3 in the Gulf of America

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
SHRIMP									
Brown Shrimp (*Penaeus aztecus*)									
fertilized eggs (0.26 mm diameter)	3,4,5	offshore	soft bottom, sand/shell	fall and spring	>24	18-110	N/A	N/A	Hatch 24 hours after spawning
Larvae, pre-settlement postlarvae (<14 mm)	3,4,5	estuarine, nearshore, offshore	WCA	year-round, peak: spring	28-30	0-82	phytoplankton and zooplankton	N/A	N/A
late post larvae juveniles (14 – 80 mm)	3,4,5	estuarine	SAV, emergent marsh, oyster reef, soft bottom, sand/shell	spring – fall	7–35	< 1	benthic algae, polychaete worms, peracarid crustaceans	predation is the major cause of mortality, cold temperatures in shallow water	higher growth rates in salt marsh than soft bottom and with carnivorous feeding; reduced growth in low salinity due to increased metabolic costs and decreased food resources; 0.9 mm/day
sub – adults	3,4,5	estuarine, nearshore	soft bottom, sand/shell	spring – fall	18–28	1–18	polychaetes, amphipods, other benthic invertebrates	cold fronts, hypoxia	N/A
non-spawning adults (females > 140 mm TL)	3,4,5	offshore	soft bottom, sand/shell	summer and fall	10–37	14-110	omnivorous, feed at night	N/A	N/A
spawning adults	3,4,5	offshore	soft bottom, sand/shell	fall and spring, year-round in depths >64m	N/A	18–110	omnivorous, feed at night	N/A	N/A

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Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
Pink Shrimp (*Penaeus duorarum*)									
fertilized eggs (0.31 – 0.33 mm diameter)	1,2,3,5	offshore	sand/shell	year - round	> 27	9–48	N/A	N/A	N/A
larvae, pre-settlement postlarvae (< 15 mm)	1,2,3,5	estuarine, nearshore, offshore	WCA	year - round	15-35	1-50	phytoplankton, zooplankton	Mortality is higher at 35°C	N/A
late postlarvae juveniles (>15 mm)	1,2,3,5	estuarine, nearshore,	SAV, soft bottom, sand/shell, mangroves (low densities)	year–round (W. FL); fall – spring (TX)	6–38	0–3	seagrass, annelids, small crustaceans, shrimp, bivalves	no recorded kills from cold fronts	0.05 – 2.08 mm CL/week
sub - adults	1,2,3,5	estuarine, nearshore, offshore	SAV, soft bottom, sand/shell, mangroves (low densities), oyster reefs	year-round (W. FL); fall – spring (TX)	6-38	1-65	annelids, small crustaceans, shrimp, bivalves	avoid cold by migrating to deeper water; low predation offshore	0.05-2.08 mm CL/week
non-spawning adults (>75 mm TL)	1,2,3,5	nearshore, offshore	sand/shell	year-round	16-31	1–110	carnivores	low predation offshore	N/A
spawning adults (capable at 65 – 75 mm TL)	1,2,3,5	nearshore, offshore	sand/shell	year-round (W. FL); fall – spring (TX)	16-31	9-48	carnivores	low predation offshore	N/A
White Shrimp (*Panaeus setiferus*)									
fertilized eggs	2,3,4,5	estuarine, nearshore, offshore	N/A	spring - fall	N/A	9–34	N/A	daily Z =0.373	demersal eggs, hatch 10 – 12 hours after spawning; egg/larval stage lasts 16 days
larvae/ Pre-settlement postlarvae	2,3,4,5	estuarine, nearshore, offshore	N/A	spring – fall	17–28.5	0–82	phytoplankton and zooplankton	N/A	egg/larval stage lasts 16 days

Attachment C-1: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 3 in the Gulf of America

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
late postlarvae/ juveniles	2,3,4,5	estuarine, nearshore	emergent marsh	late spring - fall	postlarvae 13–31; juveniles 9 - 33	< 1	omnivorous; detritus, annelid worms, peracarid crustaceans, caridean shrimp diatoms	predation; daily Z =0.014–0.126	growth rates increase with temperatures 18–32.5°C, but decrease at 35°C; grow slowly at < 18°C; 0.3–1.2 mm/day; stage duration = 79 days
sub - adults	2,3,4,5	estuarine, nearshore, offshore	soft bottom, sand/shell	summer - fall	> 6	1 – 30	omnivorous, scavengers; annelids, insects, detritus, gastropods, copepods, bryozoans, sponges, corals, fish, filamentous algae, vascular stems and roots	daily Z = 0.023–0.048	stage duration = 33 days; 0.4–1.5 mm/day
adults	2,3,4,5	estuarine, nearshore, offshore	soft bottom	late summer and fall	7 – 38	< 27	omnivorous	daily Z = 0.004–0.034	adult/spawning stage duration is about 237 days; 0.4–1.0 mm/day
spawning adults	2,3,4,5	estuarine, nearshore, offshore	N/A	spring – late fall; peak: Jun - Jul	N/A	9 – 34	omnivorous	N/A	adult/spawning stage duration is about 237 days; 0.4–1.0 mm/day
RED DRUM									
Red Drum (*Sciaenops ocellatus*)									
eggs	1,2,3, 4,5	N/A	WCA	summer, fall	20–30	20–30	N/A	high early in spawning	N/A
larvae	1,2,3, 4,5	estuarine	SAV, soft bottom, WCA	late summer, fall	18.3–31	N/A	copepods	higher at 20–24°C than 25–30°C	0.5 mm/day. Faster at 25-30°C. 3-6 mm at 2 weeks. peak settlement from 6–8 mm TL
postlarvae	1,2,3, 4,5	estuarine	SAV, emergent marsh, soft bottom, sand/shell	late summer, fall	18.3–31	N/A	copepods	N/A	increased with increasing salinity (up to 30 parts per thousand)

Attachment C-1: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 3 in the Gulf of America

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
early juveniles	1,2,3, 4,5	estuarine, nearshore	SAV, soft bottom, emergent marsh	Sep – Dec	> 5–32.2	0–3	copepods, mysids, amphipods, shrimp, polychaetes, insects, fish, isopods, bivalves, decapods, crabs	rapid decline in water temperature can cause mortality	higher in backwater than seagrass beds. 15 – 20 mm/month
late juveniles	1,2,3, 4,5	estuarine, nearshore	SAV, soft bottom, hard bottom, sand/shell	fall	> 5–30	0–5	mysids, amphipods, shrimp, polychaetes, insects, crabs, fish	changes in environment, disease, parasites, rapid decline in water temperature	15–20 mm/ month
adults	1,2,3, 4,5	estuarine, nearshore, offshore	SAV, emergent marsh, soft bottom, hard bottom, sand/shell, WCA	N/A	2–33	1-70	crabs, shrimp, fish	*M* (age constant) = 0.07–0.13	L_{inf} = 881 mm FL, *k* = 0.32, t_0= -1.29, max age =42 years
spawning adults	1,2,3, 4,5	offshore	SAV, soft bottom, hard bottom, sand/shell	Mid-Aug – Oct.	20–30	40–70	N/A	N/A	L_{50} (male)= 529 mm FL, L_{50} (female) = 825-900(male) mm FL

Attachment C-1: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 3 in the Gulf of America

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
REEF FISH									
Red Snapper (*Lutjanus campechanus*)									
eggs	1,2,3, 4,5	offshore	WCA	Apr – Oct.	N/A	18-126	N/A	N/A	N/A
larvae	1,2,3, 4,5	offshore	WCA	Jul – Nov.	17.3–29.7	18-126	alga, rotifers (in laboratory)	N/A	N/A
postlarvae	1,2,3, 4,5	offshore	WCA	Jul – Nov.	17.3–29.7	18-126	N/A	N/A	N/A
early juveniles	1,2,3, 4,5	nearshore, offshore	reefs, hard bottom, banks/shoals, soft bottom, sand/shell	Jul – Nov.	17.3–29.7	17-183	zooplankton, shrimp, chaetognaths, squid, copepods	shrimp trawl bycatch; *M* (age 0) = 2.0/year	N/A
late juveniles	1,2,3, 4,5	nearshore, offshore	reefs, hard bottom, banks/shoals, soft bottom, sand/shell	year-round	20-28	18-55	fish, squid, crabs, shrimp	shrimp trawl bycatch; *M* (age 1) = 1.2/year	N/A
adults	1,2,3, 4,5	nearshore, offshore	reefs, hard bottom, banks/shoals	year-round	14-30	7-146	fish, shrimp, squid, octopus, crabs	Enter fishery at age 2; *M=0.094/ year*	N/A
spawning adults	1,2,3 4,5	offshore	sand/shell, banks/shoals	Apr-Oct.	16-29	18-126	N/A	N/A	50% mature (female) at age 4-5, 400-450 mm TL; 100% mature (female) at age 8, 700 mm TL
Gray (mangrove) snapper (*Lutjanus griseus*)									
eggs	1,2	offshore	WCA	Jun-Sep	N/A	*0-180*	N/A	N/A	pre-settlement duration: 25- 33d
larvae	1,2	offshore	WCA	Apr-Nov peak: Jun-Aug	15.6-27.2	*0-180*	lab: zooplankton	N/A	pre-settlement duration: 25- 33d
postlarvae	1,2	estuarine	SAV	N/A	N/A	N/A	copepods, amphipods	N/A	pre-settlement duration: 25-33d
early juveniles	1,2	estuarine	SAV, mangrove, emergent marsh	N/A	12.8-36.0	1-3	amphipods	N/A	growth rate = 0.60-1.02 mm/d; SAV residents ~ 8 months; settle Sep-Oct (at 78 mm TL)

Attachment C-1: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 3 in the Gulf of America

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
late juveniles	1,2	estuarine, nearshore	SAV, mangrove, emergent marsh	N/A	12.8-36.0	*0-180*	penaeid shrimp, crabs, fish, mollusks, polychaetes	N/A	growth rate = 0.60-1.02 mm/d; *SAV residents ~ 8 months; occupy mangroves from 100-120+ mm TL*
adults	1,2,3, 4,5	estuarine, nearshore, offshore	hard bottom, soft bottom, reef, sand/shell, banks/shoals, emergent marsh	N/A	13.4-32.5	0-180	fish, shrimp, crabs	*Z*=0.17- 0.22, *M*=0.15	recruit to fishery @ age 4; max. age = 28 years; L_{inf}=656.4 mm TL, *k* = 0.22, t_o = 0
spawning adults	1,2,3, 4,5	estuarine, nearshore, offshore	reef, hard bottom	year-round (S. FL), summer elsewhere	N/A	0-180	N/A	N/A	maturation at 185 mm TL for males and 200 mm TL for females
Lane snapper (*Lutjanus synagris*)									
eggs	1,2,3, 4,5	offshore	WCA	Mar-Sep, peak: Jul-Aug	N/A	*4-132*	N/A	N/A	N/A
larvae	1,2,3, 4,5	*estuarine, nearshore, offshore*	*WCA*	*Jun- Aug*	28 (in lab); *28.4-30.4*	*0-50*	plankton and rotifers (in laboratory)	death by day 10 at 25°C in lab; * *Z*= - 0.429± 0.053(SE), subject to size-selective mortality*	*SL-age curve = 0.032, *K*=0.047 ±0.008 (SE; W. Straits of FL), *K* = 0.042 ±0.008 (SE; E. Straits of FL), PLD=25.6 d*
postlarvae	1,2,3, 4,5	*estuarine, nearshore, offshore*	*WCA*, SAV	*Jun- Aug*	*28.4-30.4*	*0-50*	N/A	death by day 10 at 25°C in lab; * *Z*= - 0.429± 0.053(SE), subject to size-selective mortality*	*SL-age curve = 0.032, *K* =0.047 ±0.008 (SE; W. Straits of FL), *K*= 0.042 ±0.008 (SE; E. Straits of FL), PLD =25.6 d*
early juveniles	1,2,3, 4,5	estuarine, nearshore, offshore	SAV, sand/shell, reefs, soft bottom, banks/shoal, *mangrove*	late summer-early fall	28-29.5	0-24	copepods, grass shrimp, small inverts	*subject to growth-selective mortality*, daily *Z*= 0.097-0.165	settle Jul- Aug, min. settle length =15.1 mm SL, min. settle age= 25 d, growth rate = 0.9-1.3 mm/d

Attachment C-1: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 3 in the Gulf of America

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
late juveniles	1,2,3, 4,5	estuarine, nearshore, offshore	SAV, sand/shell, reefs, soft bottom, banks/shoals, mangrove	late summer-early fall	28-29.5	0-24	copepods, grass shrimp, small inverts	*subject to growth-selective mortality*, daily *Z* = 0.097-0.165	growth rate = 0.9-1.3 mm/d
adults	1,2,3, 4,5	nearshore, offshore	reef, sand/shell, banks/shoals, hard bottom	N/A	16-29	4-132	fish, crustaceans, annelids, mollusks, algae	*Z* = 0.38-0.58; *M* =0.11-0.24	max. length = 673 mm TL. Males grow faster, and larger at age than females; L_{inf} = 449 mm FL, *k*= 0.17, t= -2.59, max age = 19 years
spawning adults	1,2,3, 4,5	offshore	*reef, shelf edge/slope*	May-Aug	N/A	*30-70 m*	N/A	N/A	*50% maturity = 230 mm (females), 242 mm (males); 100% maturity > 350 mm TL (females), > 377 mm TL (males)*
Vermilion Snapper (Rhomboplites aurorubens)									
eggs	1,2,3, 4,5	offshore	WCA	N/A	N/A	*18-100*	N/A	N/A	N/A
larvae	1,2,3, 4,5	offshore	WCA	*Jun-Nov*	N/A	*30-40*	N/A	N/A	N/A
postlarvae	1,2,3, 4,5	offshore	WCA	*Jun-Nov*	N/A	*30-40*	N/A	N/A	N/A
early juveniles	1,2,3, 4,5	nearshore, offshore	hard bottom, reefs	N/A	N/A	*18-100*	*copepods, nematodes*	N/A	N/A
late juveniles	1,2,3, 4,5	nearshore, offshore	hard bottom, reefs	N/A	N/A	*18-100*	*fish scales, copepods, small pelagic crustacea, cephalopods*	N/A	N/A

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Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
adults	1,2,3, 4,5	nearshore, offshore	banks/shoals, reef, hard bottom	*year-round*	*16.4-26.2*	18-100	benthic tunicates, amphipods, juvenile vermilion (rare), *cephalopods*	Recruit to comm. long-line age 7, hand-line age 4, rec. age 3; *Z* = 0.39 ± 0.05, *M* =0.25	L_{inf} = 344 mm FL, *k*= 0.3254, t_0 = - 0.7953, max. age = 26 years
spawning adults	1,2,3, 4,5	nearshore, offshore	N/A	May- Sep	N/A	*18-100*	N/A	N/A	50% mature at 138 mm (TL)
Greater amberjack (*Seriola dummerili*)									
eggs	1,2,3, 4,5	N/A	WCA	N/A	N/A	N/A	N/A	N/A	hatch in 2 days
larvae	1,2,3, 4,5	offshore	WCA	year- round	N/A	N/A	N/A	N/A	N/A
postlarvae	1,2,3, 4,5	offshore	WCA, drifting algae	summer	N/A	N/A	N/A	N/A	N/A
early juveniles	1,2,3, 4,5	nearshore, offshore	WCA, drifting algae	summer-fall	N/A	N/A	invertebrates	*Z*=0.0045	1.65-2.00 mm/d
late juveniles	1,2,3, 4,5	nearshore, offshore	WCA, drifting algae, hard bottom	summer-fall	N/A	N/A	invertebrates	*Z*=0.0045	1.65-2.00 mm/d
adults	1,2,3, 4,5	nearshore, offshore	WCA, hard bottom, banks/shoals, *reefs*	year- round	14.25	4.6-187	fish, crustaceans, cephalopods	males (7-8 years) have shorter life span than females (10-15 years)	females usually larger than males; L_{inf} = 1436 mm FL, *k* = 0.175, t_0 = - 0.954, max. age =15 years
spawning adults	1,2,3, 4,5	offshore	WCA, *reef*	Feb-May	N/A	N/A	N/A	N/A	50% maturity at *644 mm FL (males); 900 mm FL and age 4 (females)
Gray triggerfish (*Balistes capriscus*)									
eggs	1,2,3, 4,5	nearshore, offshore	reefs	late spring, summer	N/A	*10-100*	*N/A*	N/A	hatch in 48-55 hours
larvae	1,2,3, 4,5	N/A	WCA, drifting algae	N/A	N/A	N/A	N/A	N/A	spend 4-7 months in pelagic zone

Attachment C-1: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 3 in the Gulf of America

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
postlarvae	1,2,3, 4,5	N/A	WCA, drifting algae	N/A	N/A	N/A	N/A	N/A	spend 4-7 months in pelagic zone
early juveniles	1,2,3, 4,5	N/A	drifting algae, *mangrove*	N/A	N/A	N/A	algae, hydroids, barnacles, polychaetes	N/A	spend 4-7 months in pelagic zone
late juveniles	1,2,3, 4,5	nearshore, offshore	drifting algae, *mangrove*, reefs	N/A	N/A	*10-100*	algae, hydroids, barnacles, polychaetes	*Z = 0.95, M = 0.28*	N/A
adults	1,2,3, 4,5	nearshore, offshore	hard bottom, reefs	N/A	N/A	10-100	bivalves, barnacles, polychaetes, decapod crabs, gastropods, sea stars, sea cucumbers, brittle stars, sea urchins, sand dollars	predation, recreational fishery (age 3), commercial fishery (age 4). *Z=0.95, M=0.28*	rapid in year one, then slows. Relatively long lived. L_{inf} = 589.7 mm FL, K = 0.0.14, t_o = -1.66, max. age = 15 years
spawning adults	1,2,3, 4,5	nearshore, offshore	reefs	late spring, summer	20.9-30.0	10-100	bivalves, barnacles, polychaetes, decapod crabs, gastropods, sea stars, sea cucumbers, brittle stars, sea urchins, sand dollars	predation, recreational fishery (age 3), commercial fishery (age 4)	rapid in year one, then slows. Relatively long lived. Males larger than females
COASTAL MIGRATORY PELAGICS									
King mackerel (*Scomberomorus cavalla*)									
eggs	3,4,5	offshore	WCA	spring, summer	hatch = 18-21 hours at 27	35-180	N/A	N/A	N/A
larvae	1,2,3, 4,5	offshore	WCA	May-Oct	20-31	*35-180*	larval fish (carangids, clupeids, engraulids)	predation, starvation	enhanced in N.C. Gulf and N.W. Gulf, associated with MS River plume
post larvae	1,2,3, 4,5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
early juveniles	3,4,5	nearshore	WCA	May-Oct peak: Jul, Oct	N/A	≤ 9	fish, some squid	bycatch (shrimp fishery), sport fishery	enhanced in N.C. Gulf and N.W. Gulf, associated with MS River plume
late juveniles	3,4,5	nearshore	WCA	N/A	N/A	N/A	estuarine-dependent fish, some squid	bycatch (shrimp fishery), commercial and recreational fisheries	enhanced in N.C. Gulf and N.W. Gulf, associated with MS River plume
adults	1,2,3, 4,5	nearshore, offshore	WCA	N/A	> 20	0-200	fish, squid, shrimp; feeding sometimes associated with *Sargassum*	fishing mortality, *M* = 0.174	highest growth occurs in eastern Gulf; L_{inf} = 1154.1 mm FL, *k* = 0.19, t =-2.60; max. age = 24 years
spawning adults	3,4,5	offshore	WCA	May-Oct	> 20	35-180	N/A	N/A	N/A
Spanish mackerel (*Scomberomorus maculatus*)									
eggs	2,3	nearshore, offshore	WCA	spring, summer	hatch in 25 hours at 26	< 50	N/A	N/A	N/A
larvae	1,2,3 4,5	nearshore, offshore	WCA	May-Oct	20-32	9-84	larval fish, some crustaceans	N/A	N/A
post larvae	1,2,3 4,5	nearshore, offshore	WCA	May-Oct	20-33	9-84	larval fish, some crustaceans	N/A	N/A
early juveniles	2,3	estuarine, nearshore	WCA	Mar- Nov	15.5-34.0	1.8-9.0	mostly fish, some crustaceans, gastropods, shrimp	bycatch in shrimp trawl fishery	N/A
late juveniles	2,3	estuarine, nearshore, offshore	WCA	Mar- Nov	15.5-34.0	1.8-50	fish, squid	bycatch in shrimp trawl fishery, vulnerable to recreational fishery	N/A

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Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
adults	1,2,3	estuarine, nearshore, offshore	WCA	N. Gulf in spring, S. Florida and Mexico in fall	15.5-34.0	3-75	fish, crustaceans, squid	fishing mortality, impacted by baitfish harvest; *M*= 0.37/year	females grow faster, live longer than males; t_o = -0.5, k= 0.61, L_{inf} = 560 mm FL; max. age = 11 years
spawning adults	2,3	nearshore, offshore	WCA	May- Sep	> 25	< 50	N/A	N/A	N/A
Cobia (*Rachycentron canadum*)									
eggs	2,3,4,5	estuarine, nearshore	WCA	summer	28.1-29.7	top meter of water column	N/A	N/A	hatch within 36 hours
larvae	2,3,4,5	estuarine, nearshore, offshore	WCA	May-Sep	24.2-32	3.1-300, in surface waters	In lab: zooplankton, primarily copepods	N/A	22 mm SL in 22 days (lab)
post larvae	3,4,5	nearshore, offshore	WCA	May-Jul	25.9-30.3	11-53 *in or near surface waters*	In lab: zooplankton, primarily copepods	N/A	25 mm SL in 25 days (lab)
early juveniles	3,4,5	nearshore, offshore	WCA	Apr-Jul	*16.8-25.2*	5-300 * in or near surface waters*	In lab: *Gambusia*, shrimp and fish parts	N/A	~ 55 mm SL by 50 days (lab)
late juveniles	3,4,5	nearshore, offshore	WCA	May-Oct	N/A	*1-70*	fish, shrimp, squid	N/A	231 mm SL by 130 days (lab)
adults	1,2,3,4,5	nearshore, offshore	WCA, banks/shoals, hard bottom	Mar-Oct (N. Gulf), Nov- Mar (S. Gulf, S. FL)	23.0-28.0	1-70	crustaceans and fish	*M* =0.38/year	rapid growth for first 2 years; L_{inf} = 1281.5 mm FL, *k* = 0.42, t_o = -0.53, max. age = 11 years
spawning adults	3,4,5	nearshore, offshore	N/A	Apr-Sep (N. Gulf)	23.0-28.0	*1-70*	N/A	N/A	50% maturity at age 2

Attachment C-1: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 3 in the Gulf of America

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]

Source: GMFMC 2004; GMFMC 2016

Notes: Information in asterisks comes from studies conducted outside GMFMC jurisdiction; N/A = not applicable (information not available).

[a] mm = millimeters; TL = total length

[b] WCA = water column associated; SAV = submerged aquatic vegetation

[c] °C = degrees Celsius

[d] m = meters

[e] Z = the instantaneous mortality coefficient (M + F); M = natural mortality; F= fishing mortality

[f] CL = caudal tail length ; L_{inf} = average maximum size; k = growth rate; t_0 = the theoretical age at which the fish has a length of 0; SL = standard length; FL = fork length; for additional detail regarding growth rates, see GMFMC 2016

Attachment C-2

Life Histories for Highly Migratory Species Identified in Ecoregion 3 in the Gulf of America

Attachment C-2: Essential Fish Habitat for Highly Migratory Species Identified in Ecoregion 3 in the Gulf of America

Life Stage	EFH State Waters of Ecoregion 3	Temperature (°C)	Salinity (parts per thousand)	Depth (m)	Seasonal Occurrence	Habitat Description	Notes
Blacktip shark (*Carcharinus limbatus*)							
Neonate and YOY	All estuarine, nearshore, and offshore waters (ex. Lake Borgne)	20.8 -32.2	22.4-36.4	0.9-7.6	summer primary nursery (May – Sept.)	Silt, sand, mud, and seagrass habitats within shallow coastal areas, including estuaries.	N/A
Juvenile	All estuarine, nearshore, and offshore waters (ex. Lake Borgne)	19.8-32.2	7.0-36.8	7.0-9.4	Summer secondary nursery	Multiple substrates including silt, sand, mud, and seagrass habitats.	N/A
Adult	All estuarine, nearshore, and offshore waters (ex. Lake Borgne, Mobile, Perdido, and Pensacola Bays)	21.5-31.1	22.3-34.7	0.9-6.6	N/A	Multiple substrates including silt, sand, mud, and seagrass habitats.	Typically found further offshore than juveniles.
Bull shark (*Carcharhinus leucas*)							
Neonate and YOY	Lake Borgne east to waters around Ship Island; Lower Mobile Bay and nearshore waters off Dauphin Island to Gulf Breeze	28.8	16.9	<9	Nurseries: May to August, often into November	In shallow coastal waters, inlets and estuaries	N/A
Juvenile	All waters Mississippi River delta to Perdido Bay (ex. portions of Chandeleur Sound and Lake Borgne)	24.2-30.9	10.6-30.8	1.4-5.8	Estuarine nurseries: April through summer months.	In shallow coastal waters, inlets and estuaries	N/A
Adult	Estuarine waters of birdfoot delta, Chandeleur Island; Lower Mobile Bay and Mississippi Sound around Dauphin Island and Perdido Bay; nearshore and offshore waters Hat Island east to Pensacola Bay	24.2-30.9	10.6-30.8	1.4-5.8	N/A	In shallow coastal waters, inlets and estuaries	Usually found in higher salinities than juveniles and neonates/YOYs.
Dusky shark (*Carcharhinus obscurus*)							
Neonate and YOY	The Gulf nearshore and offshore water >30 feet off mouth of Pensacola Bay	18.1-22.2	25-35	4.3-15.5	N/A	N/A	Seaward depth of EFH is 60m.

Attachment C-2: Essential Fish Habitat for Highly Migratory Species Identified in Ecoregion 3 in the Gulf of America

Life Stage	EFH State Waters of Ecoregion 3	Temperature (°C)	Salinity (parts per thousand)	Depth (m)	Seasonal Occurrence	Habitat Description	Notes
Juvenile/Adult		N/A	N/A	N/A	N/A	At and seaward of the shelf break and in proximity to banks.	N/A
Spinner shark (*Carcharhinus brevipinna*)							
Juvenile	Mississippi River birdfoot delta, outer Chandeleur Sound, Mississippi Sound, Mobile Bay, and Perdido Bay; nearshore waters (Ex. off Pensacola Bay)	21.9-30.1	21.0-36.2	<20 m	N/A	Shallow, sandy bottom substrates of the continental and insular shelves.	N/A
Adult	Mississippi River birdfoot delta, waters off Chandeleur Island, and nearshore waters off Pensacola Bay into East Pensacola Bay and Santa Rosa Sound	21.9-30.1	21.0-36.2	<90 m	N/A	Shallow, sandy bottom substrates of the continental and insular shelves.	N/A
Tiger shark (*Galeocerdo cuvier*)							
Neonate and YOY	Nearshore waters east of Gulf Shores; Perdido Bay, lower Pensacola Bay and Santa Rosa Sound	N/A	N/A	N/A	N/A	N/A	N/A
Juvenile	Eastern Mississippi Sound from Pascagoula (ex. Grande and Portersville Bays), lower Mobile and Bon Secour Bays, Perdido and Escambia Bays; all nearshore waters east of Horn Island	N/A	N/A	N/A	N/A	Grass flats and coastal/pelagic habitats	N/A
Whale shark (*Rhincodon typus*)							
All	Waters off Mississippi River birdfoot delta; waters around Chandeleur Islands	N/A	N/A	N/A	N/A	N/A	N/A
Bonnethead shark (*Sphyrna tiburo*)							
Neonate and YOY	Mississippi Sound east of Ship Island; nearshore waters to 60 feet.	18-33.5	N/A	N/A	Migrate out of nurseries in October.	Shallow coastal waters with sandy or muddy substrates.	N/A

Attachment C-2: Essential Fish Habitat for Highly Migratory Species Identified in Ecoregion 3 in the Gulf of America

Life Stage	EFH State Waters of Ecoregion 3	Temperature (°C)	Salinity (parts per thousand)	Depth (m)	Seasonal Occurrence	Habitat Description	Notes
Juvenile	Mississippi Sound east of Ship Island; nearshore waters to 60 feet	28.4-31.4	N/A	N/A	N/A	Shallow coastal waters with sandy or muddy substrates.	N/A
Adult	Mobile Bay; Mississippi Sound east of Ship Island; nearshore waters to 60 feet	20.0-33.6	14.4-41.7	7.6-40 m	N/A	Shallow coastal Shallow coastal waters frequenting sandy or muddy substrates.	N/A
Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)							
Neonate and YOY	Estuarine, nearshore, and offshore waters to 90 feet	16.7-32	10-38	N/A	N/A	Shallow coastal areas including bays and estuaries	N/A
Juvenile	All nearshore and offshore waters to 90 feet; estuarine waters W of Mobile Bay (ex. Lake Borgne)	16-32	10-38	N/A	N/A	Coastal waters	N/A
Adult	Estuarine waters west of Mobile Bay, nearshore and offshore waters to 200 feet	16-32	10-38	< 200	N/A	Coastal waters	N/A
Blacknose shark (*Carcharhinus acronotus*)							
Juvenile	Waters around Chandeleur and Dauphin Islands	20.8-33.6	32.1	3.7	N/A	N/A	N/A
Adult	All nearshore waters Perdido Bay to Mississippi River birdfoot delta, estuarine waters of Mississippi Sound to Horn Island and seaward band of state waters around Chandeleur Islands	20.8-33.6	32.1	3.7	N/A	N/A	N/A
Finetooth shark (*Carcharhinus isodon*)							
Neonate and YOY	Nearshore waters west of Perdido Bay to Chandeleur Island; Mississippi Sound (ex. Lake Borgne)	19.5-31.4	N/A	16-36	N/A	Shallow coastal waters in northern Gulf with muddy substrates.	N/A

Attachment C-2: Essential Fish Habitat for Highly Migratory Species Identified in Ecoregion 3 in the Gulf of America

Life Stage	EFH State Waters of Ecoregion 3	Temperature (°C)	Salinity (parts per thousand)	Depth (m)	Seasonal Occurrence	Habitat Description	Notes
Juvenile	Nearshore and offshore waters Pensacola Bay to Mississippi River birdfoot delta; Mississippi Sound and Chandeleur Sound (ex. Lake Borgne)	19.2-30.6	N/A	16-36	N/A	Shallow coastal waters in northern Gulf with muddy substrates	N/A
Adult	Nearshore and offshore waters Pensacola Bay to Mississippi River birdfoot delta; Mississippi Sound and Chandeleur Sound (ex. Lake Borgne)	19.2-30.6	N/A	16-36	N/A	Shallow coastal waters in northern Gulf with muddy substrates	N/A

Source: NMFS 2006, 2009, 2010, 2017

Note: N/A = not applicable (information not available)

Attachment D

Chandeleur Island Seagrass Survey Report

COASTAL PROTECTION AND RESTORATION AUTHORITY

CHANDELEUR ISLAND RESTORATION (PO-0199)

PHASE 2 - SEAGRASS SURVEY REPORT

PREPARED FOR
Coastal Engineering Consultants, Inc.

December 2023

PREPARED BY
SWCA Environmental Consultants

DRAFT COASTAL PROTECTION AND RESTORATION AUTHORITY CHANDELEUR ISLAND RESTORATION PROJECT (PO-0199) – SEAGRASS SURVEY REPORT

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SWCA Project No. 00081792-001

December 2023

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CONTENTS

Appendices

Figures

Tables

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1 INTRODUCTION

1.1 Project Overview

The Chandeleur Island Restoration (PO-0199) Project (Project) is located on the Chandeleur Islands in St. Bernard Parish, Louisiana (Figure 1). The Chandeleur Island system includes those lands between Chandeleur Sound and the Gulf of Mexico, consisting of Chandeleur Island, Gosier Islands, Grand Gosier Islands, Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands forming the Breton National Wildlife Refuge (Figure 2). This report's Study Area includes Chandeleur and New Harbor Islands and the seagrass beds and water bottoms surrounding them (Figure 3).

The purpose of the Project is to engineer and design a restoration project benefitting the Chandeleur Islands and the many species that use them as defined in the Restoration Plan and Environmental Assessment Plan #1 of the Region-wide Trustee Implementation Group (2021). Phase 1 of the Project focuses on plan formulation for restoration of the main Chandeleur Island and New Harbor Island. The Coastal Protection and Restoration Authority (CPRA) serves as the designated State agency for the Project.

The purpose of this report is to provide methodology used to identify the seagrass community composition and map the extent of the seagrass beds at the main Chandeleur Island and New Harbor Island during late summer/early fall 2022 and present the results of the survey. The approach and methods are described in the SWCA 2022 Chandeleur Island Restoration Project (PO-0199) Seagrass Survey Plan (Appendix A).

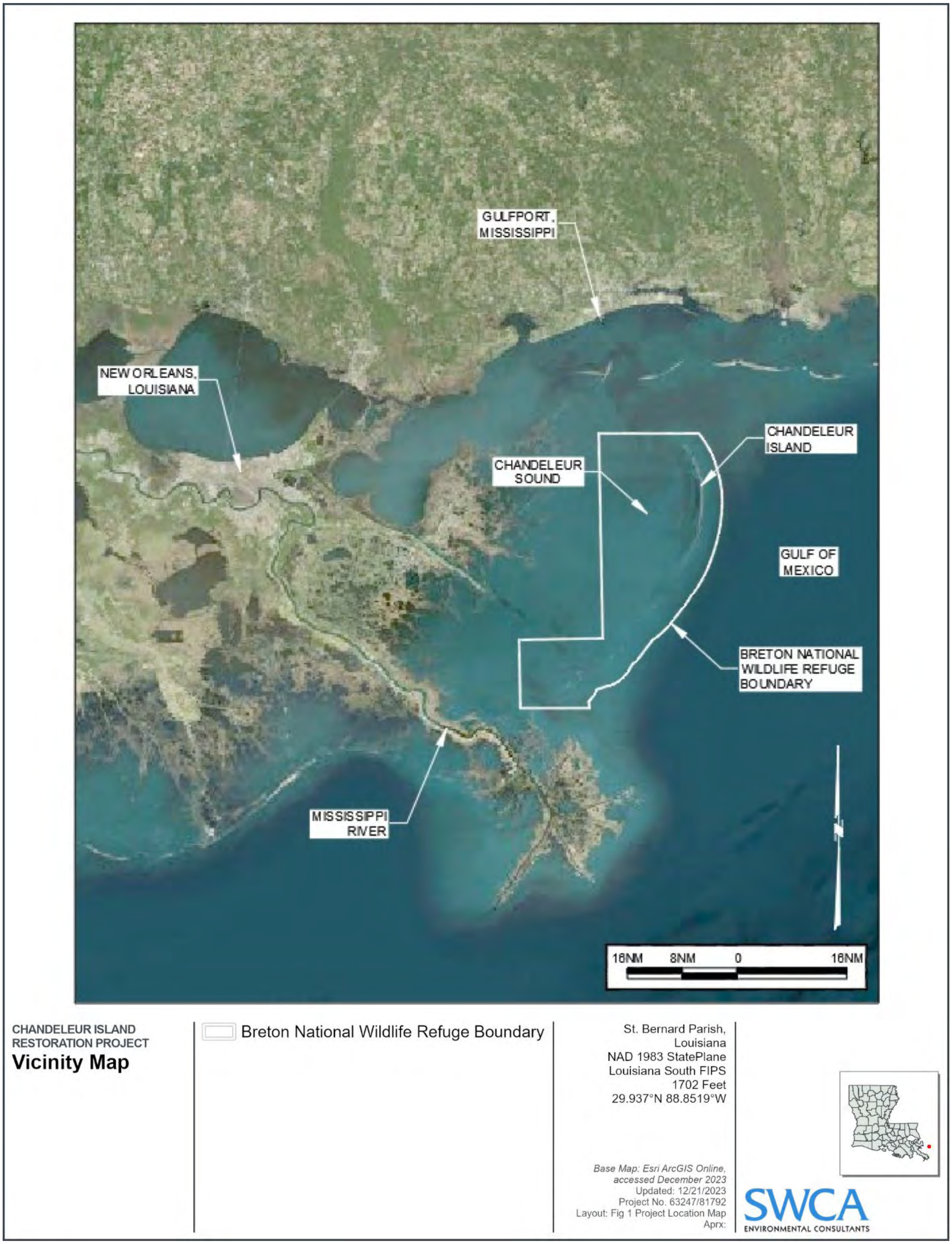

Figure 1. Project vicinity map.

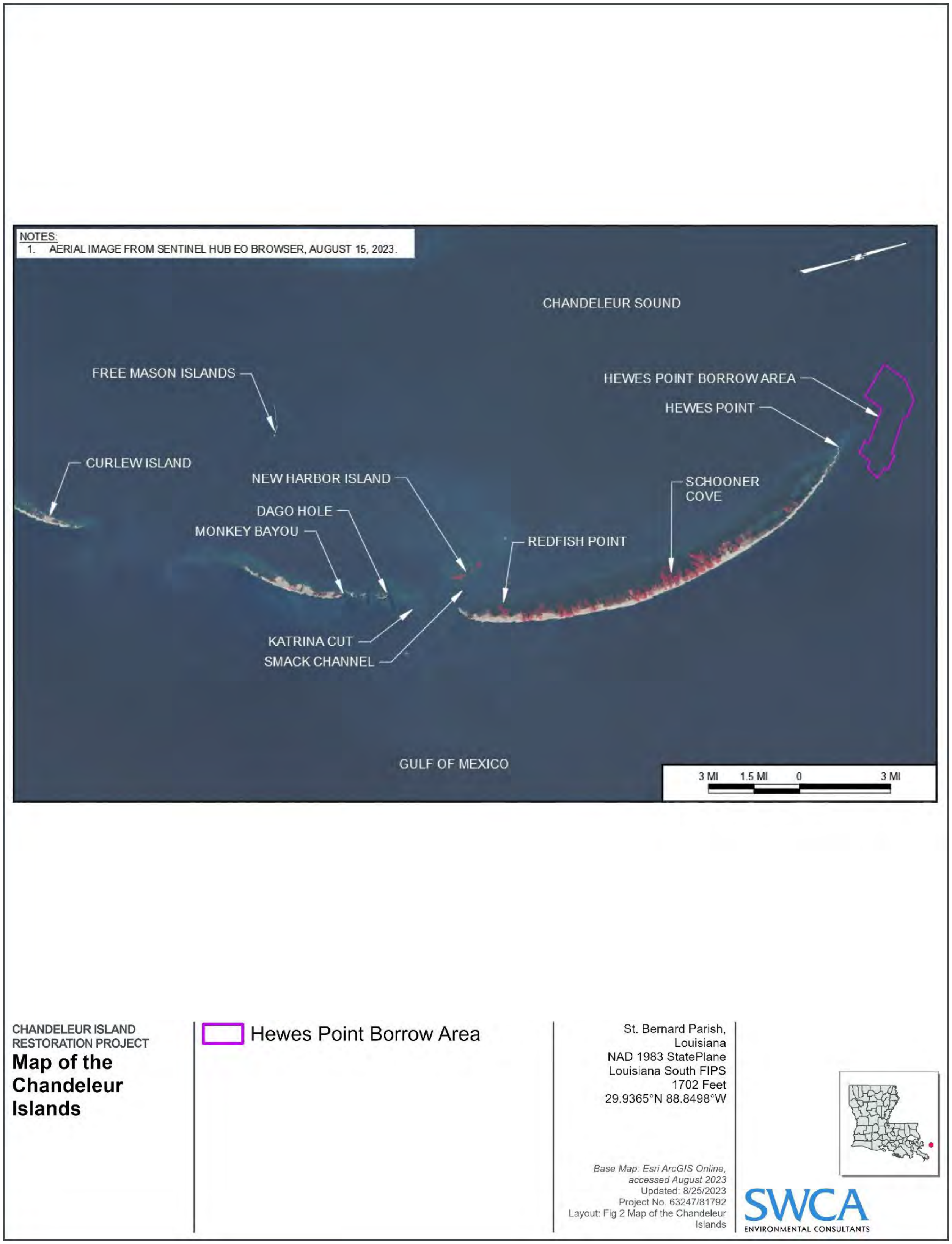

Figure 2. Map of the Chandeleur Islands and potential borrow area location.

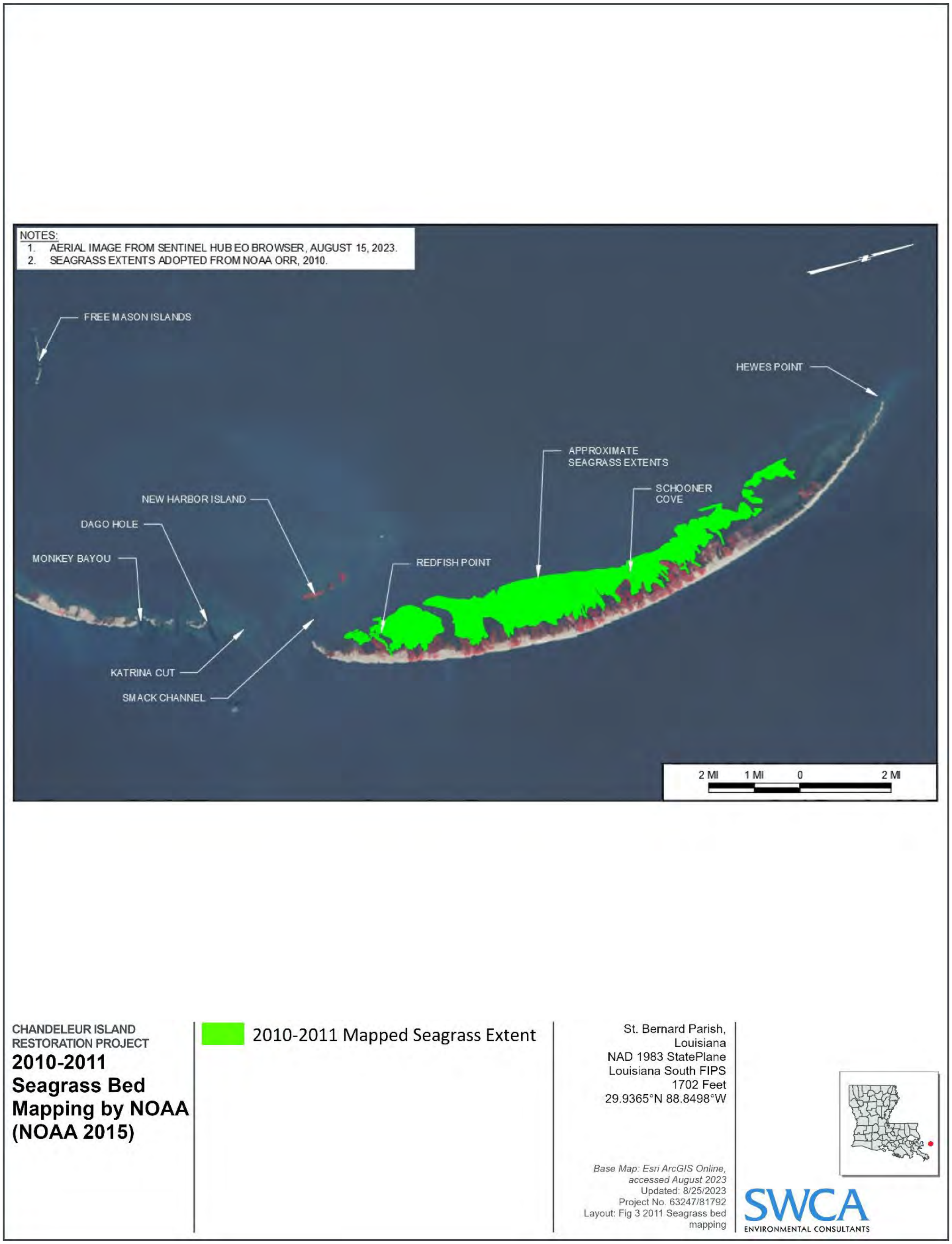

Figure 3. 2010-2011 Seagrass bed extent mapped by NOAA (NOAA 2015)

1.2 Project Area Description

The Chandeleur Islands can be subdivided into two subsets, which are affected by different hydrologic inputs, energy regimes, barrier island dynamics, and environmental stressors. The northern islands include the main Chandeleur Island, New Harbor Island, and Freemason Island. The southern islands include Curlew Island, Grand Gosier Islands and Breton Island. The primary ecological drivers in the Chandeleur Islands system are attributed to natural coastal processes such as barrier island dynamics, disintegration of abandoned river deltas, and impacts from tropical storms and hurricanes. The southern islands are proximal to major outlets of the Mississippi River where they receive significant seasonal freshwater inputs and attendant high nutrient and turbidity levels. The northern islands experience only limited influence from riverine inputs as they are located farther from freshwater sources such as coastal Mississippi waters and inputs from the Pearl River and passes of Lake Pontchartrain. Importantly, the northern islands are far more stable due to higher sand content and robust backbarrier marshes compared to the southern islands that are sand-starved and lack significant backbarrier marshes. As a result, the northern islands respond differently to storm impacts than southern parts of the chain. Storm response in the north is characterized by barrier breaching and overwash processes that transfer the beach and dune system landward with backbarrier marshes providing a platform for sand deposition, maintaining subaerial exposure and healing of breaches during post storm recovery. In the south, major storms can result in complete island submergence with recovery and emergence significantly delayed and only after extended periods (years to decades) of minimal storm impacts. These contrasting barrier island storm responses are important to consider with respect to stability of seagrasses because of the protection afforded to the backbarrier seagrass communities by the more robust northern islands both during storms and the recovery period as breaches heal. The ephemeral island/shoal behavior that characterizes the southern islands does not provide for long term protection to the backbarrier from open Gulf conditions. As a result, seagrass meadows have persisted in the shelter of the northern islands at least for the historical record. However, as the northern island chain has undergone rapid land loss by thinning and shortening over the past three decades, the backbarrier area with sufficient protection to host resilient seagrass communities has also decreased (Miner et al. 2021). Along with protection from high-energy conditions, seagrass growth and persistence requires good overall water quality and clarity, habitats along the southern islands are not conducive to seagrass growth, whereas seagrass has developed and thrived in environment of the northern islands (Handley et al. 2007).

Studies throughout the past five decades have reported varying coverage of seagrasses along the Chandeleur Islands, however, as summarized in Poirrier and Handley (2007), and identified during species composition investigations after the Deepwater Horizon oil spill (Kenworth et al. 2017) the species composition has remained fairly consistent and includes turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*). Frequent damage due to passing hurricanes influences the species composition and abundance in certain areas. Areas that experience higher levels of damaging forces, such as locations where the protecting barrier island was breached during a storm and sediment overwash features with significant sediment deposition, and exposure to higher wave action, were found to have some turtle grass, but also manatee grass and shoal grass. Those areas that are sheltered from storm damage are dominated by dense turtle grass meadows (Franze 2002; Poirrier and Handley 2007). Star grass was found to be present in these disturbed areas but was quite rare (Handley et al. 2007). In a 20-year study of the region, using information on leaf tissue nutrient levels, specifically in *T. testudinum*, Darnell et al. (2017) concluded that high nutrient levels and eutrification, noted as the primary driver in seagrass loss along more coastal environments, there does not appear to be strong evidence that this is the case at the Chandeleurs. Furthermore, the 2014 study by Pham et al. provided a comparison of aerial mapping efforts at the Chandeleurs from 1992 to 2005, documenting an evolution of the Chandeleur Islands, documenting rapid rates of land loss and declining seagrass coverage, therefore supporting the causation between land loss and declining seagrass coverage.

The last comprehensive investigation for seagrass bed extent, viability, and species composition within the Chandeleur Islands was conducted by the NOAA and the United States Geological Survey (USGS) in 2010 and 2011. The investigation was conducted as part of the post-incident exposure of the Deepwater Horizon Oil Spill on seagrass vegetation throughout the northern Gulf of Mexico (NOAA 2015). The 2010 and 2011 seagrass coverage totaled approximately 2,385 acres, and 2,614 acres, respectively (NOAA 2015). The National Aeronautics and Space Administration (NASA) Tool CREOL (NASA 2021) also provided supporting aerial imagery of the Project Area to illustrate changes in seagrass extent. In addition to the summary of studies provided above, investigations are ongoing through the University of Mississippi.

2 METHODOLOGY

2.1 Defining the Survey Area

The limits of the 2010 and 2011 NOAA and USGS aerial data, as well as project-specific high resolution aerial photography collected in May 2022 were georeferenced to establish the preliminary Survey Area and allow for reproducibility in the 2022 survey efforts in order to: 1) verify the identification of the entire seagrass habitat or potential habitat, and 2) enable comparisons of species, community compositions, and densities over time.

To define the Survey Area (Figure 4), a single polygon was created, identifying the maximum bounds of the 2010/2011 seagrass extent (NOAA 2015) and the results of the photogrammetric interpretation of the aerial imagery acquired in May 2022. As the aerial photographs collected in May 2022 occurred prior to the start of the peak growing season in the Chandeleurs (mid-September to early October) (*pers. comm.* Darnell 2022)), additional satellite data was collected in September 2022 to confirm the current extent at the time of the seagrass field survey. The 50-cm resolution satellite data was obtained from Planet Labs SkySat for an approximately 105-sq km area encapsulating the known 2010 and 2011 seagrass and Survey Area extent. Considering the size of Survey Area, the use of aerial imagery is a cost-effective and more precise method for delineating seagrass fringe habitat than diver delineated methods. Obtaining the aerial imagery prior to field survey allowed for spot checking in the field rather than swimming the full edge of the Survey Area. Additional data to be collected under separate tasks, including the collection of topographic and bathymetric data during the Summer of 2023, and identification or collection of new aerial imagery, will provide further insights to characterize the area and refine the initial seagrass community discussion.

2.2 Fixed Station Location

The field survey plan utilized the methods outlined in Dunton et al. (2010) which allows for robust data collection and reproducibility over a large Survey Area. The recommended practice utilizes a grid of tessellated hexagons (500 meters per side) to identify sampling locations for all levels of seagrass monitoring. This hexagonal grid was overlaid onto the Survey Area to establish the sampling locations (Figure 4). One fixed sample location was randomly selected within each hexagon, for a total of 143 sample locations. The USM, by Principal Investigator, Kelly Darnell (*personal communication*, August 2022), is conducting ongoing research at the Chandeleur Islands. In order to contribute spatially consistent data, SWCA compared hexagonal grids and fixed locations, and in instances where a USM location was in an SWCA hexagon, the USM location was used and SWCA adopted the nomenclature. Locations belonging to USM are identified by C-###, whereas the SWCA location are identified by S-###.

For survey planning purposes beginning in March 2022, the hexagonal grid was overlaid on the most current publicly available, high resolution aerial data (Google Earth 2019). Due to the dynamic nature of the barrier islands and presumed migration of the island from the last large scale seagrass mapping effort (2011) to its current position, some survey grid locations containing historical seagrass data extensively overlap with the island and extend into the Gulf. Figure 4 illustrates how some survey hexagons were truncated to account for island overlap.

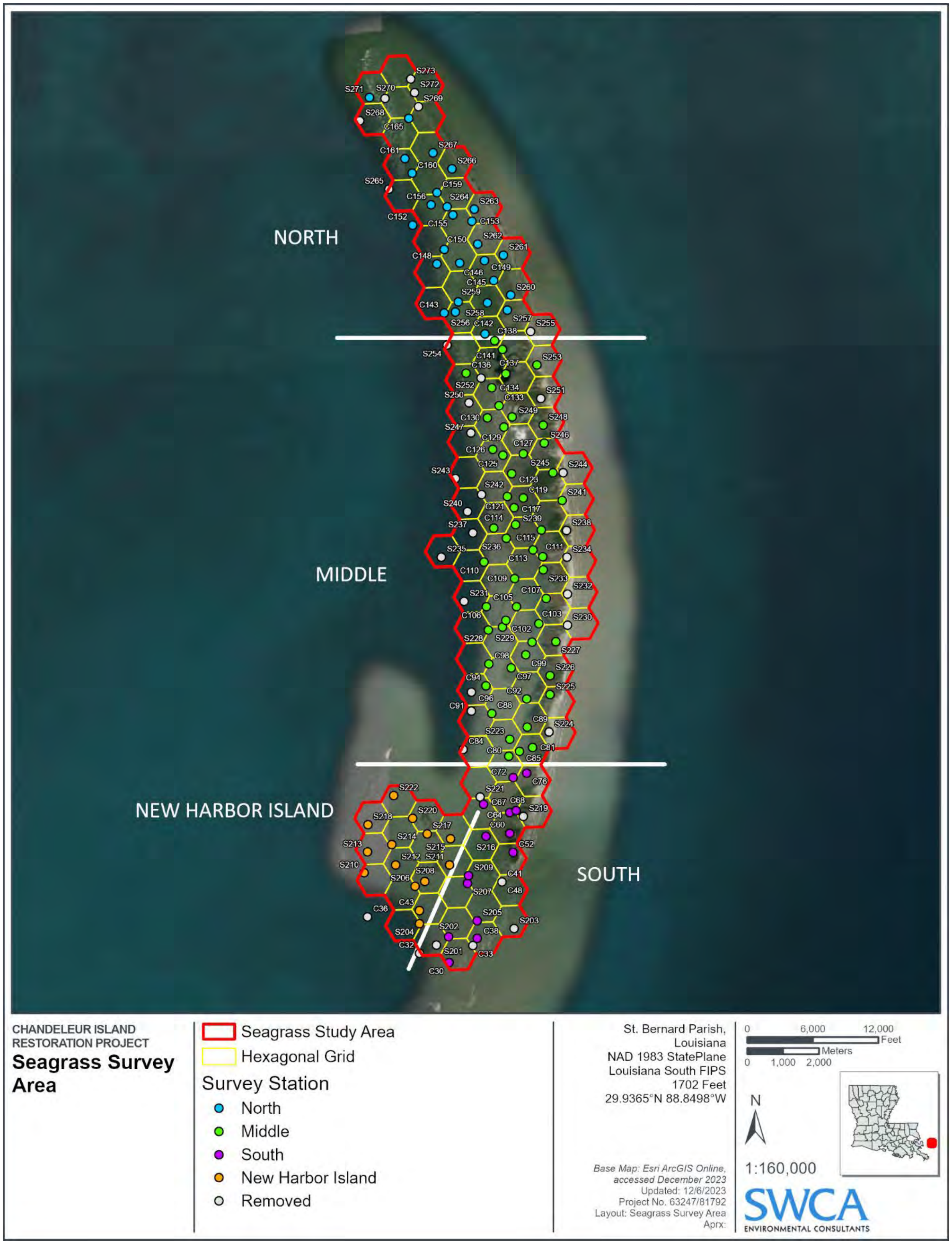

Figure 4. Seagrass Study area.

2.3 Field Data Collection

The field study was conducted from September 15 through September 25, 2022, known to be within the peak seagrass growing season at the Chandeleur Islands. While Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Environmental Quality do not stipulate a seagrass growing season, especially as it pertains to environmental surveys, initial guidance on timing for surveys utilized the Florida Department of Environmental Protection (FDEP 2020) regulatory season as June 1 and Sept. 30 for the Florida and the northern Gulf of Mexico coastal regions. However, personal communication with Kelly Darnell (USM) provided further detail that that the peak growing season at the Chandeleurs occurs from early to mid-September and can extend as late as early October.

The primary objective of the survey was to collect data metrics that would characterize the seagrass community, including species composition, percent cover, seagrass bed configuration (patchiness), and preliminary water quality information to establish a baseline condition at the peak of the 2022 growing season. The fixed location is to be navigated to with GPS accuracy of 4 meters or better. All location information was documented in ArcGIS Field Maps, and all water quality and seagrass metrics were recorded on hard copy datasheets for transcription into a database. The location was identified as having a 10-meter radius, and the four stations were sampled within this circle. In situ water quality parameters, water transparency, and photosynthetically active radiation (PAR) were collected prior to deployment of any benthic sampling equipment to minimize disturbance to the water column or sediment.

Species community composition and areal coverage were documented at each randomly selected, fixed location. Four replicate stations were sampled in set directions oriented around each location: forward starboard, aft starboard, aft port, forward port, (Figure 5). Direct observations were evaluated in the field within a 0.25 m^2 PVC quadrat frame with 100 subdivided cells. An underwater camera was used to document each quadrat. A summary of primary data metrics collected is described in Table 1.

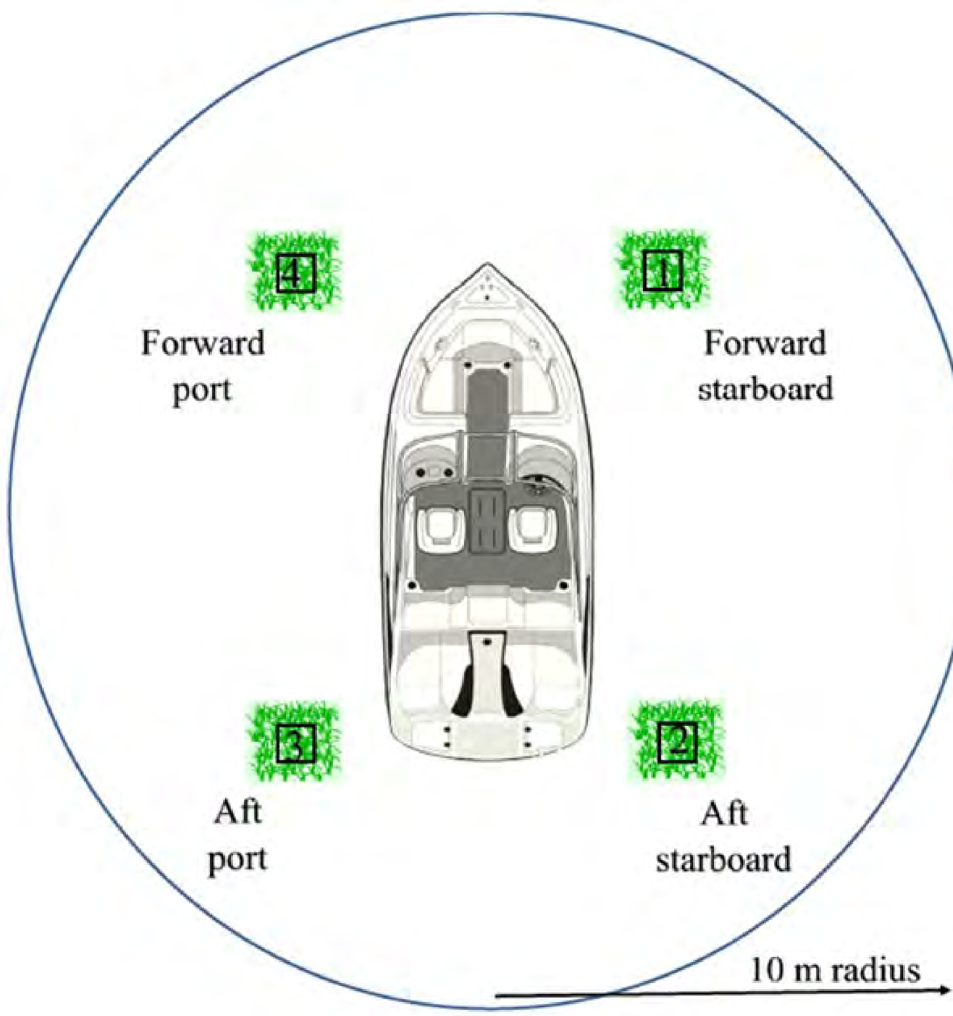

Figure 5. Sampling stations oriented around each randomly selected fixed location.

Table 1. Survey metrics for locations and stations.

Data Collection Location	Metrics	Equipment
Vessel Location	Date/Time	
	GPS location	GPS unit (submeter accuracy)
	Relative Water depth	Sounding rod
	Water temperature, salinity, conductivity, pH, dissolved oxygen	YSI Pro Series, multi-probe sonde
	Light attenuation	LI-COR (Li-192) Underwater PAR sensor
	Transparency	Secchi disk
Stations	Sediment type	Direct Observation using .25 m^2 PVC quadrat. (with underwater camera)
	Species composition	
	Total percent cover	
	Percent cover by species	
	Representative canopy height	Ruler

2.4 Data Validation

2.4.1 Water Quality

The United States Environmental Protection Agency (USEPA) in its *National Coastal Condition Assessment (NCCA) 2020 Quality Assurance Project Plan (QAPP)* (USEPA 2020) provides appropriate data reporting unit criteria for in situ measurements:

Table 2. Data report unit criteria for in situ measurements (USEPA 2020).

Measurement	Units	No. Significant Figures	Maximum No. Decimal Places
Temperature	ºC	2	1
Salinity	ppt	2	1
Conductivity	µS/cm at 25ºC	3	1
Dissolved Oxygen	mg/L	2	1
pH	pH units	3	Not reported
PAR	$\mu E/m^2/s$	2	1
Secchi Depth	Meters	3	1
Depth	Meters	3	1

As the Chandeleur Islands are a fairly unique environment removed from typical anthropogenic influence in Louisiana's coastal waters, and not considered an open ocean environment, SWCA used the range of values for the above water quality parameters as guidance for site specific values based previous research at the Chandeleur Islands. Table 3 presents the reported water quality values from previous studies conducted at the Chandeleur Islands.

Table 3. Summary of in situ water quality measurements from past research at the Chandeleur Islands.

Source	Sampling Timeframe	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	PAR ($\mu E/m^2/s$)	Secchi (m)
Darnell, *per. comm*. 2022 (range of values)	September and October 2018	25.2 to 35.4	21.8 to 30.1	4.8 to 13.8	53 to 1603	0 to Depth
Darnell et al. 2017 (average values)	October 2014, and April 2015	27.3 +/- 0.9	30.7 +/- 0.3	6.8 +/- 0.5	Not reported	Not reported
Robertson and Baltzer 2017 (range of values)	September and July of 2015 and 2016	23.8 to 31.1	23.0 to 30.8	2.6 to 10.5	Not reported	Not reported

2.4.2 Species Descriptions

The following species are known to occur within the northern Gulf of Mexico and documented during this survey at the Chandeleur Islands.

2.4.2.1 *HALODULE WRIGHTII* (SHOAL GRASS)

Halodule wrightii (shoal grass), a fairly ubiquitous species, plentiful along the Atlantic Coast from North Carolina, and into the Caribbean, is tolerant of low light, can tolerate a range of temperatures and salinities, and can survive in high wave energy and turbid environments (Gutierrez et al., 2010, Ray et al. 2014, and Florida Museum of Natural History 2018). *H. wrightii* is easily distinguished by its flat narrow blades that grow to a length of 10-15 cm and a width of 2-3 mm. These blades grow from a single node and are notched at the tip (Florida Museum of Natural History 2018). Reference photographs and illustrations are presented in Figure 7 (Meiman 2019).

Figure 6. Reference photographs and illustrations of *H. wrightii*.

2.4.2.2 *THALASSIA TESTUDINUM* (TURTLE GRASS)

Thalassia testudinum (turtle grass) is a subtropical and tropical marine seagrass, common in the Gulf of Mexico and Caribbean, typically found in waters with salinity between 24 and 35 parts per thousand (ppt), and temperatures ranging between 27 and 30ºC. The species occurs in narrow depth ranges, typically between 0.5 and 2 m, and within areas that are protected from wave energy and other factors causing high turbidity and poor water quality (TPWD 2012, McDonald et al. 2016, LDWF 2023). *T testudinum* is identified by flat, ribbon-like blades, with rounded tips, growing in small clusters up to 35 cm long or longer. During the flowering season, pale green to pink, fruit-producing flowers can be observed (LDWF 2023). Reference photographs and illustrations are presented in Figure 7 (Meiman 2019).

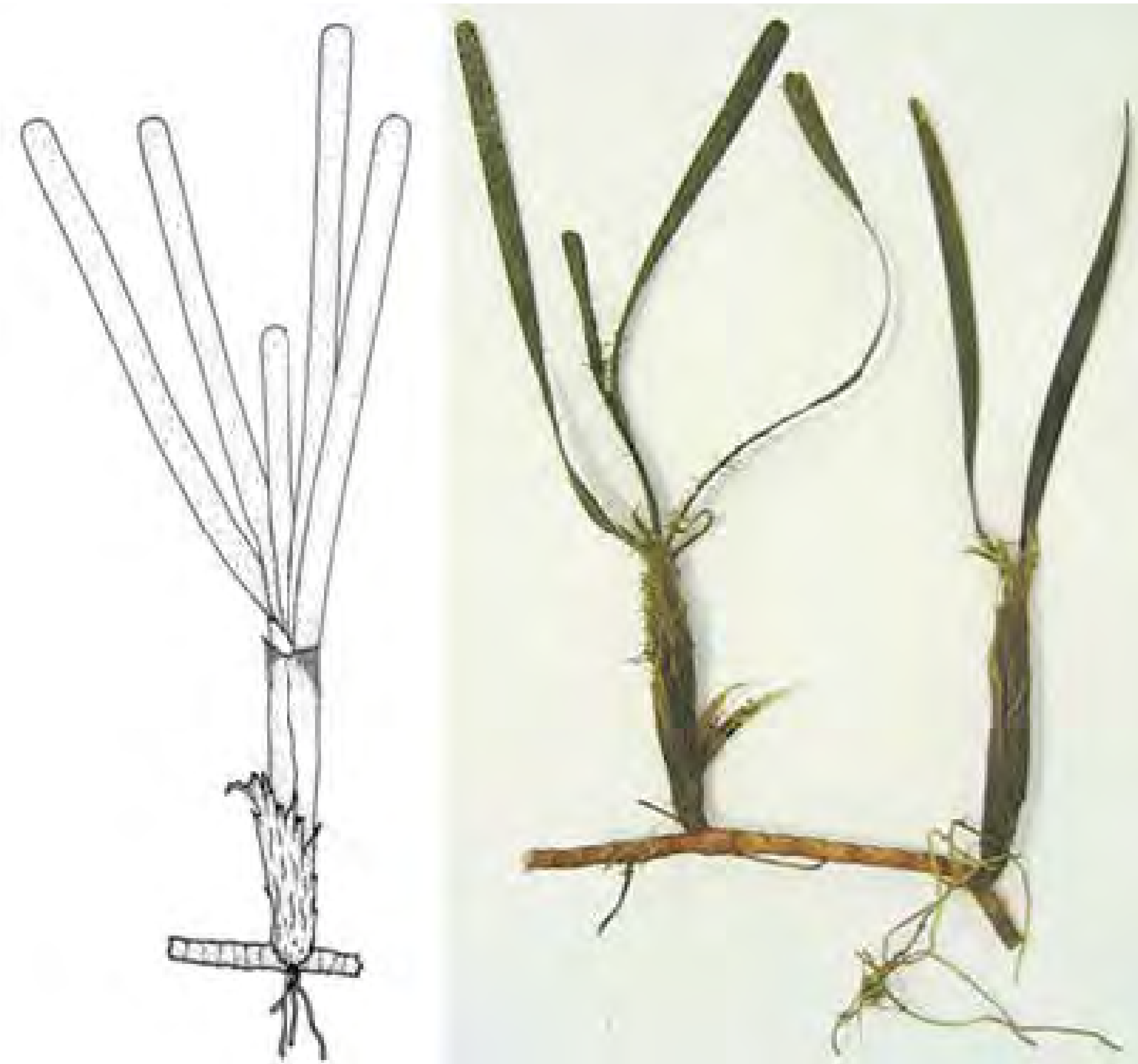

Figure 7. Reference photos and illustrations of *T. testudinum*.

2.4.2.3 *RUPPIA MARITIMA* (WIDGEON GRASS)

Ruppia maritima (widgeon grass) is a wide distributed seagrass, tolerating a broad range of salinity, temperature, light, and nutrient conditions, and can be found in waters as shallow as a few centimeters, and up to 4.5 m, depending on light penetration and wave disturbance. *R. maritima* occupies a wide range of habitats including tidally influenced rivers, bays, estuaries, and along barrier islands. *R. maritima* can colonize an area quickly due to a high shoot turnover and its ability to reproduce sexually and asexually and can be perennial or annual depending on temperature and salinity ranges, acting as a perennial species in areas of higher temperature and salinity maxima. R. maritima produces a large number of underwater flowers about 5 to 6 weeks after the onset of spring growth and within 1 to 2 weeks the flower spike develops, releasing pollen into the water column (Byrnes et al., 2022, Kantrud 1991, NatureServe 2023). *R. maritima* can be identified by shoots reaching lengths up to 2.5 m with leaves ranging between 5 and 20 cm, however when not reproducing, leaves only grow to a length of 1-2 mm. Leaf blades are wider at the base of the stem and slowly taper into long pointed tips (Byrnes et al. 2022). At the time of survey, *R. maritima* was not flowering, therefore requiring a further examination of the roots and rhizomes to

distinguish from shoal grass. Reference photographs and illustrations are presented in Figure 8 (iNaturalist 2023, Native Plant Trust 2023).

Figure 8. Reference photos and illustrations of *R. maritima*.

2.4.2.4 *HALOPHILA ENGELMANNII* (STAR GRASS)

H. engelmannii is known to thrive on sandy or muddy bottoms in depths ranging from near surface to 20 meters, in areas with low wave energy (NatureServe 2022). Unlike most seagrass species *H. engelmannii* can tolerate lower light levels, caused by depth or high turbidity, and found in typical marine environments which makes it more common in deeper waters of the Gulf of Mexico than other species (NatureServe 2022). *H. engelmannii* has 4 to 8 oblong leaves in a whorl at the end of each stem. These leaves are around 2.5 cm long and 0.6 cm wide. Stems do not usually exceed 10 cm in length (TPWD 2012). Reference photographs and illustrations are presented in Figure 9 (Meiman 2019).

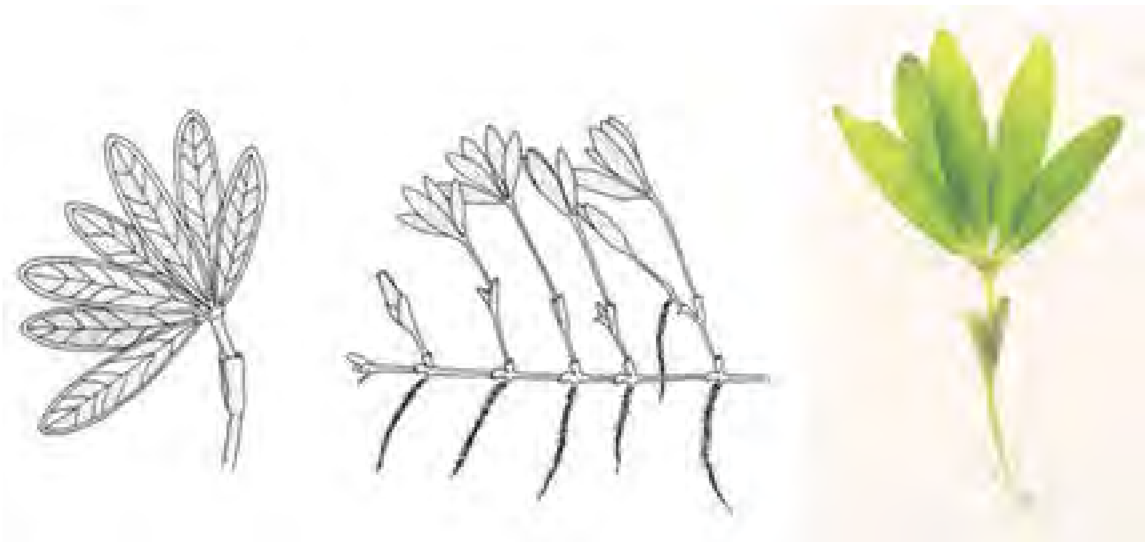

Figure 9. Reference photos and illustrations of *H. engelmannii*.

2.4.2.5 *SYRINGODIUM FILIFORME* (MANATEE GRASS)

S. filiforme is common along the Gulf Coast and the Caribbean in bays and shallow waters, ranging from 0.75 to 2.0 m in depth (TPWD 2012). Its cylindrical leaves help distinguish it from other species. *S. filiforme* has leaves that can reach 50 cm in length that often cluster in numbers of 2 to 4 with roots growing just below the surface (Florida Museum of Natural History 2018). *S. filiforme* is found in coastal waters with salinities of 20-36 ppt. This species often grows in small patches or in areas with other species of seagrass.

S. filiforme reproduces through sexual reproduction of seeds and vegetatively by rhizome elongation (Samper-Villarreal et al., 2020). Reproductive cymes (flat-topped cluster of flowers on a branch or a system of branches in which the central flowers open first, followed by the peripheral flowers) can be observed when the seagrass is reproducing. They usually only appear during the warmer months, however in the northern Gulf of Mexico this occurs in shorter intervals versus more tropical to subtropical locations (Samper-Villarreal et al., 2020). Reference photographs and illustrations are presented in Figure 10 (Meiman 2019).

Figure 10. Reference photos and illustrations of *S. filiforme*.

2.5 Data Analysis

2.5.1 Aerial Photogrammetric Interpretation

Seagrass was digitized using a mixture of photointerpretation and image analysis according to methodology described in *Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach* (NOAA Coastal Services Center 2001). Satellite imagery of study area was captured on September 14, 2022, by Planet Labs PBC through their Planet Tasking service. Planet Labs technology has 20 of its SkySat satellites in orbit, capable of high frequency fly over of a given area 5-7 times a day. SkySat produces 3 band natural color imagery at a resolution of 50cm, capable of download within a few hours of acquisition. The overflight photomosaics collected in May 2022 were not used during this analysis as those images were not collected during the peak growing season, and therefore would not provide the

maximum extent of seagrass coverage. Satellite imagery was acquired just days before the field survey, providing near real-time imagery for comparison and analysis.

The satellite imagery was first processed using the ArcGIS Pro 2.9 Image Analyst extension, using the Image Classification and Classification tools to digitize areas of contrast within the seagrass study area. This classification consisted of a machine learning model created from small areas of trained data input from geospatial scientists which focused on contrast changes within the imagery that specifically identified the difference between potential seagrass and open water. From there the delineation of seagrass was visually confirmed and revised to include all areas of seagrass discernable from the satellite imagery. This method included "heads-up digitization," defined as manual digitization by tracing a mouse over features displayed on a computer monitor, used as a method of vectorizing raster data, focusing on outer boundaries and using a minimum mapping unit of 0.03 hectares (0.25 acres) to differentiate patchy seagrass as described in the reference methodology. The analog digitization and revisions of modeled seagrass boundaries were also completed in ArcGIS Pro 2.9. Focus was applied to determine the outer boundaries of the seagrass with the goal of capturing any areas above 10 percent cover as described in *Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach* (NOAA Coastal Services Center 2001).

2.5.2 In situ Measurements and Observational Data

Water quality and seagrass coverage were examined as a function of relative water depth at the time of survey, and "zones" based on barrier island morphology within the Survey Area. For locations found in depths between 0 and 1.0 m, only one measurement was recorded at 0.3 m below the water line. Locations in depths > 1.0 m were recorded both at 0.3 m and at 1.0 m. For measurements in depths at or just over 1.0 m, readings were taken approximately 0.3 m from the bottom to avoid disturbing the bottom sediments. In this survey report, SWCA calculated the average water quality measurements within each zone at the surface and at 1.0 m, as applicable. All depth measurements discussed in the body of this report are relative depths. Tidally corrected depths are presented in Appendix B.

As the secchi reading is relative to the depth of the water column at each location, measured as the depth at which the Secchi disk is no longer visible when lowered into water from the shaded side of a boat, and the point at which it reappears after raising it.

As the Li-Cor sensor is highly sensitive, five replicate PAR readings were recorded at each depth (0.3 m, and as appropriate at 1.0 m or 0.3 m off the bottom) for each location, and the five readings were then averaged for each depth zone. The diffuse attenuation coefficient (K_d) for downward irradiance was calculated using the following equation: $K_d = [-\ln(l_o/L_z)]$.

General notes taken at each location also included substrate, which was categorized as sand (coarse, medium, fine grain), a combination of silt and sand, and silt. These notes were based on visual observation and did not include a detailed assessment or laboratory analysis for grain size.

2.5.3 Defining Island Zonation

Based on visual observation in the field, primarily related to the above sea level island land mass and vegetative properties, SWCA defined the following "Zones" within the Survey Area. The locations are color coded by zone in Figure 4, above.

North Zone: In general, there is minimal to no discernable land mass above sea level to provide protection to the backside of the island. There is no supporting backmarsh vegetation between the island

and the seagrass beds. There is evidence that sand bars separate the more inland areas from Chandeleur Sound. Twenty-seven of the 108 locations are found within the North Zone.

Middle Zone: These stations are in areas found behind the island with elevation above sea level, providing protection to the seagrasses from wind and wave action. Large tracts of marsh grasses further protect the shallow water seagrass. The most landward areas are characterized by slower moving, and protected waters. The middle zone is characterized by cuts between the marsh, draining of the island. As distance from the island increases, the water movement is influenced by the Chandeleur Sound, increasing in velocity. Fifty-two of the 108 locations are found within the Middle Zone.

South Zone: These locations are found in areas behind the island with above sea level land mass, however exhibit evidence of erosion. The lack of supporting back marsh systems indicates this area is fairly dynamic. At the southernmost point, locations are found in open water on the Gulf side, with no evidence of seagrass. Historic aerials indicate the point was more prominent and likely though wind and wave action, has eroded backwards. Fifteen of the 108 locations are found within the South Zone.

New Harbor Island (NHI Zone): The locations in this area border smaller mangrove islands and are separated from the main island by a deep and wide channel. Fourteen of the 108 locations are found within the NHI Zone.

2.5.4 Seagrass Distribution and Community Composition

The seagrass community composition was assessed similarly to the in-situ water quality data, where coverage was examined based on island zones and relative depth. The measured relative depth was refined into categories to identify trends in species distribution and coverage, defined as follows:

- Shallow: 0 to 0.6 m
- Mid: >0.6 m to 1.2 m
- Deep: >1.2 m to >2.0

Results below present species community composition and occurrence, coverage, and canopy height as a function of location, zone within the study area, relative depth zone, and general substrate observations.

To estimate the spatial pattern of seagrass community composition, SWCA estimated individual species percent cover within a quadrat based on standardized guidance on cover classifications, provided in Figure 11, as presented in Meiman (2019). This allowed for a rapid, visual, and repeatable classification product.

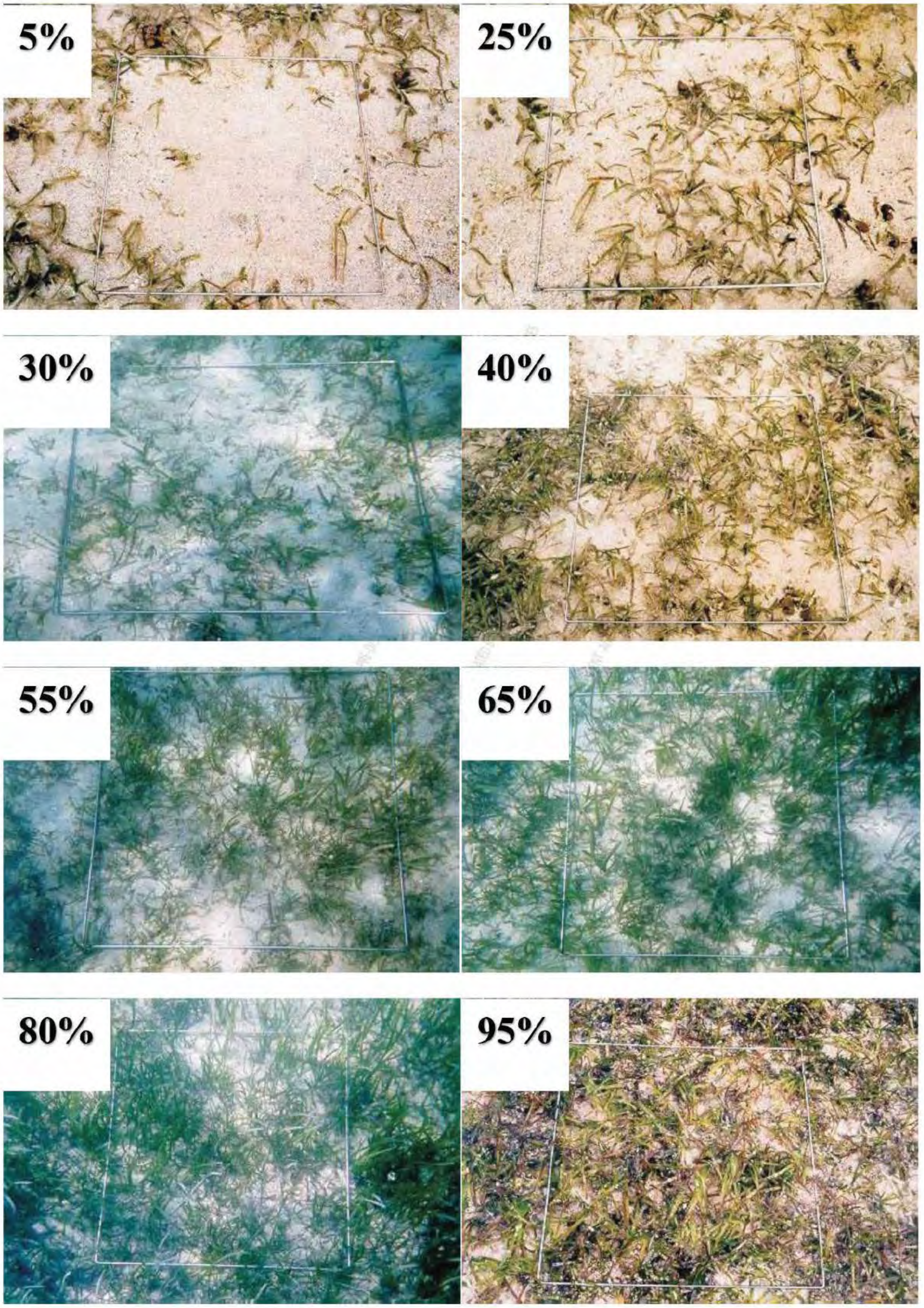

Figure 11. Standardization guidance for estimating percent seagrass cover.

The seagrass density analysis and modeling were completed using the ArcGIS suite of software and tools. The seagrass data and observations for each station were assessed using the percent cover values observed in the field. Each observation was recorded in the field and digitized into a geospatial database that tied the values of each species observation to the point at which it was recorded. Using this digitized field data, the density of seagrass was run through an ArcGIS Average Nearest Neighbor tool, to calculate seagrass coverage across the Study Area. The Average Nearest Neighbor returns the observed mean distance, expected mean distance, nearest neighbor index, z-score, and p-value for measures of statistical significance.

3 FIELD RESULTS

3.1 Water Quality Measurements

Of the 143 locations identified for survey, 108 locations fell within the sea grass coverage area identified and mapped using the September 2022 satellite imagery. Within each zone, the average relative depth of the randomly sampled locations was 1.0 m (SD ±0.8m) in the North Zone, 1.3 m (SD ±0.7m) in the Middle Zone, 1.4 m (SD ±0.7m) in the South Zone, and 1.7 m (SD ±0.6m) in the NHI Zone. A summary of the average water quality measurements are presented in Table 5, and described below.

For water temperature, pH, and PAR, measurements were fairly consistent between the zones. Surface temperature was characteristic for the time of year and exhibited only minor decrease between the surface measurement and the measurement at depth. Average surface temperature was fairly consistent between zones with averages between 30.0°C and 29.1°C, and measurements at 1.0 m averaged between 28.4°C and 29.5°C. pH measurements were consistent between zones and depths, ranging from 8.18 to 9.06. The average diffuse attenuation coefficient (K_d) ranged from 0.38 to 0.46, with the lowest occurring at NHI.

Salinity at the surface and at depth was lowest in the North Zone (26.3 ppt at surface; 28.5 ppt at depth), and gradually increased moving south through the Survey Area. The NHI Zone recorded 34.1 ppt at the surface and 35.2 ppt at depth. Similar trends are seen in the conductivity measurements.

Average dissolved oxygen was highest in the North Zone (8.4 mg/L at the surface [128.0%]; 7.6 mg/L [115.8%] at depth), and lowest in the NHI Zone (7.1 mg/L[110.0%] the surface;7.1 mg/L [117.6%] at depth). There were five locations where the dissolved oxygen was higher than 11 mg/L. A review of other environmental conditions indicate that these high dissolved oxygen values were at locations where the total water depth was less than 0.3 m. Due to the shallow water allowing for rapid exchange with the air, based on SWCA's professional opinion, these values were left in the data set. These values were primarily in the North Zone, and one in the Middle Zone, However, removal of these values would bring the average dissolved oxygen down to 7.4 mg/L, which is consistent with the other zones on the main Chandeleur Island.

Appendix B provides a complete summary of water quality data by station.

Table 4. Average water quality measurements per zone.

Average Measurements at Surface (0.3m)													
Zone	**Temp**		**Salinity**		**Conductivity**		**DO**		**pH**	**Secchi**		**PAR**	
	°C	**SD**	**ppt**	**SD**	**μS/cm**	**SD**	**mg/L**	**SD**	**range**	**Depth (m)**	**SD**	**K_d**	**SD**
North Zone	30.0	2.5	26.3	3.0	48.1	4.8	8.4	2.2	8.17 - 8.73	1.0	0.8	0.46	0.15
Middle Zone	29.4	1.2	28.8	5.4	58.2	3.4	7.4	2.1	8.06 - 9.09	1.2	0.7	0.46	0.24
South Zone	29.1	0.4	24.6	0.5	64.5	2.2	7.7	1.4	8.36 - 8.90	1.1	0.5	0.45	0.13
NHI Zone	29.7	0.5	23.9	0.2	64.5	1.6	7.1	2.2	8.24 - 8.59	1.5	0.4	0.38	0.05

Average Measurements at Depth (1.0m)													
Zone	**Temp**		**Salinity**		**Conductivity**		**DO**		**pH**	**Secchi**		**PAR**	
	°C	**SD**	**ppt**	**SD**	**μS/cm**	**SD**	**mg/L**	**SD**	**range**	**Depth (m)**	**SD**	**K_d**	**SD**
North Zone	28.4	*0.8*	28.5	*4.7*	50.2	6.9	7.6	1.7	8.18 - 8.71	--	--	--	--
Middle Zone	28.8	*0.6*	28.7	*6.7*	59.5	2.8	7.5	1.6	8.29 - 8.71	--	--	--	--
South Zone	28.9	*0.6*	24.9	*0.5*	64.6	2.0	7.5	0.9	8.36 - 8.60	--	--	--	--
NHI Zone	29.5	*0.6*	24.2	*0.4*	64.8	1.5	7.1	2.1	8.47 - 8.60	--	--	--	--

3.2 Direct Observation Occurrence and Coverage

Of the 108 locations surveyed for seagrass, 40 were bare, 46 were dominated (greater than 50% cover) by *H. wrightii*, 10 dominated by *T. testudinum*, 6 dominated by *R. maritima*, 3 had relatively even coverage of *H. wrightii* and *R. maritima*, 2 dominated by *H. engelmannii*, and 1 was evenly dominated by *H. wrightii* and *T. testudinum*. One location, C142, had a species richness of 4 species, and was the only location with documented *S. filiforme*. *T. testudinum* was not present at this location. This location was on the boundary between the North Zone and the Middle Zone. The Middle Zone supported the next highest species richness, with 3 species at C129: *H. wrightii*, *T. testudinum*, and *R. maritima*. Only one location in the NHI Zone contained seagrass: S217 supported *H. wrightii*. Table 5 presents the dominant species and distribution of those dominance classes within each zone.

Table 5. Dominant seagrass species by zone presented as count of locations.

	Bare	*H. wrightii*	*T. testudinum*	*R. maritima*	*H. wrightii/ R. maritima*	*H. engelmannii*	*H. wrightii/ T. testudinum*
North Zone	6	15	--	5	1	--	--
Middle Zone	11	27	10	1	2	2	
South Zone	10	3	--	--	--	--	1
NHI Zone	13	1	--	--	--	--	
Total	40	46	10	6	3	2	1

In the North Zone, the greatest percent cover of *H. wrightii* was found at the mid depth locations, while *R. maritima* had evenly distributed covers between shallow and deep locations.

In the Middle Zone, *H. wrightii* cover was greatest at shallow locations, and decreased in coverage into the mid and deep locations. *T. testudinum* showed similar trends, decreasing in coverage from shallow to deep locations. *H. engelmannii* was not present in shallow locations and had the highest coverage at locations at mid-depth locations. *R. maritima* had lower coverage than the other species present and had highest coverage at shallow locations.

In the South Zone, *H. wrightii* had the highest coverage at the shallow and mid depth locations, with minimal coverage at the deep locations. Only minimal coverage of *T. testudinum* was found at the deep locations, and the highest coverage of *R. maritima* was found at shallow locations.

In the NHI Zone, only minimal *H. wrightii* coverage was observed at a shallow location. Table 6 presents the average coverage by species in each zone and at relative depths.

Appendix C provides a complete summary of seagrass percent coverage data and canopy height by location.

Table 6. Average seagrass species percent cover per zone and depth

Zone	Depth	*H. wrightii*	*T. testudinum*	*S. filiforme*	*H. engelmannii*	*R. maritima*
North	Shallow	5.2%	--	--	--	24.1%
	Mid	74.3%	--	--	--	1.5%
	Deep	20.1%		3.8%	6.3%	28.8%
Middle	Shallow	44.9%	53.8%	--	--	4.7%

	Mid	39.1%	47.2%	--	21.0%	1.8%
	Deep	28.7%	48.8%	--	8.4%	--
South	Shallow	99.8%	--	--	--	45.5%
	Mid	89.9%	--	--	--	0.3%
	Deep	6.3%	4.0%	--	--	--
NHI	Shallow	16.8%	--	--	--	--
	Deep	--	--	--	--	--

3.3 Seagrass Data Interpolation and Cover Modeling

Through image processing of the September 2022 satellite imagery for total coverage as described above, maximum extent of acreage that supports seagrass growth within the Study Area is 2,102 hectares. 1,711 hectares of this area was classified as dense (51-100%) seagrass with the remaining 391 hectares considered patchy (50% or less). Results of the coverage mapping showing the maximum extent are presented in Figure 12. Appendix D presents the detailed results to depict the areas of dense cover and the areas of patchy cover. Cover classification mapping using the percent cover from the September 2022 field studies, and data interpolation for percent cover as described above, are provided for total seagrass coverage (Figure 13), and for each species identified during the field survey: *H. wrightii* (Figure 14), *T. testudinum* (Figure 15), *R. maritima* (Figure 16), *H. engelmannii* (Figure 17), and *S. filiforme* (Figure 18). Coverage classification mapping was completed using the nearest neighbor interpolation method within ArcGIS using coverage values per sampling station location. The maximum seagrass extent from aerial image processing (orange boundary in Figure 12), was overlaid on the data interpolation models, to provide context to the modeled high cover and low cover areas. The maximum 2022 extent from the imagery is seen as a black polygon layer over the modeled results in Figure 13 through Figure 18.

Figure 12. Total seagrass cover through satellite imagery interpretation, and direct observation for species counts.

Figure 13. Total seagrass coverage modeling results.

Figure 14. *H. wrightii* coverage modeling results.

Figure 15. *T. testudinum* coverage modeling results.

Figure 16. *R. maritima* coverage modeling results.

Figure 17. *H. engelmannii* coverage modeling results

Figure 18. ***S. filiforme*** **coverage modeling results.**

4 DISCUSSION

4.1 Seagrass Distribution Observations

In general, the in-situ water quality measurements were within similar ranges between zones and locations indicating that these parameters are likely not a limiting factor for the growth and coverage of the seagrasses at the Chandeleur Islands. Values were typical of a shallow, coastal environment with limited anthropogenic influence, and indicated overall good water quality.

Based on the defined zonation of the Northern Chandeleur Island, the North and South Zones supported higher coverage of *H. wrightii*, and also a relatively high coverage of *R. maritima* but in large, isolated patches, not interspersed with *H. wrightii*. The North and South Zones experience higher overall entropy from wave and tidal currents at the most extreme points. Additionally, in these Zones the more dominant substrate type was sand, with fewer sites documenting finer silt material. As these Zones experience the highest levels of periodic disturbance from large storm events, the recovery species *H. wrightii* and *R. maritima* will grow and thrive, as they can quickly grow during periods of calm, but are also quickly removed during storm and disturbance events with the ability to recover quickly after disturbance, acting as both perennial and annual species. *T. testudinum* was not dominant in these zones, as this species requires more stable conditions for growth as an annual species. In general, the lack of *T. testudinum* was consistent with previous studies, however the distribution of *H. wrightii* and *R. maritima* should be examined further. Previous studies indicate a larger distribution of specifically *R. maritima*, rather than isolated patches, as identified here. At the time of the study, flowering *R. maritima* was not observed, and required examination of roots and rhizomes for differences in identification between that and *H. wrightii*. With both *R. maritima* and *H. wrightii* considered weedy species, influenced by disturbance, the dominance of these species can change over time. Furthermore, one station documented *S. filiforme*. This is consistent with observations of rare coverage documented by Kenworthy et al. 2017, who notes that as this species flowers and produces seeds that remains buried in sediment seed banks for more than 12 months before germinating. Kenworthy et al. 2017 concluded that it is possible that seed banks were chronically exposed to contamination from *Deepwater Horizon*, with population level effects on this, and other seed producing species.

The Middle Zone supported the highest coverage of *T. testudinum*, with moderate coverage of *H. wrightii* and *H. engelmannii*. In this area, silt and sand combination, and silt were the dominant substrate. As the Middle Zone is more protected from wave energy from an observed higher land mass and supporting back marsh system, and lower water velocity based on distance from the Chandeleur Sound, the finer grain sediments have the opportunity to settle out. In areas of high *T. testudinum* coverage, these sediments are trapped within the dense foliage and thick root structure. In this area of good water quality, and minimal evidence of wash over and breeches in the island morphology, *T. testudinum* is the climax species thriving in the stable environment, and within its acceptable depth requirements. As the area becomes more unstable due to water velocity, depth limitations, and water quality, the more tolerant species, the *H. wrightii* and *H. engelmannii* succeed. At the shallow extent of *T. testudinum distribution*, there is an increase in *H. engelmannii* and *R. maritima.*

The NHI Zone is separated from the main Chandeleur Island by a deep channel. The buildup of the land mass and the establishment of the mangrove forest provides habitat for seagrass; however, the current dynamics and wave energy appears to be different. The overall water clarity was lower at the NHI Zone than the other zones. At the time of survey, the tide was slack, and water was calm, indicating this area may not receive adequate water movement, allowing for particulates in the water to remain suspended. Only one location in this Zone supported seagrass growth, with a relative low coverage of *H. wrightii*.

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Appendix A

Chandeleur Island Restoration Project (PO-0199) Seagrass Survey Plan

Chandeleur Island Restoration Project (PO-0199)

Seagrass Survey Plan

MAY 2022

PREPARED FOR

Coastal Engineering Consultants, Inc.

PREPARED BY

SWCA Environmental Consultants

CHANDELEUR ISLAND RESTORATION PROJECT (PO-)0199)
SEAGRASS SURVEY PLAN

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CONTENTS

Figures

Tables

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1 INTRODUCTION

1.1 Project Overview

The Chandeleur Island Restoration (PO-0199) Project (Project) is located on the Chandeleur Islands in St. Bernard Parish, Louisiana (Figure 1). The Chandeleur Islands include those lands between Chandeleur Sound and the Gulf of Mexico to include Chandeleur Island, Gosier Islands, Grand Gosier Islands, Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands (Figure 2). This Project Area includes the Chandeleur Islands and the seagrass beds and water bottoms within the Breton National Wildlife Refuge (Figure 3).

The purpose of the Project is to engineer and design a restoration project benefitting the Chandeleur Islands and the many species that use them with a particular focus on birds as defined in the Restoration Plan and Environmental Assessment Plan #1 of the Region-wide Trustee Implementation Group. Phase 1 of the Project focuses on plan formulation for restoration of the main Chandeleur Island and New Harbor Island. The Coastal Protection and Restoration Authority (CPRA) serves as the designated State agency for the Project.

The purpose of this document it to define the Survey Area and present the Survey Plan to map the current extent and document the species composition and relative density of the seagrass beds in conjunction with the Project data collection efforts; and describe the changes to the seagrass beds over time.

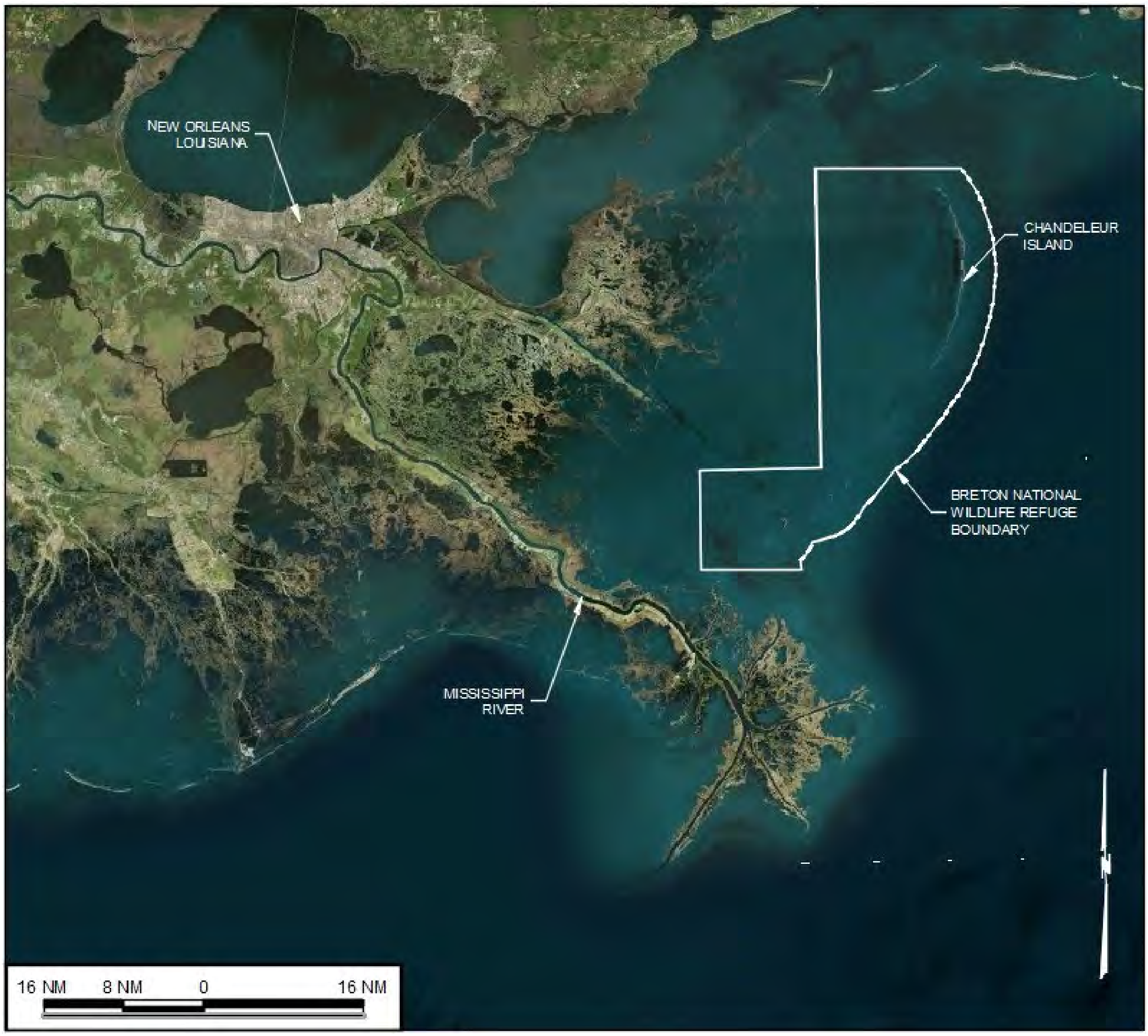

Figure 1. Project Location Map

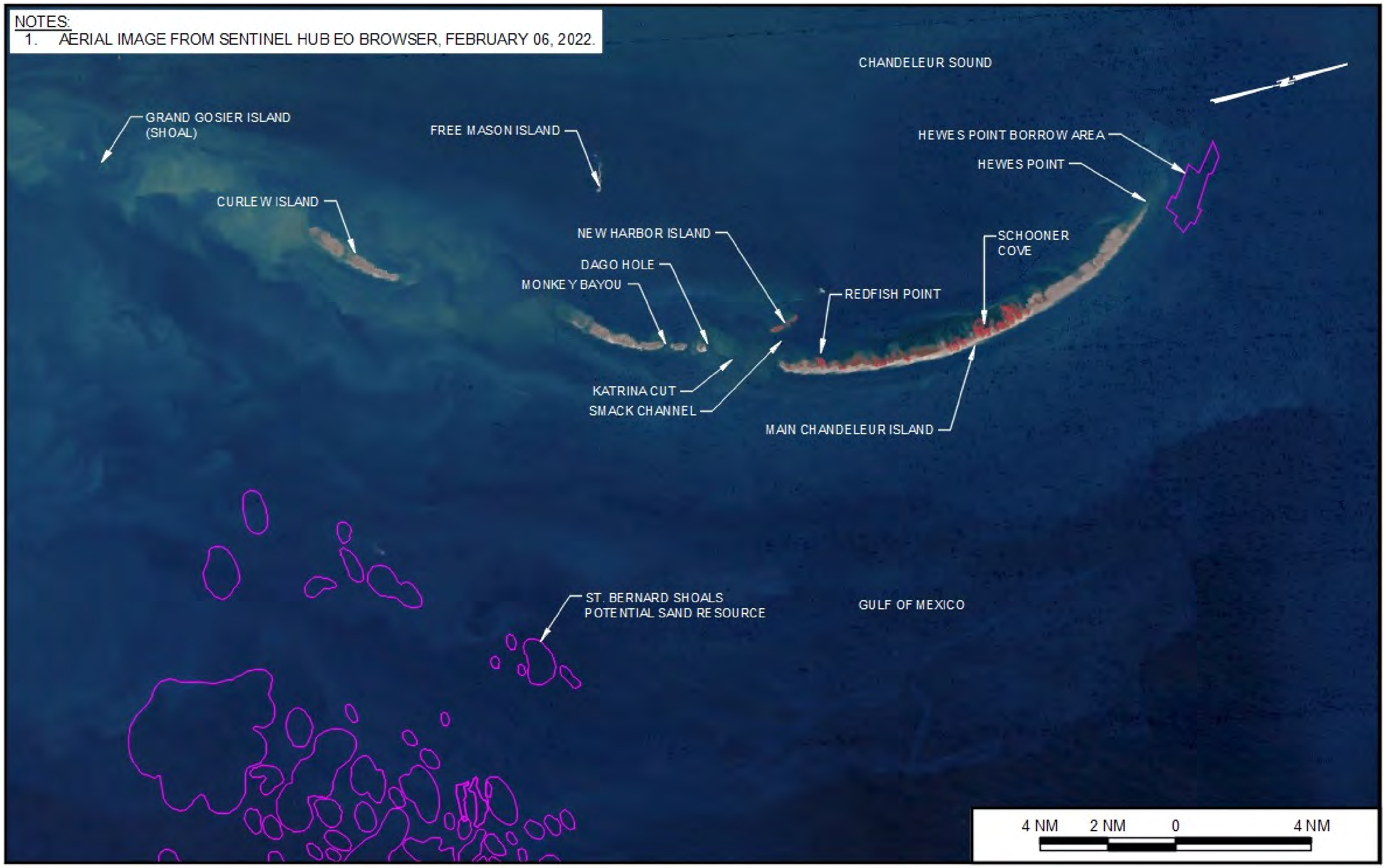

Figure 2. Chandeleur Islands

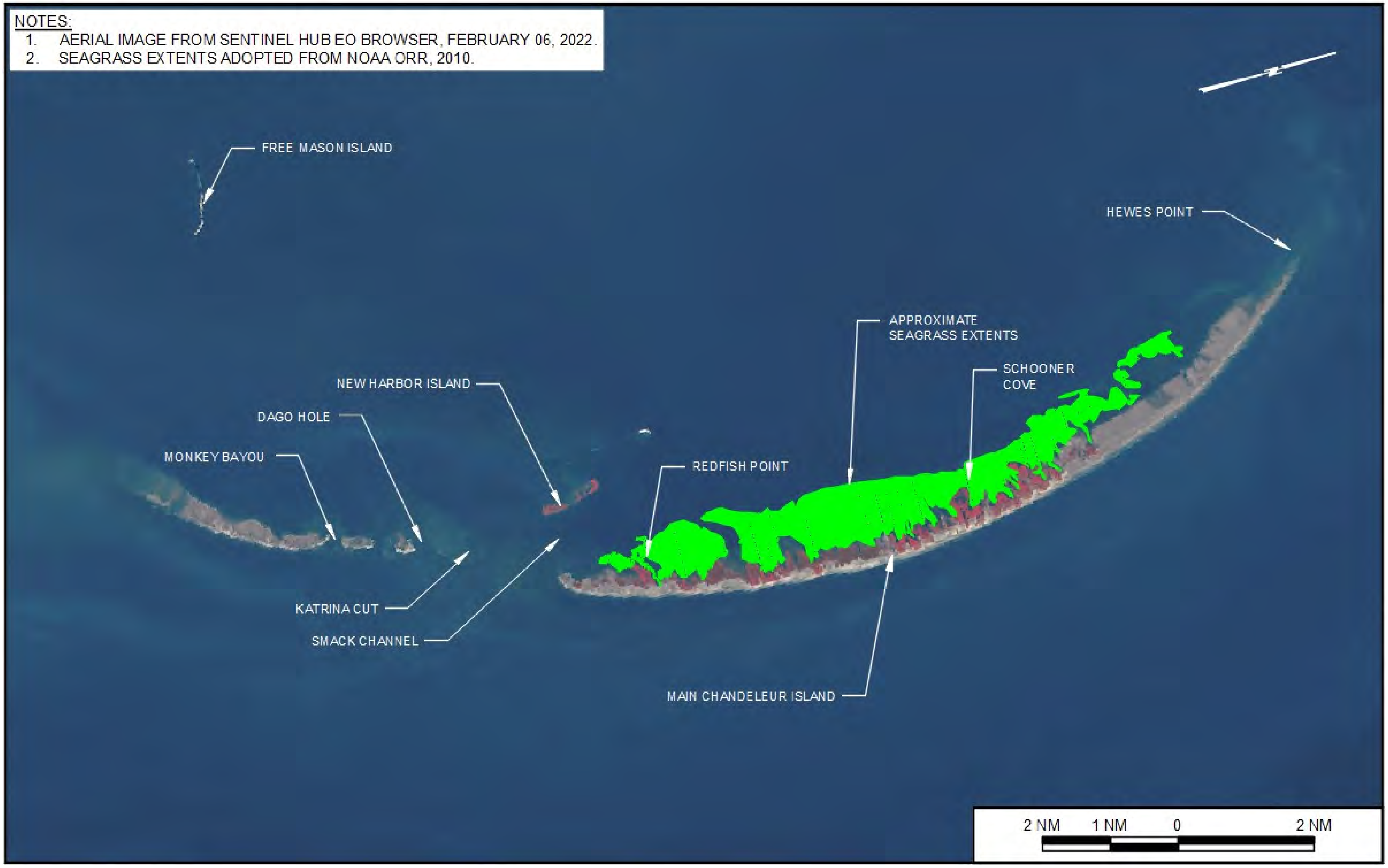

Figure 3. 2010-2011 Seagrass Bed Mapping by NOAA (NOAA 2015)

1.2 Project Area Description

The Chandeleurs Islands can be subdivided into two subsets, which are affected by different hydrologic inputs and environmental stressors. The northern islands include the main Chandeleur Island, New Harbor Island, Freemason Island, and Curlew Island. The southern islands include Grand Gosier Island and Breton Islands. The primary ecological drivers in the Project Area are attributed to natural coastal processes such as barrier island dynamics, abandoned river deltas, and damage from tropical storms and hurricanes. The southern islands are within close proximity to major passes of the Mississippi River. Due to the significant freshwater inputs, high nutrient levels and increased turbidity levels, seagrass development has been adversely impacted in this area. The northern islands are located far enough away from pollutant sources, including waters from coastal Mississippi, buffered by the Biloxi marsh system, and inputs from the Pearl River and passes of Lake Ponchartrain, and do not appear to have adverse impacts to seagrass development in this area (Handley et al. 2007).

Studies throughout the past five decades have reported varying coverage of seagrasses along the Chandeleur Islands, however the species composition has remained fairly consistent and includes turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*). Frequent damage due to passing hurricanes shown influences the species composition and abundance in certain areas. Those areas that are sheltered from damage are dominated by dense turtle grass meadows. Areas that experience higher levels of damaging forces, such as the creation of channel cuts and sediment washover features with high levels of sediment deposition, were found to have some turtle grass, but also manatee grass and shoal grass. Star grass was found to be present but was quite rare. The change in species composition from dense beds of turtle grass and manatee grass to gradual colonization of shoal grass and widgeon grass indicates a gradual pattern of stressors from storm damage over time (Handley et al. 2007).

The last comprehensive investigation for seagrass bed extent, viability, and species composition within the Chandeleur Islands was conducted by the National Oceanic and Atmospheric Administration (NOAA) and the United States Geological Survey (USGS) in 2010 and 2011. The investigation was conducted as part of the post-incident exposure of the Deepwater Horizon Oil Spill on seagrass vegetation throughout the northern Gulf of Mexico (NOAA 2015). The 2010 and 2011 seagrass coverage totals approximately 2,385 acres, and 2,614 acres, respectively (NOAA 2015). The National Aeronautics and Space Administration (NASA) Tool CREOL (NASA 2021) also provides supporting aerial imagery of the Project Area to illustrate changes in seagrass extent. The Project Area has been subjected to multiple storms of varying and increasing intensity storms. These storms have the potential to produce overwash and breaching of the dunes that can smother, bury, and otherwise impact water quality necessary for maintaining seagrass health and coverage.

2 SURVEY PLAN GOALS

The Survey Plan will utilize the available historic seagrass bed mapping and Project data to be collected including aerial photographs and imagery, topography, and bathymetry to establish the Survey Area for ground-truthing surveys of the seagrass beds. Detailed survey plan goals include:

1. Summarize the existing aerial and ground-truthed seagrass survey data from existing sources to give us an understanding of the historical seagrass bed extent and health through water quality, species composition, and biomass indicators, and to incorporate ground truthing data collection points for sample locations. The robust sampling plan will allow for consistency and reproducible data collection to evaluate trends in extent and health over time.

2. Determine the 2022 spatial distribution of seagrass beds utilizing new aerial data collected for the Project and Summer 2022 field surveys to verify boundary edges between aerial data collection timeline and field survey timeline.

3. Characterize the 2022 Seagrass communities. Primary data collection metrics will include species composition, percent cover, patchiness, and basic water quality parameters.

4. Determine and describe the biological and water quality health through secondary data collection at a subset of sampling locations, which will be used to guide future monitoring and restoration phases of the Project.

5. Set up and maintain a GIS platform (SWCA AI Platform) to evaluate in near real-time field data collection updates and compare between the 2022 aerial survey data with historic seagrass maps and aerial imagery.

2.1 Survey Plan

The limits of the 2010 and 2011 NOAA and USGS aerial data were georeferenced to establish the preliminary Survey Area and allow for reproducibility in the 2022 survey efforts: 1) verifying the entire seagrass habitat or potential habitat is identified, and 2) enable comparisons of species, compositions, and densities over time. Furthermore, the Survey Plan will incorporate Project Design Team data efforts to ensure proper data collection methods, logistics, and safety.

The work flow includes developing the preliminary Survey Area as presented herein, obtaining high resolution aerial photographs in May 2022 (separate task), mapping seagrasses utilizing the May 2022 aerial photographs, collecting topography and bathymetry in Summer 2022 (separate task), comparing and correlating Summer 2022 bathymetry to May 2022 seagrass mapping, obtaining satellite data in Summer 2022, refining seagrass edge mapping utilizing Summer 2022 data and satellite data, and finalizing the Survey Area to match the current extent of seagrasses. The seagrass survey field work is anticipated to be conducted within a two week period in August 2022 depending on weather and environmental constraints. Refining and finalizing the Survey Area will be an iterative process among the Project Design Team and CPRA.

2.2 Definition of Survey Area

In order to define a preliminary Survey Area (Figure 4), a single polygon was created identifying the maximum bounds of the 2010/2011 seagrass extent (NOAA 2015). This preliminary Survey Area will be refined based on results of the 2022 aerial data acquisition. The Survey Area will be confirmed based on the current extent of the seagrasses, which will be digitally mapped through photogrammetric interpretation. The aerial photographs will be collected in May 2022, prior to the start of the known seagrass growing season (June through September),. Topographic and bathymetric data and satellite data

will be collected in Summer 2022 to confirm the current extent at the time of the seagrass field survey The Survey Area will be refined as needed to capture the current extent of the seagrasses.

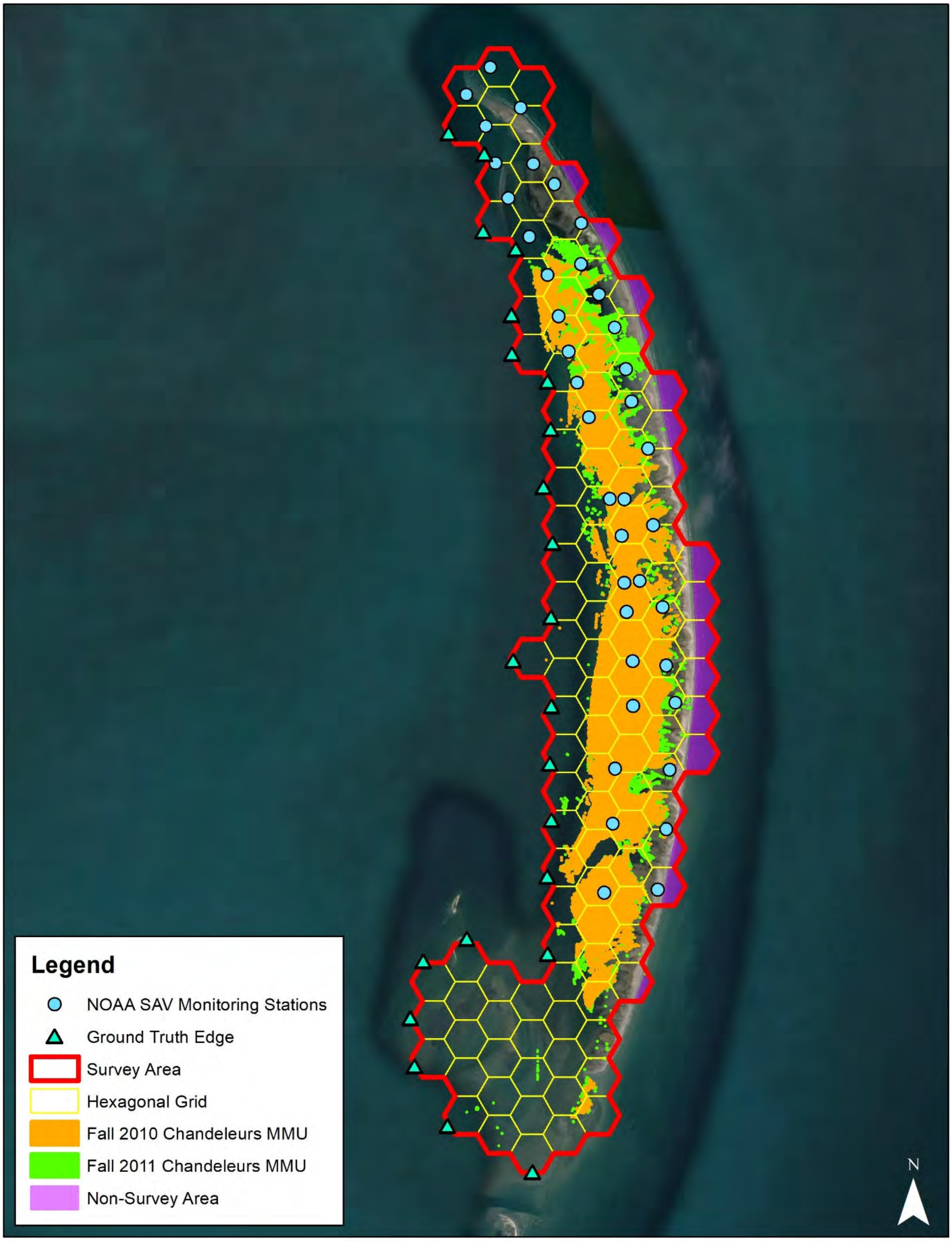

Figure 4. Seagrass Study Area

2.3 Field Survey Plan: Fixed Station Locations

The field survey plan utilizes the methods outlined in Dunton et al. (2010), as recommended by the National Academies of Sciences, Engineering and Medicine (2017), combined with the sampling locations from the 2010 and 2011 NOAA sampling program (NOAA 2015), allowing for robust data collection and reproducibility. The recommended practices utilize a grid of tessellated hexagons (500 meters per side) to identify sampling locations for all levels of seagrass monitoring. This hexagonal grid was overlaid on to the Survey Area to establish the sampling locations (Figure 4). Prior to the start of the field survey effort, one fixed sample location will be randomly selected within each hexagon, for a total of 123 sample locations. In situations where there are existing data points from the 2010 / 2011 NOAA sampling program, those station locations will be selected in lieu of the randomly selected data point for that hexagon.

For survey planning purposes, the hexagonal grid was overlaid on the most current publicly available, high resolution aerial data (Google Earth 2022). Due to the dynamic nature of the barrier islands and presumed migration of the island from the last large scale seagrass mapping effort (2011) to its current position, some survey grid locations containing historical seagrass data extensively overlap with the island and extend into the Gulf. Figure 4 illustrates how some survey hexagons will be truncated to account for island overlap. Once the April/May Project aerial data is collected, the survey grids will be similarly truncated to capture the most landward extent of the Survey Area.

Sampling will occur in the July – August 2022 time frame, during or shortly after the peak seagrass growing season for the region, which is mid to late summer. While Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Environmental Quality do not stipulate a seagrass growing season, especially as it pertains to environmental surveys, the Florida Department of Environmental Protection (FDEP 2020) further defines this season as June 1 and Sept. 30 for the Florida and the northern Gulf of Mexico coastal regions and will be utilized for this Survey Plan.

Primary Data Collection

The primary objective of the survey is to collect data metrics that will characterize the seagrass community, including species composition, percent cover, seagrass bed configuration (patchiness), and preliminary water quality information to establish a baseline condition at the peak of the 2022 growing season. Patchiness will be evaluated by the relative connectivity to surrounding seagrass beds (continuous vs patchy) and the relative biomass per unit (patchy vs very patchy). As outlined in Dunton et al. (2010) at each randomly selected, fixed location, four stations will be sampled in each of the cardinal directions surrounding the vessel. The fixed station is to be navigated to with GPS accuracy of 4 meters or better. The station is identified as having a 10-meter radius, and the four locations are sampled within this circle. Basic water quality parameters are collected with a data sonde prior to deployment of any benthic sampling equipment. Species composition and percent cover will be evaluated in the field within a 0.25 m^2 quadrat outfitted with an underwater camera to document coverage within the quadrat. Additionally, the primary data metrics will be collected during the diver-verified fringe locations, described further below. A summary primary data metrics to be collected are described in Table 1.

Secondary Data Collection

Secondary seagrass composition and metrics could be collected at a subset of the locations identified for primary data collection. These secondary data metrics would provide baseline health information that will support the restoration planning phase of the Project design and post-construction restoration monitoring and Adaptive Management (MAM). Secondary data collection could occur at 13 of the established hexagons, or 10% of the sample locations, selected accordingly to assess conditions in the shallow areas, shoaling habitats, and deeper established seagrass meadows from the northern to the southern extent of the seagrass beds. The secondary data collection locations will be selected based on final Study Area design, described above. A summary of secondary data metrics to be collected are described in Table 1.

Table 1. Survey and Sampling Metrics

Metrics	Metrics	Equipment
Primary Data Collection		
Vessel Location	Date/Time	GPS unit (submeter accuracy)
	GPS location	Sounding rod
	Water depth	Underwater light sensor
	Light attenuation	Multi-probe sonde
	Water temperature, salinity, pH, dissolved oxygen	
	Distance from shoreline	
Stations (N, E, S, W)	Sediment type	.25 m^2 quad (with underwater camera)
	Species composition	Ruler
	Total percent cover	
	Percent cover by species	
	Canopy height	
	Shoot density	
Secondary Data Collection (subset)		
Vessel Location	Biomass (above/below)	Benthic corer
	Root:shoot ratio	

2.4 Peak-Season Fringe Mapping: Remote Sensing

In order to capture the full coverage of the seagrass beds at peak or near-peak growing season (i.e. later than the May aerial photographs) and delineate the dense and patchy seagrass habitats, SWCA will obtain 50-cm resolution satellite data from Planet Labs SkySat for an approximately 105-sq km area encapsulating the known 2010 and 2011 seagrass and Study Area extent. Considering the size of Survey Area, the use of aerial imagery is a cost-effective and more precise method for delineating seagrass fringe habitat than diver delineated methods. Obtaining the aerial imagery prior to field survey will allow for spot checking in the field rather than swimming the full edge of the Survey Area. Divers will collect the primary data metrics, as outlined in Table 1, and will collect additional light attenuation measurements at depth, mid-water column, and subsurface to provide additional information to characterize that edge habitat.

2.5 Data Analysis

Aerial data interpretation will utilize colorimetric signatures to differentiate and delineate the various seagrass habitats including continuous and dense coverage, patchy coverage, sand bottom indicating no seagrass.

For standardization and rapid assessment of seagrass coverage, each of the quadrats will be scored utilizing the Braun-Blanquet classes (Dunton et al., 2010; Fourqurean et al., 2001) where the percent cover of seagrass may be visually assessed and reported to the nearest 5% or reported using the Braun-Blanquet cover-abundance scores. The abundance score for each species present within the quadrats will be scored.

ArcGIS software will be used to manage, analyze, and display water quality and seagrass data using techniques such as kriging interpolation. This process allows for accurate depiction of changes over a relatively small area and allows for the development of visually clear map products.

3 DELIVERABLES

SWCA will provide survey polygons and data mapping products as KMZs, shapefiles, required format.

SWCA will provide a Seagrass Bed Survey Report summarizing survey protocol, survey results, and data analysis including text, data tables, and maps and figures which will be provided in PDF format along with electronic files of all pictures, field notes, and data sheets.

SWCA will set up and maintain a GIS platform (SWCA AI Platform) to evaluate in near real-time field data collection updates and compare between the 2022 aerial survey data, the 2010/2011 aerial imagery, and NASA imagery.

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Appendix B

Water Quality Data By Location

Table B-1. Water quality data by location at 0.3 m

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C101	9/22/2022	10:45	0.8	0.8	29.6	53.8	58.6	35.4	105.3	6.56	8.63
C102	9/22/2022	10:09	1.8	1.8	29.3	37.68	--	23.78	123.8	8.38	8.5
C103	9/22/2022	11:55	1	1	30.4	35.18	--	22.02	147.7	9.88	8.74
C105	9/22/2022	10:37	1.4	1.4	29.5	37.52	--	25.37	124.1	8.33	8.51
C106	9/22/2022	8:48	2.7	2.7	28.8	37.27	--	23.51	128.8	8.73	8.37
C107	9/22/2022	11:05	0.6	0.6	30.4	34.44	--	34.51	126	8.36	8.56
C109	9/21/2022	13:04	1.5	1.5	29.7	37.42	--	23.59	139.0	9.26	8.53
C110	9/21/2022	9:00	2.6	2.6	28.2	37.32	--	23.56	114.3	7.84	8.27
C111	9/21/2022	12:02	0.6	0.6	30.0	34.92	--	21.85	123.4	8.30	8.54
C113	9/21/2022	11:42	0.9	0.9	29.4	36.93	--	23.28	113.5	7.63	8.47
C114	9/21/2022	13:03	1.7	1.7	29.2	52.60	56.70	34.50	117.1	7.40	8.54
C115	9/21/2022	10:24	1.0	1.0	28.8	36.88	--	23.24	100.8	6.86	8.41
C117	9/21/2022	10:54	1.2	1.2	28.2	52.20	55.40	34.20	74.1	4.81	8.33
C119	9/21/2022	10:24	0.8	0.8	28.2	53.3	56.5	35.0	43.2	2.74	8.15
C121	9/21/2022	9:26	0.9	0.9	28.2	52.2	55.4	34.23	93.3	5.96	8.4
C123	9/21/2022	9:50	1.3	1.3	28.4	52.60	56.00	34.54	99.8	6.43	8.46
C125	9/20/2022	12:49	1.4	1.4	29.3	37.78	--	23.86	151.4	10.20	8.54
C126	9/20/2022	13:11	2.6	0.8	29	37.8	--	23.87	132.7	8.97	8.44
C127	9/20/2022	12:15	0.9	--	29.9	36.92	--	23.24	147.9	9.89	8.67
C129	9/20/2022	10:20	1.1	1.1	27.7	37.47	--	23.68	80	5.51	8.17
C130	9/20/2022	9:25	>3	2.4	28.5	38.08	--	24.09	125.6	8.62	8.36
C133	9/20/2022	12:44	1.0	1.0	29.0	52.60	56.70	34.45	145.6	9.27	8.61
C134	9/20/2022	10:03	2.3	2.2	28.1	53.6	56.7	35.1	85.3	5.26	8.52
C136	9/20/2022	9:00	2.4	2.4	28.1	54.1	57.3	E	101	6.56	8.43
C137	9/20/2022	10:54	1.9	1.2	28.3	53.4	56.9	35.15	99.3	6.39	8.44

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C138	9/19/2022	11:45	1.4	1.4	27.7	52.20	54.90	34.30	94.4	6.20	8.54
C141	9/19/2022	1:31	0.2	0.2	33.2	46.00	53.50	30.66	206.7	14.42	9.09
C142	9/19/2022	10:48	1.7	1.7	28.5	52.10	55.60	34.24	93.6	6.01	8.40
C143	9/19/2022	9:21	2.5	2.5	28.2	42.32	44.99	27.08	95.5	6.40	8.32
C145	9/19/2022	11:35	0.05	0.05	32	39.09	--	24.5	140.5	9.13	8.34
C146	9/19/2022	9:46	1	--	28.5	37.37	--	23.52	103	7.04	8.54
C148	9/19/2022	9:00	1.9	1.9	28.3	38.04	--	24.07	119.3	8.16	8.31
C149	9/19/2022	10:25	0.4	0.4	28.5	38.93	--	24.69	105.2	7.12	8.36
C150	9/18/2022	10:20	1.7	1.7	26.8	37.05	--	23.41	91.6	6.35	8.34
C152	9/18/2022	9:15	2.5	2.5	27.8	38.44	--	24.39	90.7	6.24	8.17
C153	9/18/2022	13:45	0.1	0.1	34.2	38.91	--	24.54	201.2	12.47	8.73
C155	9/18/2022	12:10	0.9	0.9	27.6	38.3	--	24.07	133.6	9.27	8.44
C156	9/18/2022	15:32	1.2	1.2	29.0	41.77	46.00	26.68	137.2	9.24	8.66
C159	9/18/2022	15:03	0.5	0.5	34.4	42.70	50.40	27.10	136.5	8.20	8.60
C160	9/18/2022	10:28	1.3	1.3	27.0	42.15	43.81	27.00	82.8	5.63	8.45
C161	9/18/2022	9:42	1.0	1.0	27.1	41.96	43.62	26.80	72.8	4.91	8.52
C165	9/15/2022	14:50	0.5	--	29.5	40.27	43.78	25.61	104.5	6.92	8.32
C30	9/25/2022	11:32	0.9	0.9	29.6	62.2	67.6	E	96.5	5.8	8.4
C32	9/25/2022	--	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	1.4	1.4	29.2	59.6	64.4	E	109.5	67.5	8.45
C41	9/24/2022	11:21	2	1.3	29.1	39.63	--	25.15	122.4	8.22	8.36
C43	9/25/2022	10:52	2.4	1.3	29.3	61.5	66.5	E	103.4	6.3	8.5
C48	9/24/2022	--	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	0.3	0.3	29.1	39.24	--	24.88	126.3	8.47	8.4
C60	9/24/2022	10:30	0.6	0.6	28.3	38.435	--	24.33	108.8	7.43	8.47
C64	9/24/2022	9:37	1	1	28.9	38.319	--	24.24	108.6	7.34	8.44

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C67	9/24/2022	9:00	2.8	1.7	28.9	38.32	--	24.25	123.8	8.4	8.43
C68	9/24/2022	10:00	0.6	0.6	28.6	38.083	--	24.09	118.1	8.01	8.43
C72	9/24/2022	12:18	1.5	1.3	29.6	58.6	63.7	E	111.6	6.9	8.6
C76	9/24/2022	11:52	0.7	0.7	29.7	57.4	62.5	E	185.4	11.3	8.9
C80	9/24/2022	12:45	1.7	1.5	29.6	58.3	63.4	E	118.8	7.38	8.6
C81	9/24/2022	11:17	0.8	0.8	29	67.7	62.1	E	113	7.1	8.6
C84	9/24/2022	--	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	1.7	1.7	29.3	58.3	63.1	28.7	105.8	6.6	8.6
C88	9/24/2022	9:57	1.8	1.8	28.9	58.3	62.6	E	92.1	5.75	8.5
C89	9/24/2022	10:30	0.8	0.8	28.2	56.2	59.6	E	87	5.5	8.66
C91	9/24/2022	--	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	0.6	0.6	30.8	54	60	35.49	176.1	10.82	8.79
C94	9/22/2022	14:24	1.8	1.8	30.5	55.7	61.6	E	123	7.58	8.54
C96	9/22/2022	--	--	--	--	--	--	--	--	--	--
C97	9/22/2022	9:50	2.1	2.1	29	55.7	59.4	E	110.4	6.9	8.54
C98	9/22/2022	9:10	2.6	1.8	29.2	55.5	59.1	E	21.7	7.5	8.54
C99	9/22/2022	10:18	0.8	0.8	29	54	58.1	35.53	87.2	5.45	8.48
S201	9/25/2022	--	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	1.4	1.4	29.1	61.90	66.80	E	96.3	5.89	8.41
S203	9/25/2022	--	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	2.5	2.3	29.1	60.40	65.20	E	102.0	6.30	8.40
S205	9/25/2022	12:11	2.0	1.4	29.4	57.20	62.10	E	115.8	7.17	8.45
S206	9/25/2022	10:39	2.2	1.7	29.0	60.80	65.50	E	101.0	6.20	8.44
S207	9/24/2022	11:48	2	2	29.1	39.8	--	25.28	128.8	8.75	8.4
S208	9/25/2022	10:30	1.8	1.4	28.9	62.30	66.90	E	100.8	6.14	8.24
S209	9/24/2022	11:58	2.1	--	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1.4	1.4	29.7	57.70	62.80	E	106.7	6.60	8.48

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S211	9/24/2022	12:11	2.2	1.3	29.9	38.39	--	24.27	136	9.05	8.53
S212	9/24/2022	14:26	1.7	1.7	30.6	37.971	--	23.95	154.8	10.2	8.57
S213	9/25/2022	12:45	1.3	1.3	29.6	58.00	63.20	E	105.2	6.50	8.48
S214	9/24/2022	14:46	1.3	1.3	30.3	37.86	--	23.89	148.6	9.82	8.55
S215	9/24/2022	12:30	2.3	1.7	30.1	38.04	--	24.02	1.4	1.3	8.56
S216	9/24/2022	12:41	>3	--	--	--	--	--	--	--	--
S217	9/24/2022	15:17	0.4	0.4	30.4	37.44	--	23.59	139.7	9.26	8.51
S218	9/24/2022	14:55	1.7	1.7	29.9	58.8	64.4	E	112.9	6.9	8.58
S219	9/24/2022	--	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	1.7	1.7	29.4	58.3	63.1	E	116.4	7.2	8.59
S221	9/24/2022	--	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	1.4	1.4	29.7	57.5	62.6	E	111.6	7	8.55
S223	9/24/2022	10:53	1.7	1.7	28.8	58.6	67.8	E	74.6	4.6	8.5
S224	9/24/2022	--	--	--	--	--	--	--	--	--	--
S225	9/22/2022	13:50	0.3	0.3	32.9	53.4	61.5	25	140.7	8.37	8.44
S226	9/22/2022	13:04	0.8	0.8	31.5	53.4	60	35	118.4	7.15	8.45
S227	9/22/2022	11:10	0.4	0.4	29.7	51.6	56.2	33.8	30.9	2.06	8.06
S228	9/22/2022	9:19	2.2	2.2	28.9	37.68	--	23.8	126.5	8.59	8.48
S229	9/22/2022	9:48	2.1	2.1	29.2	37.759	--	23.84	137	9.22	8.55
S230	9/22/2022	--	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1.1	1.0	29.8	35.48	--	22.30	131.9	8.88	8.64
S234	9/21/2022	--	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	1.6	1.6	27.9	37.49	--	23.68	101.5	6.91	8.33
S237	9/20/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (μs/cm)	Conductivity (μs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S238	9/21/2022	--	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1.8	1.8	29.2	52.9	57.1	34.73	97.5	6.1	8.4
S240	9/20/2022	--	--	--	--	--	--	--	--	--	--
S241	9/21/2022	11:48	0.2	0.2	29.2	50.3	54.3	32.76	110.0	7.00	8.42
S242	9/21/2022	--	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	0.7	0.6	29.2	51.30	55.50	33.60	60.5	3.80	8.12
S246	9/20/2022	11:32	0.9	0.9	29.6	37.04	--	23.33	121.6	8.18	8.5
S247	9/20/2022	--	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	0.3	0.3	29.6	36.822	--	23.18	123.7	8.34	8.44
S249	9/20/2022	13:26	0.6	0.6	30.6	48.1	53.3	31.25	103.8	6.55	8.49
S250	9/20/2022	--	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--	--
S252	9/20/2022	--	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	0.3	0.3	31.7	47.7	54	31.26	143.9	8.97	8.49
S254	9/19/2022	--	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1.6	1.6	29.6	51.20	55.70	33.49	128.8	8.21	8.56
S257	9/19/2022	14:40	0.27	--	33.2	38.84	--	24.49	215.8	13.63	8.65
S258	9/19/2022	13:35	1.2	--	29.2	36.98	--	23.31	147.8	10.00	8.64
S259	9/19/2022	14:45	1.4	1.4	29.9	51.50	56.20	33.66	105.7	9.26	8.46
S260	9/19/2022	14:13	0.11	--	34.7	39.58	--	24.96	202.7	12.42	8.47
S261	9/19/2022	10:50	0.3	0.3	28.7	39.27	--	24.92	125.1	8.48	8.49
S262	9/18/2022	14:26	0.4	0.4	35.1	39.20	--	24.68	200.6	12.23	8.66
S263	9/18/2022	12:58	0.3	0.3	30.3	38.51	--	24.34	124.3	8.24	8.33
S264	9/18/2022	14:19	0.9	0.9	29.6	42.17	45.92	26.97	122.1	8.11	8.54

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S265	9/18/2022	--	--	--	--	--	--	--	--	--	--
S266	9/18/2022	12:47	0.1	0.1	33.4	42.17	48.96	26.80	122.9	7.36	8.56
S267	9/18/2022	11:43	0.3	0.3	29.7	42.62	46.52	27.28	153.2	9.76	8.6
S268	9/15/2022	--	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	2.0	1.4	28.9	42.10	44.44	26.83	98.6	6.52	8.31
S272	9/15/2022	--	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--	--

E = outlier readings; potential sensor error

Table B-2. Water quality data by location at 1.0 m

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C101	9/22/2022	10:45	0.8	0.8	--	--	--	--	--	--	--
C102	9/22/2022	10:09	1.8	1.8	29.2	37.69	--	23.79	124.3	8.36	8.49
C103	9/22/2022	11:55	1	1	--	--	--	--	--	--	--
C105	9/22/2022	10:37	1.4	1.4	29.5	37.53	--	23.68	126.3	8.48	8.51
C106	9/22/2022	8:48	2.7	2.7	28.9	37.26	--	23,50	129.4	8.77	8.39
C107	9/22/2022	11:05	0.6	0.6	--	--	--	--	--	--	--
C109	9/21/2022	13:04	1.5	1.5	29.7	37.40	--	23.57	144.4	9.66	8.5
C110	9/21/2022	9:00	2.6	2.6	28.3	37.31	--	23.55	114.9	7.86	8.29
C111	9/21/2022	12:02	0.6	0.6	--	--	--	--	--	--	--
C113	9/21/2022	11:42	0.9	0.9	--	--	--	--	--	--	--
C114	9/21/2022	13:03	1.7	1.7	29.0	53.30	57.40	35.00	117.8	7.50	8.54
C115	9/21/2022	10:24	1.0	1.0	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C117	9/21/2022	10:54	1.2	1.2	28.2	52.20	55.40	34.26	70.1	4.50	8.34
C119	9/21/2022	10:24	0.8	0.8	--	--	--	--	--	--	--
C121	9/21/2022	9:26	0.9	0.9	--	--	--	--	--	--	--
C123	9/21/2022	9:50	1.3	1.3	28.2	53.30	56.70	35.10	86.5	5.63	8.39
C125	9/20/2022	12:49	1.4	1.4	29.1	37.79	--	23.86	153.2	10.32	8.54
C126	9/20/2022	13:11	2.6	0.8	29	38.22	--	24.17	141.5	9.58	8.48
C127	9/20/2022	12:15	0.9	--	--	--	--	--	--	--	--
C129	9/20/2022	10:20	1.1	1.1	--	--	--	--	--	--	--
C130	9/20/2022	9:25	>3	2.4	28.5	38.09	--	24.09	128.1	8.71	8.37
C133	9/20/2022	12:44	1.0	1.0	--	--	--	--	--	--	--
C134	9/20/2022	10:03	2.3	2.2	28.3	54.5	57.7	35.8	96.7	6.23	8.49
C136	9/20/2022	9:00	2.4	2.4	28.1	56.1	59.4	E	103.1	6.59	8.44
C137	9/20/2022	10:54	1.9	1.2	28.4	53.7	57.2	35.22	99.4	6.51	8.44
C138	9/19/2022	11:45	1.4	1.4	27.7	53.40	56.20	35.15	92.2	6.08	8.54
C141	9/19/2022	1:31	0.2	0.2	--	--	--	--	--	--	--
C142	9/19/2022	10:48	1.7	1.7	28.5	54.40	58.10	35.91	109.5	6.84	8.45
C143	9/19/2022	9:21	2.5	2.5	28.3	42.45	45.11	27.19	94.7	6.41	8.32
C145	9/19/2022	11:35	0.05	0.05	--	--	--	--	--	--	--
C146	9/19/2022	9:46	1	--	--	--	--	--	--	--	--
C148	9/19/2022	9:00	1.9	1.9	28.3	38.07	--	24.08	120	8.2	8.33
C149	9/19/2022	10:25	0.4	0.4	--	--	--	--	--	--	--
C150	9/18/2022	10:20	1.7	1.7	27.5	37.20	--	23.50	92.3	6.42	8.34
C152	9/18/2022	9:15	2.5	2.5	27.8	38.53	--	24.42	90.5	6.22	8.18
C153	9/18/2022	13:45	0.1	0.1	--	--	--	--	--	--	--
C155	9/18/2022	12:10	0.9	0.9	--	--	--	--	--	--	--
C156	9/18/2022	15:32	1.2	1.2	29.1	41.99	45.24	26.84	153.6	10.28	8.71
C159	9/18/2022	15:03	0.5	0.5	--	--	--	--	--	--	--
C160	9/18/2022	10:28	1.3	1.3	27.1	42.32	44.05	27.13	91.4	6.03	8.47

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C161	9/18/2022	9:42	1.0	1.0	--	--	--	--	--	--	--
C165	9/15/2022	14:50	0.5	--	--	--	--	--	--	--	--
C30	9/25/2022	11:32	0.9	0.9	--	--	--	--	--	--	--
C32	9/25/2022	--	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	1.4	1.4	29	60.2	64.8	E	109	6.72	8.44
C41	9/24/2022	11:21	2	1.3	29.1	39.66	--	25.18	123.4	8.3	8.37
C43	9/25/2022	10:52	2.4	1.3	29.2	61.7	66.6	E	102.7	2.3	8.5
C48	9/24/2022	--	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	0.3	0.3	--	--	--	--	--	--	--
C60	9/24/2022	10:30	0.6	0.6	--	--	--	--	--	--	--
C64	9/24/2022	9:37	1	1	28	38.329	--	24.25	109	7.36	8.43
C67	9/24/2022	9:00	2.8	1.7	28	39.05	--	24.77	120.3	8.14	8.36
C68	9/24/2022	10:00	0.6	0.6	--	--	--	--	--	--	--
C72	9/24/2022	12:18	1.5	1.3	29.4	58.4	63.2	E	115.9	7.2	8.6
C76	9/24/2022	11:52	0.7	0.7	--	--	--	--	--	--	--
C80	9/24/2022	12:45	1.7	1.5	29.6	58.4	63.5	E	114.9	7.08	8.6
C81	9/24/2022	11:17	0.8	0.8	--	--	--	--	--	--	--
C84	9/24/2022	--	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	1.7	1.7	28.8	58.8	63	E	85.5	5.3	8.6
C88	9/24/2022	9:57	1.8	1.8	28.6	59	63	E	94	5.9	8.5
C89	9/24/2022	10:30	0.8	0.8	--	--	--	--	--	--	--
C91	9/24/2022	--	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	0.6	0.6	--	--	--	--	--	--	--
C94	9/22/2022	14:24	1.8	1.8	30	57.2	62.6	E	130.1	7.9	8.58
C96	9/22/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C97	9/22/2022	9:50	2.1	2.1	29	55.7	60	E	106.7	6.6	8.54
C98	9/22/2022	9:10	2.6	1.8	29.2	55.8	60.2	E	113.5	7.4	8.54
C99	9/22/2022	10:18	0.8	0.8	--	--	--	--	--	--	--
S201	9/25/2022	--	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	1.4	1.4	29.2	62.30	67.30	E	97.6	5.96	8.41
S203	9/25/2022	--	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	2.5	2.3	29.0	60.80	65.50	E	101.3	6.24	8.40
S205	9/25/2022	12:11	2.0	1.4	29.4	58.00	63.00	E	116.4	7.20	8.45
S206	9/25/2022	10:39	2.2	1.7	28.9	61.60	66.10	E	98.9	6.10	8.45
S207	9/24/2022	11:48	2	2	29.1	39.79	--	25.28	128.3	8.86	8.4
S208	9/25/2022	10:30	1.8	1.4	28.8	62.50	67.00	E	99.5	6.10	8.42
S209	9/24/2022	11:58	2.1	--	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1.4	1.4	29.4	58.30	63.30	E	107.3	6.61	8.49
S211	9/24/2022	12:11	2.2	1.3	29.7	39.16	--	24.83	127.7	8.5	8.43
S212	9/24/2022	14:26	1.7	1.7	30.6	37.973	--	23.96	156.7	10.3	8.56
S213	9/25/2022	12:45	1.3	1.3	29.7	57.90	63.10	E	102.9	6.33	8.49
S214	9/24/2022	14:46	1.3	1.3	30.3	37.86	--	23.89	150.2	9.9	8.54
S215	9/24/2022	12:30	2.3	1.7	30	38.22	--	24.16	137.9	9.22	8.54
S216	9/24/2022	12:41	>3	--	--	--	--	--	--	--	--
S217	9/24/2022	15:17	0.4	0.4	--	--	--	--	--	--	--
S218	9/24/2022	14:55	1.7	1.7	29.9	59.4	65	E	114	7	8.58
S219	9/24/2022	--	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	1.7	1.7	29.1	59.1	63.7	E	115.5	7.1	8.58
S221	9/24/2022	--	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	1.4	1.4	29.3	58.5	63.3	E	114.4	7	8.54
S223	9/24/2022	10:53	1.7	1.7	28.9	58.2	62.4	E	83.8	5.2	8.5
S224	9/24/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (μs/cm)	Conductivity (μs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S225	9/22/2022	13:50	0.3	0.3	--	--	--	--	--	--	--
S226	9/22/2022	13:04	0.8	0.8	--	--	--	--	--	--	--
S227	9/22/2022	11:10	0.4	0.4	--	--	--	--	--	--	--
S228	9/22/2022	9:19	2.2	2.2	28.9	37.69	--	23.8	129.1	8.72	8.47
S229	9/22/2022	9:48	2.1	2.1	29.2	37.767	--	23.85	137.7	9.24	8.54
S230	9/22/2022	--	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1.1	1.0	29.7	35.55	--	22.29	155.0	10.51	8.71
S234	9/21/2022	--	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	1.6	1.6	28.1	37.50	--	23.69	100.7	6.91	8.33
S237	9/20/2022	--	--	--	--	--	--	--	--	--	--
S238	9/21/2022	--	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1.8	1.8	28.8	53.2	57.1	35.1	97.8	6.1	8.4
S240	9/20/2022	--	--	--	--	--	--	--	--	--	--
S241	9/21/2022	11:48	0.2	0.2	--	--	--	--	--	--	--
S242	9/21/2022	--	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	0.7	0.6	--	--	--	--	--	--	--
S246	9/20/2022	11:32	0.9	0.9	--	--	--	--	--	--	--
S247	9/20/2022	--	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	0.3	0.3	--	--	--	--	--	--	--
S249	9/20/2022	13:26	0.6	0.6	--	--	--	--	--	--	--
S250	9/20/2022	--	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S252	9/20/2022	--	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	0.3	0.3	--	--	--	--	--	--	--
S254	9/19/2022	--	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1.6	1.6	29.4	53.00	57.50	34.80	142.3	9.00	8.57
S257	9/19/2022	14:40	0.27	--	--	--	--	--	--	--	--
S258	9/19/2022	13:35	1.2	--	--	--	--	--	--	--	--
S259	9/19/2022	14:45	1.4	1.4	29.7	52.30	57.10	34.30	168.2	10.50	8.69
S260	9/19/2022	14:13	0.11	--	--	--	--	--	--	--	--
S261	9/19/2022	10:50	0.3	0.3	--	--	--	--	--	--	--
S262	9/18/2022	14:26	0.4	0.4	--	--	--	--	--	--	--
S263	9/18/2022	12:58	0.3	0.3	--	--	--	--	--	--	--
S264	9/18/2022	14:19	0.9	0.9	--	--	--	--	--	--	--
S265	9/18/2022	--	--	--	--	--	--	--	--	--	--
S266	9/18/2022	12:47	0.1	0.1	--	--	--	--	--	--	--
S267	9/18/2022	11:43	0.3	0.3	--	--	--	--	--	--	--
S268	9/15/2022	--	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	2.0	1.4	28.2	41.78	44.30	26.72	95.3	6.55	8.32
S272	9/15/2022	--	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--	--

E = outlier readings; potential sensor error

Table B-3. Water quality data by location for PAR

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
C101	9/22/2022	10:45	1152.5	1141.9	1182.9	1166.2	1175.2	--	--	--	--	--
C102	9/22/2022	10:09	997.6	1102.9	967.7	1039.5	910.7	636.4	620.5	625.7	634.2	661.2
C103	9/22/2022	11:55	1337.6	1303.6	1298.5	1301.5	1310.0	944.1	908.2	884.6	885.5	845.2
C105	9/22/2022	10:37	1059.7	1150.8	1097.7	1098.7	1099.0	813.1	687.7	793.0	902.5	831.5
C106	9/22/2022	8:48	704.4	724.1	778.5	811.4	820.0	558.9	557.5	504.6	527.7	529.8
C107	9/22/2022	11:05	1346.6	1331.4	1286.5	1279.7	1294.2	--	--	--	--	--
C109	9/21/2022	13:04	1444.4	1403.3	1425.6	1446.6	1405.5	939.4	916.3	945.8	987.7	920.6
C110	9/21/2022	9:00	348.9	340.4	332.4	333.6	330.4	230.2	231.5	238.8	242.4	238.6
C111	9/21/2022	12:02	687.3	1046.0	870.5	1079.8	927.8	631.7	762.2	588.8	452.0	477.5
C113	9/21/2022	11:42	734.8	1462.4	684.3	600.8	609.8	324.4	299.6	289.5	294.5	308.3
C114	9/21/2022	13:03	1074.2	1123.0	998.5	930.8	870.5	820.0	824.7	934.2	939.4	908.2
C115	9/21/2022	10:24	372.0	390.2	411.8	401.0	412.8	202.2	213.7	222.0	175.8	162.8
C117	9/21/2022	10:54	1264.2	1143.1	1166.7	1165.0	1168.4	901.3	901.7	909.9	916.3	888.9
C119	9/21/2022	10:24	1137.5	1079.4	1090.5	1097.3	1146.1	--	--	--	--	--
C121	9/21/2022	9:26	1101.6	1072.1	1215.0	1187.2	1162.8	751.9	744.2	665.9	712.1	685.6
C123	9/21/2022	9:50	868.8	832.4	955.2	913.3	1000.6	644.9	598.0	552.6	547.6	550.5
C125	9/20/2022	12:49	1503.1	1393.1	1494.5	1344.7	1358.4	990.3	954.8	927.8	910.7	841.4
C126	9/20/2022	13:11	1468.0	1438.4	1477.0	1447.5	1405.5	966.4	906.9	937.2	895.3	919.3
C127	9/20/2022	12:15	1530.9	1462.8	1422.2	1452.1	1466.7	1150.4	1180.4	1190.2	1177.4	1196.2
C129	9/20/2022	10:20	1228.3	1182.5	1158.5	1189.8	1144.4	752.8	719.0	699.7	749.8	740.4
C130	9/20/2022	9:25	857.7	908.2	922.7	914.6	952.2	615.8	615.0	615.0	621.4	628.2
C133	9/20/2022	12:44	1329.7	1294.2	1211.8	1159.0	1155.1	763.5	754.9	816.6	783.6	774.2
C134	9/20/2022	10:03	1206.0	1016.9	1059.2	1220.6	1233.0	763.9	711.3	661.2	665.9	659.6
C136	9/20/2022	9:00	680.0	608.6	595.3	611.5	642.8	417.9	423.8	424.0	407.3	414.3
C137	9/20/2022	10:54	1000.6	1087.9	1167.1	1129.0	1129.0	594.9	624.0	624.0	630.8	592.3
C138	9/19/2022	11:45	1072.5	1076.8	1073.8	1040.0	1011.3	481.8	491.4	501.8	484.6	473.4

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
C141	9/19/2022	1:31	1025.0	1029.3	1053.7	1043.8	1031.4	--	--	--	--	--
C142	9/19/2022	10:48	1188.9	1090.9	1059.7	1058.4	1048.8	658.2	681.3	679.6	582.0	595.6
C143	9/19/2022	9:21	1508.6	1485.5	1448.7	1349.0	1408.9	969.8	1003.2	1006.6	1009.5	1001.5
C145	9/19/2022	11:35	--	--	--	--	--	--	--	--	--	--
C146	9/19/2022	9:46	816.6	801.2	805.2	802.0	771.6	548.6	557.2	573.9	590.6	592.7
C148	9/19/2022	9:00	812.7	817.9	801.6	815.7	847.4	456.6	468.6	453.2	470.5	467.5
C149	9/19/2022	10:25	1171.8	1178.2	1121.3	1156.8	1130.7	--	--	--	--	--
C150	9/18/2022	10:20	1065.0	1071.0	1011.0	938.6	988.7	787.3	782.2	743.8	739.7	768.5
C152	9/18/2022	9:15	943.3	861.0	777.9	795.9	777.5	592.7	573.8	552.0	543.8	195.3
C153	9/18/2022	13:45	1491.5	1458.4	1641.8	1420.3	1119.5	--	--	--	--	--
C155	9/18/2022	12:10	1398.1	1451.6	1317.9	1400.2	1463.6	--	--	--	--	--
C156	9/18/2022	15:32	786.0	759.0	765.5	745.7	641.6	452.9	447.3	435.5	387.2	446.8
C159	9/18/2022	15:03	843.4	828.0	822.4	790.3	709.7	--	--	--	--	--
C160	9/18/2022	10:28	739.5	772.9	769.5	756.6	719.8	417.8	404.4	450.3	401.9	357.4
C161	9/18/2022	9:42	616.7	643.7	656.9	673.2	718.1	--	--	--	--	--
C165	9/15/2022	14:50	946.3	973.7	836.2	1152.5	1221.5	--	--	--	--	--
C30	9/25/2022	11:32	1405.5	1372.5	1309.7	1296.8	1523.3	849.1	859.8	936.4	931.2	922.3
C32	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	--	--	--	--	--	--	--	--	--	--
C41	9/24/2022	11:21	1087.0	1236.1	1229.1	126.6	1231.3	875.6	867.1	833.7	825.1	822.6
C43	9/25/2022	10:52	--	--	--	--	--	--	--	--	--	--
C48	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	1560.8	1475.2	1465.4	1483.8	1462.8	--	--	--	--	--
C60	9/24/2022	10:30	952.2	930.8	976.2	957.0	945.0	--	--	--	--	--
C64	9/24/2022	9:37	780.0	778.5	781.9	800.3	790.5	420.2	411.0	414.6	410.5	412.2
C67	9/24/2022	9:00	782.8	827.7	772.5	755.8	728.8	428.4	489.2	490.9	484.0	483.3

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
C68	9/24/2022	10:00	796.9	853.8	852.5	849.5	871.8	--	--	--	--	--
C72	9/24/2022	12:18	--	--	--	--	--	--	--	--	--	--
C76	9/24/2022	11:52	--	--	--	--	--	--	--	--	--	--
C80	9/24/2022	12:45	--	--	--	--	--	--	--	--	--	--
C81	9/24/2022	11:17	--	--	--	--	--	--	--	--	--	--
C84	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	--	--	--	--	--	--	--	--	--	--
C88	9/24/2022	9:57	--	--	--	--	--	--	--	--	--	--
C89	9/24/2022	10:30	--	--	--	--	--	--	--	--	--	--
C91	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	1270.2	1224.4	1227.0	1270.6	1228.7	--	--	--	--	--
C94	9/22/2022	14:24	1496.6	1489.0	1474.4	1508.6	1478.7	984.7	926.1	906.9	986.5	918.0
C96	9/22/2022	--	--	--	--	--	--	--	--	--	--	--
C97	9/22/2022	9:50	1467.1	1053.2	1138.0	1203.0	1235.1	687.3	702.7	716.8	730.1	706.1
C98	9/22/2022	9:10	1522.8	1309.5	1380.7	1481.2	1470.5	1183.8	1219.7	1176.9	1149.5	1180.8
C99	9/22/2022	10:18	1099.6	1135.4	1162.8	1123.4	1160.7	--	--	--	--	--
S201	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	--	--	--	--	--	--	--	--	--	--
S203	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	1321.1	1315.2	1241.5	1241.5	1194.9	843.1	820.8	862.8	789.2	829.4
S205	9/25/2022	12:11	1061.8	876.1	578.2	1441.0	1419.2	867.5	774.6	909.9	659.5	642.0
S206	9/25/2022	10:39	1222.3	1226.6	1233.0	1212.9	1208.2	820.8	812.3	791.3	803.7	773.3
S207	9/24/2022	11:48	1136.2	1298.5	1261.2	1292.0	1220.6	933.0	942.8	924.4	1000.2	906.4
S208	9/25/2022	10:30	--	--	--	--	--	--	--	--	--	--
S209	9/24/2022	11:58	--	--	--	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1470.1	1434.1	1394.8	1462.0	1446.1	1012.6	1004.0	934.7	903.0	931.2
S211	9/24/2022	12:11	1341.7	1380.2	1345.6	1313.9	1295.5	897.9	873.1	900.0	864.1	840.1
S212	9/24/2022	14:26	932.1	974.1	1010.9	1108.5	1034.0	825.1	736.5	726.6	721.1	721.1

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
S213	9/25/2022	12:45	--	--	--	--	--	--	--	--	--	--
S214	9/24/2022	14:46	1000.6	984.7	964.7	1007.5	924.4	747.7	565.3	695.5	719.4	740.0
S215	9/24/2022	12:30	1314.3	1435.9	1407.4	1385.8	1393.1	1013.5	1028.0	993.3	1045.5	988.6
S216	9/24/2022	12:41	--	--	--	--	--	--	--	--	--	--
S217	9/24/2022	15:17	1049.8	1029.3	1065.2	912.0	1193.6	--	--	--	--	--
S218	9/24/2022	14:55	--	--	--	--	--	--	--	--	--	--
S219	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	--	--	--	--	--	--	--	--	--	--
S221	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	--	--	--	--	--	--	--	--	--	--
S223	9/24/2022	10:53	--	--	--	--	--	--	--	--	--	--
S224	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
S225	9/22/2022	13:50	1223.1	1165.0	1169.2	1155.5	1133.7	--	--	--	--	--
S226	9/22/2022	13:04	1296.3	1223.6	1215.9	1221.9	1185.9	--	--	--	--	--
S227	9/22/2022	11:10	1114.9	891.9	1163.6	1158.5	1038.2	--	--	--	--	--
S228	9/22/2022	9:19	855.9	316.0	288.0	288.3	294.0	218.8	572.2	499.8	602.1	456.6
S229	9/22/2022	9:48	272.2	263.8	244.4	238.9	240.1	145.9	203.2	236.5	335.4	256.8
S230	9/22/2022	--	--	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1430.3	1405.0	1403.8	1350.3	1391.8	704.4	722.8	744.2	789.6	780.6
S234	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	444.9	485.3	712.1	695.9	663.8	401.5	432.7	384.7	225.6	218.8
S237	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S238	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1175.2	1174.8	1142.2	1138.8	1094.7	690.3	312.6	174.2	841.8	821.7
S240	9/20/2022	--	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
S241	9/21/2022	11:48	795.6	580.3	594.0	629.1	568.6	--	--	--	--	--
S242	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	897.5	973.6	944.1	972.4	963.4	448.4	292.6	360.4	425.7	248.9
S246	9/20/2022	11:32	1255.2	1227.5	1382.4	1372.5	1323.3	--	--	--	--	--
S247	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	1345.6	1325.0	1379.8	1321.1	1346.4	--	--	--	--	--
S249	9/20/2022	13:26	1345.1	1349.0	1348.5	1326.7	1318.2	--	--	--	--	--
S250	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S252	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	1266.4	1250.1	1256.5	1254.4	1253.5	--	--	--	--	--
S254	9/19/2022	--	--	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1528.3	1506.5	1505.6	1518.9	1492.0	1194.9	1203.9	1191.9	1182.5	1160.7
S257	9/19/2022	14:40	1400.8	1389.6	1419.2	1402.5	1381.9	--	--	--	--	--
S258	9/19/2022	13:35	1414.5	1456.8	1402.1	1413.6	1414.5	779.8	827.7	700.6	749.4	751.9
S259	9/19/2022	14:45	1294.2	1338.7	1375.5	1387.1	1325.0	1029.7	1016.9	1063.1	1049.4	1022.0
S260	9/19/2022	14:13	1377.2	1424.3	1563.4	1426.5	1464.1	--	--	--	--	--
S261	9/19/2022	10:50	1203.9	1219.3	1214.6	1313.0	1269.0	--	--	--	--	--
S262	9/18/2022	14:26	1170.0	1175.6	1218.9	1234.7	1236.9	--	--	--	--	--
S263	9/18/2022	12:58	1415.2	1446.5	1415.2	1399.8	1427.6	--	--	--	--	--
S264	9/18/2022	14:19	719.6	645.4	501.0	522.0	569.1	--	--	--	--	--
S265	9/18/2022	--	--	--	--	--	--	357.4	--	--	--	--
S266	9/18/2022	12:47	--	--	--	--	--	--	--	--	--	--
S267	9/18/2022	11:43	789.6	795.2	807.2	791.7	810.6	--	--	--	--	--

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
S268	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	1435.8	1399.3	1454.2	1425.0	1419.0	677.1	846.4	828.0	960.5	1013.5
S272	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--	--	--

Table B-4. Calculated diffuse attenuation coefficient (K_d)

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C101	9/22/2022	10:45	0.8	--	--	--	--	--	--	--
C102	9/22/2022	10:09	1.8	0.45	0.58	0.44	0.49	0.32	0.46	0.08
C103	9/22/2022	11:55	1	0.35	0.36	0.38	0.39	0.44	0.38	0.03
C105	9/22/2022	10:37	1.4	0.26	0.51	0.33	0.20	0.28	0.32	0.11
C106	9/22/2022	8:48	2.7	0.23	0.26	0.43	0.43	0.44	0.36	0.09
C107	9/22/2022	11:05	0.6	--	--	--	--	--	--	--
C109	9/21/2022	13:04	1.5	0.43	0.43	0.41	0.38	0.42	0.41	0.02
C110	9/21/2022	9:00	2.6	0.42	0.39	0.33	0.32	0.33	0.36	0.04
C111	9/21/2022	12:02	0.6	0.08	0.32	0.39	0.87	0.66	0.47	0.27
C113	9/21/2022	11:42	0.9	0.82	1.59	0.86	0.71	0.68	0.93	0.33
C114	9/21/2022	13:03	1.7	0.27	0.31	0.07	-0.01	-0.04	0.12	0.14
C115	9/21/2022	10:24	1	0.61	0.60	0.62	0.82	0.93	0.72	0.14
C117	9/21/2022	10:54	1.2	0.34	0.24	0.25	0.24	0.27	0.27	0.04
C119	9/21/2022	10:24	0.82	--	--	--	--	--	--	--
C121	9/21/2022	9:26	0.9	0.38	0.37	0.60	0.51	0.53	0.48	0.09

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C123	9/21/2022	9:50	1.3	0.30	0.33	0.55	0.51	0.60	0.46	0.12
C125	9/20/2022	12:49	1.4	0.42	0.38	0.48	0.39	0.48	0.43	0.04
C126	9/20/2022	13:11	2.6	0.42	0.46	0.45	0.48	0.42	0.45	0.02
C127	9/20/2022	12:15	0.9	0.29	0.21	0.18	0.21	0.20	0.22	0.04
C129	9/20/2022	10:20	1.1	0.49	0.50	0.50	0.46	0.44	0.48	0.03
C130	9/20/2022	9:25	>3	0.33	0.39	0.41	0.39	0.42	0.39	0.03
C133	9/20/2022	12:44	0.95	0.55	0.54	0.39	0.39	0.40	0.46	0.07
C134	9/20/2022	10:03	2.3	0.46	0.36	0.47	0.61	0.63	0.50	0.10
C136	9/20/2022	9:00	2.4	0.49	0.36	0.34	0.41	0.44	0.41	0.05
C137	9/20/2022	10:54	1.9	0.52	0.56	0.63	0.58	0.65	0.59	0.05
C138	9/19/2022	11:45	1.4	0.80	0.78	0.76	0.76	0.76	0.77	0.02
C141	9/19/2022	1:31	0.2	--	--	--	--	--	--	--
C142	9/19/2022	10:48	1.7	0.59	0.47	0.44	0.60	0.57	0.53	0.06
C143	9/19/2022	9:21	2.5	0.44	0.39	0.36	0.29	0.34	0.37	0.05
C145	9/19/2022	11:35	0.05	--	--	--	--	--	--	--
C146	9/19/2022	9:46	1	0.40	0.36	0.34	0.31	0.26	0.33	0.05
C148	9/19/2022	9:00	1.9	0.58	0.56	0.57	0.55	0.59	0.57	0.02
C149	9/19/2022	10:25	0.4	--	--	--	--	--	--	--
C150	9/18/2022	10:20	1.7	0.30	0.31	0.31	0.24	0.25	0.28	0.03
C152	9/18/2022	9:15	2.5	0.46	0.41	0.34	0.38	1.38	0.60	0.40
C153	9/18/2022	13:45	0.14	--	--	--	--	--	--	--
C155	9/18/2022	12:10	0.9	--	--	--	--	--	--	--
C156	9/18/2022	15:32	1.2	0.55	0.53	0.56	0.66	0.36	0.53	0.10
C159	9/18/2022	15:03	0.5	--	--	--	--	--	--	--
C160	9/18/2022	10:28	1.3	0.57	0.65	0.54	0.63	0.70	0.62	0.06
C161	9/18/2022	9:42	1	--	--	--	--	--	--	--
C165	9/15/2022	14:50	0.5	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C30	9/25/2022	11:32	0.9	0.50	0.47	0.34	0.33	0.50	0.43	0.08
C32	9/25/2022	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	1.4	--	--	--	--	--	--	--
C41	9/24/2022	11:21	2	0.22	0.35	0.39	0.43	0.40	0.36	0.07
C43	9/25/2022	10:52	2.4	--	--	--	--	--	--	--
C48	9/24/2022	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	0.3	--	--	--	--	--	--	--
C60	9/24/2022	10:30	0.6	--	--	--	--	--	--	--
C64	9/24/2022	9:37	1	0.62	0.64	0.63	0.67	0.65	0.64	0.02
C67	9/24/2022	9:00	2.8	0.60	0.53	0.45	0.45	0.41	0.49	0.07
C68	9/24/2022	10:00	0.6	--	--	--	--	--	--	--
C72	9/24/2022	12:18	1.5	--	--	--	--	--	--	--
C76	9/24/2022	11:52	0.7	--	--	--	--	--	--	--
C80	9/24/2022	12:45	1.7	--	--	--	--	--	--	--
C81	9/24/2022	11:17	0.8	--	--	--	--	--	--	--
C84	9/24/2022	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	1.7	--	--	--	--	--	--	--
C88	9/24/2022	9:57	1.8	--	--	--	--	--	--	--
C89	9/24/2022	10:30	0.8	--	--	--	--	--	--	--
C91	9/24/2022	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	0.6	--	--	--	--	--	--	--
C94	9/22/2022	14:24	1.8	0.42	0.47	0.49	0.42	0.48	0.46	0.03
C96	9/22/2022	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C97	9/22/2022	9:50	2.1	0.76	0.40	0.46	0.50	0.56	0.54	0.12
C98	9/22/2022	9:10	2.6	0.25	0.07	0.16	0.25	0.22	0.19	0.07
C99	9/22/2022	10:18	0.8	--	--	--	--	--	--	--
S201	9/25/2022	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	1.4	--	--	--	--	--	--	--
S203	9/25/2022	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	2.5	0.45	0.47	0.36	0.45	0.37	0.42	0.05
S205	9/25/2022	12:11	2	0.20	0.12	0.55	0.78	0.79	0.49	0.28
S206	9/25/2022	10:39	2.2	0.40	0.41	0.44	0.41	0.45	0.42	0.02
S207	9/24/2022	11:48	2	0.20	0.32	0.31	0.26	0.30	0.28	0.05
S208	9/25/2022	10:30	1.8	--	--	--	--	--	--	--
S209	9/24/2022	11:58	2.1	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1.4	0.37	0.36	0.40	0.48	0.44	0.41	0.05
S211	9/24/2022	12:11	2.2	0.40	0.46	0.40	0.42	0.43	0.42	0.02
S212	9/24/2022	14:26	1.7	0.12	0.28	0.33	0.43	0.36	0.30	0.10
S213	9/25/2022	12:45	1.3	--	--	--	--	--	--	--
S214	9/24/2022	14:46	1.3	0.29	0.55	0.33	0.34	0.22	0.35	0.11
S215	9/24/2022	12:30	2.3	0.26	0.33	0.35	0.28	0.34	0.31	0.04
S216	9/24/2022	12:41	>3	--	--	--	--	--	--	--
S217	9/24/2022	15:17	0.4	--	--	--	--	--	--	--
S218	9/24/2022	14:55	1.7	--	--	--	--	--	--	--
S219	9/24/2022	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	1.7	--	--	--	--	--	--	--
S221	9/24/2022	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	1.4	--	--	--	--	--	--	--
S223	9/24/2022	10:53	1.7	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
S224	9/24/2022	--	--	--	--	--	--	--	--	--
S225	9/22/2022	--	--	--	--	--	--	--	--	--
S226	9/22/2022	13:04	0.8	--	--	--	--	--	--	--
S227	9/22/2022	11:10	0.4	--	--	--	--	--	--	--
S228	9/22/2022	9:19	2.2	1.36	-0.59	-0.55	-0.74	-0.44	-0.19	0.78
S229	9/22/2022	9:48	2.1	0.62	0.26	0.03	-0.34	-0.07	0.10	0.32
S230	9/22/2022	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1.1	0.71	0.66	0.63	0.54	0.58	0.62	0.06
S234	9/21/2022	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	1.6	0.10	0.11	0.62	1.13	1.11	0.61	0.45
S237	9/20/2022	--	--	--	--	--	--	--	--	--
S238	9/21/2022	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1.8	0.53	1.32	1.88	0.30	0.29	0.87	0.63
S240	9/20/2022	--	--	--	--	--	--	--	--	--
S241	9/21/2022	11:48	0.2	--	--	--	--	--	--	--
S242	9/21/2022	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	0.65	0.69	1.20	0.96	0.83	1.35	1.01	0.24
S246	9/20/2022	11:32	0.9	--	--	--	--	--	--	--
S247	9/20/2022	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	0.3	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
S249	9/20/2022	13:26	0.6	--	--	--	--	--	--	--
S250	9/20/2022	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--
S252	9/20/2022	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	0.3	--	--	--	--	--	--	--
S254	9/19/2022	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1.6	0.25	0.22	0.23	0.25	0.25	0.24	0.01
S257	9/19/2022	14:40	0.27	--	--	--	--	--	--	--
S258	9/19/2022	13:35	1.2	0.60	0.57	0.69	0.63	0.63	0.62	0.04
S259	9/19/2022	14:45	1.4	0.23	0.27	0.26	0.28	0.26	0.26	0.02
S260	9/19/2022	14:13	0.11	--	--	--	--	--	--	--
S261	9/19/2022	10:50	0.3	--	--	--	--	--	--	--
S262	9/18/2022	14:26	0.415	--	--	--	--	--	--	--
S263	9/18/2022	12:58	0.26	--	--	--	--	--	--	--
S264	9/18/2022	14:19	0.9	--	--	--	--	--	--	--
S265	9/18/2022	--	--	--	--	--	--	--	--	--
S266	9/18/2022	12:47	0.1	--	--	--	--	--	--	--
S267	9/18/2022	11:43	0.3	--	--	--	--	--	--	--
S268	9/15/2022	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	2	0.75	0.50	0.56	0.39	0.34	0.51	0.14
S272	9/15/2022	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--

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APPENDIX C

Seagrass Cover and Stem Height Data

Table C-1. Seagrass cover data by location (*H. wrightii, T. testudinum, S. filiforme, and H. engelmannii*)

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C101	60	70	75	80	0	0	0	0	0	0	0	0	0	0	0	0
C102	100	95	100	65	0	0	0	0	0	0	0	0	0	0	0	0
C103	0	0	0	0	95	95	90	95	0	0	0	0	0	0	0	0
C105	0	0	0	0	100	95	20	100	0	0	0	0	0	0	0	0
C106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C107	84	80	25	35	0	0	0	0	0	0	0	0	0	0	0	0
C109	0	0	0	0	100	0	85	95	0	0	0	0	0	0	0	0
C110	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
C111	40	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0
C113	0	0	1	0	0	100	0	0	0	0	0	0	0	0	0	0
C114	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0
C115	0	0	0	1	0	0	0	0	0	0	0	0	35	0	20	29
C117	0	0	0	0	95	95	80	80	0	0	0	0	0	0	0	0
C119	75	5	0	0	0	55	85	95	0	0	0	0	0	0	0	0
C121	85	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0
C123	65	0	80	90	0	0	0	0	0	0	0	0	0	0	0	0
C125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C127	0	0	0	0	100	100	100	85	0	0	0	0	0	0	0	0
C129	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
C130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C133	0	30	1	0	0	0	0	0	0	0	0	0	0	0	0	0
C134	25	8	10	15	0	0	0	0	0	0	0	0	0	0	0	0
C136	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
C137	10	5	5	2	0	0	0	0	0	0	0	0	0	0	0	5

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C138	95	90	75	95	0	0	0	0	0	0	0	0	0	0	0	0
C141	90	90	70	75	0	0	0	0	0	0	0	0	0	0	0	0
C142	40	0	0	30	0	0	0	0	0	0	15	0	0	25	0	0
C143	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
C145	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C146	100	100	95	100	0	0	0	0	0	0	0	0	0	0	0	0
C148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C149	1	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C150	0	2	15	1	0	0	0	0	0	0	0	0	0	0	0	0
C152	1	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0
C153	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C155	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0
C156	75	95	85	90	0	0	0	0	0	0	0	0	0	0	0	0
C159	3	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C160	0	80	20	80	0	0	0	0	0	0	0	0	0	0	0	0
C161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C165	0	35	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C64	85	95	94	80	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C68	100	100	99	100	0	0	0	0	0	0	0	0	0	0	0	0
C72	20	5	0	0	0	5	1	10	0	0	0	0	0	0	0	0
C76	90	95	95	85	0	0	0	0	0	0	0	0	0	0	0	0
C80	10	30	45	2	0	0	0	0	0	0	0	0	0	0	0	0
C81	65	60	55	50	0	0	0	0	0	0	0	0	0	0	0	0
C84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C85	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
C88	20	35	25	15	0	0	0	0	0	0	0	0	0	0	0	0
C89	95	80	90	95	0	0	0	0	0	0	0	0	0	0	0	0
C91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C92	60	55	80	90	0	0	0	0	0	0	0	0	0	0	0	0
C94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C97	0	0	0	0	60	60	90	80	0	0	0	0	0	0	0	0
C98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C99	95	95	85	70	0	0	0	0	0	0	0	0	0	0	0	0
S201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S203	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S207	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S208	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S209	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S213	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S216	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S217	35	1	1	30	0	0	0	0	0	0	0	0	0	0	0	0
S218	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S219	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S222	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S223	35	15	10	0	1	0	0	0	0	0	0	0	0	0	0	0
S224	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S225	95	90	95	95	0	0	0	0	0	0	0	0	0	0	0	0
S226	60	70	10	5	0	0	5	0	0	0	0	0	0	0	0	0
S227	45	5	10	50	0	0	0	0	0	0	0	0	0	0	0	0
S228	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S229	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0
S230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S233	100	85	0	95	0	0	90	0	0	0	0	0	0	0	0	0
S234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S236	40	95	75	0	5	0	0	85	0	0	0	0	0	0	0	0
S237	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S239	0	0	0	0	0	0	0	0	0	0	0	0	15	75	5	0
S240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S241	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0
S242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S245	40	35	70	10	0	0	0	0	0	0	0	0	0	0	0	0
S246	1	0	0	1	64	95	0	0	0	0	0	0	0	0	0	1
S247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S248	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S249	90	0	5	5	0	95	90	30	0	0	0	0	0	0	0	0
S250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S251	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S252	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S253	2	5	5	15	0	0	0	0	0	0	0	0	0	0	0	0
S254	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S256	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S257	15	5	15	15	0	0	0	0	0	0	0	0	0	0	0	0
S258	35	65	98	100	0	0	0	0	0	0	0	0	0	0	0	0
S259	85	70	80	45	0	0	0	0	0	0	0	0	0	0	0	0
S260	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
S261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S262	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S263	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S264	90	100	75	80	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S266	5	5	4	15	0	0	0	0	0	0	0	0	0	0	0	0
S267	5	10	40	15	0	0	0	0	0	0	0	0	0	0	0	0
S268	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S269	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S270	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S271	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S272	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S273	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-2. Seagrass cover data by location (*R. maritima,* Bare Ground, and Total Cover)

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C101	0	0	0	0	40	30	25	20	60	70	75	80
C102	0	0	0	0	0	5	0	0	100	95	100	100
C103	0	0	0	0	5	5	10	5	95	95	90	95
C105	0	0	0	0	0	5	80	0	100	95	20	100
C106	0	0	0	0	100	100	100	100	0	0	0	0
C107	1	0	0	0	15	20	75	65	85	80	25	35
C109	0	0	0	0	0	100	15	5	100	0	85	95
C110	0	0	0	0	100	100	100	100	0	1	0	0
C111	0	0	1	0	60	100	100	0	40	0	1	100

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C113	0	0	0	0	100	0	100	100	0	100	1	0
C114	0	0	0	0	100	98	100	98	0	2	0	2
C115	0	0	0	0	65	100	80	70	35	0	20	30
C117	0	0	0	0	5	5	20	20	95	95	80	80
C119	0	0	0	0	25	40	15	5	75	60	85	95
C121	5	0	0	0	10	100	100	65	90	0	0	35
C123	0	0	0	0	35	100	20	10	65	0	80	90
C125	0	0	0	0	100	100	100	100	0	0	0	0
C126	0	0	0	0	100	100	100	100	0	0	0	0
C127	0	0	0	0	0	0	0	15	100	100	100	85
C129	0	1	0	0	100	100	100	100	0	1	1	1
C130	0	0	0	0	100	100	100	100	0	0	0	0
C133	0	0	0	0	100	70	99	100	0	30	1	0
C134	0	0	0	0	75	92	90	85	25	8	10	15
C136	0	0	0	0	100	100	100	100	0	0	0	1
C137	0	0	0	0	90	95	95	93	10	5	5	7
C138	0	0	0	0	5	10	25	5	95	90	75	95
C141	1	0	0	0	9	10	30	25	91	90	70	75
C142	0	5	0	5	60	70	85	65	40	30	15	35
C143	0	0	0	0	96	100	98	100	4	0	2	0
C145	0	0	0	0	100	99	99	99	0	1	1	1
C146	0	0	0	0	0	0	5	0	100	100	95	100
C148	0	0	0	0	100	100	100	100	0	0	0	0
C149	0	0	0	0	99	95	99	99	1	5	1	1
C150	0	0	0	0	100	98	85	100	0	2	15	1
C152	0	0	0	0	100	100	97	100	1	1	3	1
C153	1	1	1	1	100	100	98	100	2	2	2	2

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C155	0	0	0	0	0	0	0	0	100	100	100	100
C156	0	0	5	0	25	5	10	10	75	95	90	90
C159	0	0	5	5	97	80	95	95	3	20	5	5
C160	100	20	80	20	0	0	0	0	100	100	100	100
C161	0	0	0	0	100	100	100	100	0	0	0	0
C165	0	0	0	0	100	65	100	100	0	35	1	1
C30	0	0	0	0	100	100	100	100	0	0	0	0
C32	0	0	0	0	0	0	0	0	0	0	0	0
C33	0	0	0	0	0	0	0	0	0	0	0	0
C36	0	0	0	0	0	0	0	0	0	0	0	0
C38	0	0	0	0	100	100	100	100	0	0	0	0
C41	0	0	0	0	100	100	100	100	0	0	0	0
C43	0	0	0	0	100	100	100	100	0	0	0	0
C48	0	0	0	0	0	0	0	0	0	0	0	0
C52	0	0	0	0	100	100	100	100	0	0	0	0
C60	95	75	98	95	5	25	2	5	95	75	98	95
C64	0	0	1	0	15	5	5	20	85	95	95	80
C67	0	0	0	0	100	100	100	100	0	0	0	0
C68	0	0	1	0	0	0	0	0	100	100	100	100
C72	0	0	0	0	80	90	99	90	20	10	1	10
C76	0	0	0	0	10	5	5	15	90	95	95	85
C80	0	0	0	0	90	70	55	98	10	30	45	2
C81	0	0	0	0	45	40	45	50	65	60	55	50
C84	0	0	0	0	0	0	0	0	0	0	0	0
C85	0	0	0	0	100	100	100	99	0	0	0	1
C88	0	0	0	0	80	65	75	85	20	35	25	15
C89	0	0	0	0	5	20	10	5	95	80	90	95

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C91	0	0	0	0	0	0	0	0	0	0	0	0
C92	0	0	0	0	40	45	20	10	60	55	80	90
C94	0	0	0	0	100	100	100	100	0	0	0	0
C96	0	0	0	0	0	0	0	0	0	0	0	0
C97	0	0	0	0	40	40	10	20	60	60	90	80
C98	0	0	0	0	100	100	100	100	0	0	0	0
C99	0	0	15	0	5	5	0	30	95	95	100	70
S201	0	0	0	0	0	0	0	0	0	0	0	0
S202	0	0	0	0	100	100	100	100	0	0	0	0
S203	0	0	0	0	0	0	0	0	0	0	0	0
S204	0	0	0	0	100	100	100	100	0	0	0	0
S205	0	0	0	0	100	100	100	100	0	0	0	0
S206	0	0	0	0	100	100	100	100	0	0	0	0
S207	0	0	0	0	100	100	100	100	0	0	0	0
S208	0	0	0	0	100	100	100	100	0	0	0	0
S209	0	0	0	0	100	100	100	100	0	0	0	0
S210	0	0	0	0	100	100	100	100	0	0	0	0
S211	0	0	0	0	100	100	100	100	0	0	0	0
S212	0	0	0	0	100	100	100	100	0	0	0	0
S213	0	0	0	0	100	100	100	100	0	0	0	0
S214	0	0	0	0	100	100	100	100	0	0	0	0
S215	0	0	0	0	100	100	100	100	0	0	0	0
S216	0	0	0	0	100	100	100	100	0	0	0	0
S217	0	0	0	0	65	99	99	70	35	1	1	30
S218	0	0	0	0	100	100	100	100	0	0	0	0
S219	0	0	0	0	0	0	0	0	0	0	0	0
S220	0	0	0	0	100	100	100	100	0	0	0	0

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S221	0	0	0	0	0	0	0	0	0	0	0	0
S222	0	0	0	0	100	100	100	100	0	0	0	0
S223	0	0	0	0	64	85	90	100	36	15	10	0
S224	0	0	0	0	0	0	0	0	0	0	0	0
S225	0	0	0	0	5	10	5	5	95	90	95	95
S226	0	0	0	0	40	30	90	95	60	70	10	5
S227	25	10	5	30	30	85	85	20	70	15	15	80
S228	0	0	0	0	100	100	100	100	0	0	0	0
S229	0	0	0	0	100	95	100	99	0	5	0	1
S230	0	0	0	0	0	0	0	0	0	0	0	0
S231	0	0	0	0	0	0	0	0	0	0	0	0
S232	0	0	0	0	0	0	0	0	0	0	0	0
S233	0	0	0	0	0	15	10	5	100	85	90	95
S234	0	0	0	0	0	0	0	0	0	0	0	0
S235	0	0	0	0	0	0	0	0	0	0	0	0
S236	0	0	0	0	55	5	25	15	45	95	75	85
S237	0	0	0	0	0	0	0	0	0	0	0	0
S238	0	0	0	0	0	0	0	0	0	0	0	0
S239	0	0	0	0	85	25	95	100	15	75	5	0
S240	0	0	0	0	0	0	0	0	0	0	0	0
S241	0	0	0	20	100	100	100	50	0	0	0	50
S242	0	0	0	0	0	0	0	0	0	0	0	0
S243	0	0	0	0	0	0	0	0	0	0	0	0
S244	0	0	0	0	0	0	0	0	0	0	0	0
S245	0	0	0	0	60	65	30	90	40	35	70	10
S246	0	0	0	0	35	5	100	99	>65	95	0	>2
S247	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S248	0	0	0	0	100	100	100	100	0	0	0	0
S249	0	0	0	0	10	5	5	65	90	95	95	35
S250	0	0	0	0	0	0	0	0	0	0	0	0
S251	0	0	0	0	0	0	0	0	0	0	0	0
S252	0	0	0	0	0	0	0	0	0	0	0	0
S253	0	10	0	10	98	85	95	75	2	15	5	25
S254	0	0	0	0	0	0	0	0	0	0	0	0
S255	0	0	0	0	0	0	0	0	0	0	0	0
S256	0	0	0	0	100	98	100	100	0	2	0	0
S257	5	30	40	60	80	65	35	25	20	35	65	75
S258	5	0	2	0	60	35	0	0	40	65	100	100
S259	0	0	0	0	15	30	20	55	85	70	80	45
S260	1	1	1	0	98	98	98	100	2	2	2	0
S261	75	65	85	80	25	35	15	20	75	65	85	80
S262	1	100	70	0	100	0	30	100	2	100	70	0
S263	1	0	1	0	100	100	100	100	1	1	1	0
S264	0	0	0	0	10	0	25	20	90	100	75	80
S265	0	0	0	0	0	0	0	0	0	0	0	0
S266	0	0	1	0	95	95	95	85	5	5	5	15
S267	65	80	20	70	30	10	40	15	70	90	60	85
S268	0	0	0	0	0	0	0	0	0	0	0	0
S269	0	0	0	0	0	0	0	0	0	0	0	0
S270	0	0	0	0	0	0	0	0	0	0	0	0
S271	0	0	0	0	100	100	100	100	0	0	0	0
S272	0	0	0	0	0	0	0	0	0	0	0	0
S273	0	0	0	0	0	0	0	0	0	0	0	0

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-3. Seagrass stem height data by location (*H. wrightii* and *T. testudinum*)

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			**AFT STB**			**AFT PRT**			**FWD PRT**			**FWD STB**			**AFT STB**			**AFT PRT**			**FWD PRT**		
Replicate	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
C101	27	23	29	19	13	14	23	14	18	19	16	17	--	--	--	--	--	--	--	--	--	--	--	--
C102	28	22	30.5	39.5	35	38	24	22.5	30	37	30.5	30	--	--	--	--	--	--	--	--	--	33	35	33
C103	--	--	--	--	--	--	--	--	--	--	--	--	32.5	31.5	38	40.5	41.5	45.5	30.5	38	40.5	24	35.5	39
C105	--		--	--	--	--	--	--	--	--	--	--	30.5	27.5	30	40.5	31.5	41.5	30.5	16.5	31	25	27	31.5
C106	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C107	30.5	27	26	12	20.5	25.5	19	24.5	17.5	13	17	27.5	--	--	--	--	--	--	--	--	--	--	--	--
C109	--	--	--	--	--	--	--	--	--	--	--	--	39.5	34.5	38	--	--	--	40	20	22.5	38	40.5	39.5
C110	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C111	5	55	4.5	--	--	--	65	5	4.5	30.5	23.5	25	--	--	--	--	--	--	--	--	--	--	--	--
C113	--	--	--	--	--	--	5.5	7	4	--	--	--	--	--	--	38	15.5	37.5	--	--	--	--	--	--
C114	--	--	--	2	3	5	--	--	--	17	20	18.5	--	--	--	--	--	--	--	--	--	--	--	--
C115	--	--	--	--	--	--	--	--	--	13.5	17	-	--	--	--	--	--	--	--	--	--	--	--	--
C117	--	--	--	--	--	--	--	--	--	--	--	--	40	45.5	42	49	45	40	38	13	28	29	23	35.5
C119	19	22	24	9	3	4	--	--	--	--	--	--	--	--	--	7	16	25	22	23	29.5	32	34	42
C121	12	14	15	--	--	--	--	--	--	15	11	12	--	--	--	--	--	--	--	--	--	--	--	--
C123	21	22	18	--	--	--	22	19	23	25	19	13	--	--	--	--	--	--	--	--	--	--	--	--
C125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C126	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C127	--	--	--	--	--	--	--	--	--	--	--	--	36	51	38.5	39	34.5	35	29.5	28.5	26.5	17.5	22.5	24
C129	--	--	--	--	--	--	--	--	--	4.5	--	--	--	--	--	--	--	--	22.5	--	--	--	--	--
C130	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C133	--	--	--	5	9	13.5	6	2	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C134	19	20	17	7	8.5	6	14	15	10	11	16	20	--	--	--	--	--	--	--	--	--	--	--	--
C136	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C137	11	12	12.5	7	6	9	10	13	9	5	6	4	--	--	--	--	--	--	--	--	--	--	--	--
C138	45	40	41	56	47	52	48.5	44	34	38	40	43	--	--	--	--	--	--	--	--	--	--	--	--
C141	38	22.5	24.5	21	22	22	25.5	27	20	8	22.5	21.5	--	--	--	--	--	--	--	--	--	--	--	--
C142	3	4	8	--	--	--	--	--	--	28	28.5	22	--	--	--	--	--	--	--	--	--	--	--	--
C143	3	4	3.5	--	--	--	1.5	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C145	--	--	--	7.5	4	--	5	11.5	2.5	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C146	28	29	28	26	32	34	24	26	23.5	33	38	31	--	--	--	--	--	--	--	--	--	--	--	--
C148	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C149	4.5	7.5	6	12	17	6	8	2	7	5	5.5	6	--	--	--	--	--	--	--	--	--	--	--	--
C150	--	--	--	17	--	--	14	27	20	11	17	10	--	--	--	--	--	--	--	--	--	--	--	--
C152	21	19	--	7.5	8	8	7.5	7.5	8.5	9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C153	5	--	--	5.5	13.5	--	4.5	11.5	5	7	5	6.5	--	--	--	--	--	--	--	--	--	--	--	--
C155	30.5	38.5	33	45	46	38	44.5	46.5	51	38	43	41	--	--	--	--	--	--	--	--	--	--	--	--
C156	31	32.5	31.5	30	38	28	30	38	28	20	32	34	--	--	--	--	--	--	--	--	--	--	--	--
C159	14	8	18.5	16	14	14.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C160	--	--	--	26	29	28	28	32	27	33	35	26	--	--	--	--	--	--	--	--	--	--	--	--
C161	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C165	--	--	--	8	6	6.5	1	2	2	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C36	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C43	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C64	25	35.5	34	36.5	35	37.5	34	36	37.5	40	30	39.5	--	--	--	--	--	--	--	--	--	--	--	--
C67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C68	31.5	23	23.5	30	21.5	27	29.5	23	22.5	39	29	25.5	--	--	--	--	--	--	--	--	--	--	--	--
C72	21	12	18	6	8	10.5	--	--	--	4	5	-	--	--	--	28	36	34	16	--	--	24	15	23
C76	26	30	23	24	24	16	30	20	28	21	29	18	--	--	--	--	--	--	--	--	--	--	--	--
C80	18	15	11	10	20	17	10	17	15	6	7	4	--	--	--	--	--	--	--	--	--	--	--	--
C81	12	12	19	10	11	11	13	14	17	13	13	18	--	--	--	--	--	--	--	--	--	--	--	--
C84	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C85	--	--	--	--	--	--	--	--	--	4	5	--	--	--	--	--	--	--	--	--	--	--	--	--
C88	7	10	12	11.5	8	12	14	13	19	14	13.5	12	--	--	--	--	--	--	--	--	--	--	--	--
C89	30	22	23	20	26	18	22	23	22	33	27	28	--	--	--	--	--	--	--	--	--	--	--	--
C91	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C92	24	25	21.5	25	27.5	28	29	25	21	19	22	30	--	--	--	--	--	--	--	--	--	--	--	--
C94	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C97	--	--	--	--	--	--	--	--	--	--	--	--	22	23	33	31	27	34	36	37	44	31	42	43
C98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C99	22	29	27	27	25	31	22	18	20	17	23	19	--	--	--	--	--	--	--	--	--	--	--	--
S201	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S202	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S203	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S204	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S205	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S206	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S207	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S208	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S209	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S210	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S211	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S212	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S213	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S214	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S215	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S216	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S217	7.5	8	6	6	3.5	3.5	2	-	-	6	5.5	5	--	--	--	--	--	--	--	--	--	--	--	--
S218	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S219	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S220	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S221	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S222	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S223	25	17	24	14	12	10	114	17	8	--	--	--	34	--	--	--	--	--	--	--	--	--	--	--
S224	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S225	22	25	24	22	25	23	24	26	23	25.5	26	24	--	--	--	--	--	--	--	--	--	--	--	--
S226	7	12	15	12	12	14	7	4	8	3	2	4	--	--	--	--	--	--	10	5	8	--	--	--
S227	13	12	10	8	6	7	11.5	11	10	15.5	10.5	12	--	--	--	--	--	--	--	--	--	--	--	--
S228	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S229	--	--	--	7.5	9	8.5	--	--	--	4	2.5	7	--	--	--	--	--	--	--	--	--	--	--	--
S230	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S231	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S232	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S233	42	21	19.5	32.5	38	36	--	--	--	31.5	33	16	--	--	--	--	--	--	24	31	32	--	--	--
S234	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S235	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S236	31.5	27.5	12	32.5	33	23	34.5	27	45.5	--	--	--	32	32.5	37.5	--	--	--	--	--	--	20	25.5	35.5
S237	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S239	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S241	--	--	--	--	--	--	--	--	--	7	9	6	--	--	--	--	--	--	--	--	--	--	--	--
S242	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S243	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S244	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S245	13	16	11	11.6	6	17	31	22	34	5	8	10.5	--	--	--	--	--	--	--	--	--	--	--	--
S246	4.5	12	19.5	--	--	--	--	--	--	3	2	--	14	12	9.5	29.5	12	24	--	--	--	--	--	--
S247	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S249	8.5	7.5	6	--	--	--	9	11	13	4	5	5.5	--	--	--	22	10	9	10	2.4	22	9.5	6	10
S250	7.5	--	--	--	--	--	9	11	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S251	6	--	--	--	--	--	9	11	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S252	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S253	4	4.5	5	13	12	10	5.5	8	10	7	7	7.5	--	--	--	--	--	--	--	--	--	--	--	--
S254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S255	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S256	--	--	--	9.5	13	11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S257	11	6	17.5	6.5	8	10	17	10.5	8	19	10	19.5	--	--	--	--	--	--	--	--	--	--	--	--
S258	10.5	12.5	4	15	15.5	27.5	30	26	34	20	32	31	--	--	--	--	--	--	--	--	--	--	--	--
S259	44.5	50	43.5	41	38	41.5	34	38	40	22	10	16	--	--	--	--	--	--	--	--	--	--	--	--
S260	15.5	15	14	7.5	7.5	9	11	7	9.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S261	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S262	24.4	15.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S263	--	--	--	4	22.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S264	31	20.5	10	31.5	44	35	9.5	8	6	40	34	31	--	--	--	--	--	--	--	--	--	--	--	--
S265	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S266	8	7	8	7.5	8	8.5	5	6	6	6.5	5	7	--	--	--	--	--	--	--	--	--	--	--	--
S267	10	9	11	8	7	6	12	12	8	10	12.5	7	--	--	--	--	--	--	--	--	--	--	--	--
S268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S269	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S270	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S271	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S272	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S273	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-4. Seagrass stem height data by location (*S. filiforme and H. engelmannii*)

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii Stem Height (cm)*											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C101	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C102	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C103	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C105	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C106	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C107	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C109	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C110	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	1.5	0.5	--	--	--	--	--	--
C111	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C113	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C114	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C115	--	--	--	--	--	--	--	--	--	--	--	--	2	2.5	3	--	--	--	3	3.5	3	4.5	3	3
C117	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C119	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C121	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C123	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C126	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C127	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C129	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C130	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C133	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C134	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C136	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C137	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	6	4
C138	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C141	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C142	--	--	--	--	--	--	32	22	17	--	--	--	--	--	--	6	7	5	--	--	--	--	--	--
C143	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C145	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C146	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C148	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C149	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C152	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C153	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C155	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C156	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C159	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C160	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C161	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C36	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C43	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C64	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C72	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C76	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C80	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii Stem Height (cm)*											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C81	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C84	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C85	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C88	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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S207	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S208	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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S213	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S214	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S215	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S216	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S217	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S218	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S219	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S220	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S221	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S222	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S223	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S224	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S225	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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S231	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S232	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S233	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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S235	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S236	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S237	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S239	--	--	--	--	--	--	--	--	--	--	--	--	5.5	6	4	5.5	6	7	2	2.5	3	--	--	--
S240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S241	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S242	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S243	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S244	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S245	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S246	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	1	0.5
S247	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S249	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S250	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S251	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S252	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S253	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S255	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S256	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S257	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S258	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S259	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S261	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S262	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S263	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S264	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S265	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S266	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S267	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S269	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S270	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S271	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S272	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S273	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-5. Seagrass stem height data by location (*R. maritima*)

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C101	--	--	--	--	--	--	--	--	--	--	--	--
C102	--	--	--	--	--	--	--	--	--	--	--	--
C103	--	--	--	--	--	--	--	--	--	--	--	--
C105	--	--	--	--	--	--	--	--	--	--	--	--
C106	--	--	--	--	--	--	--	--	--	--	--	--
C107	16.5	20.5	21.5	--	--	--	--	--	--	--	--	--
C109	--	--	--	--	--	--	--	--	--	--	--	--
C110	--	--	--	--	--	--	--	--	--	--	--	--
C111	--	--	--	--	--	--	7.5	3.5	--	--	--	--
C113	--	--	--	--	--	--	--	--	--	--	--	--
C114	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C115	--	--	--	--	--	--	--	--	--	--	--	--
C117	--	--	--	--	--	--	--	--	--	--	--	--
C119	--	--	--	--	--	--	--	--	--	--	--	--
C121	8	10	13	--	--	--	--	--	--	--	--	--
C123	--	--	--	--	--	--	--	--	--	--	--	--
C125	--	--	--	--	--	--	--	--	--	--	--	--
C126	--	--	--	--	--	--	--	--	--	--	--	--
C127	--	--	--	--	--	--	--	--	--	--	--	--
C129	--	--	--	7.5	4	5	--	--	--	--	--	--
C130	--	--	--	--	--	--	--	--	--	--	--	--
C133	--	--	--	--	--	--	--	--	--	--	--	--
C134	--	--	--	--	--	--	--	--	--	--	--	--
C136	--	--	--	--	--	--	--	--	--	--	--	--
C137	--	--	--	--	--	--	--	--	--	--	--	--
C138	--	--	--	--	--	--	--	--	--	--	--	--
C141	27.5	23.5	--	--	--	--	--	--	--	--	--	--
C142	--	--	--	28.5	17	26	--	--	--	22	36	28.5
C143	--	--	--	--	--	--	--	--	--	--	--	--
C145	--	--	--	--	--	--	--	--	--	--	--	--
C146	--	--	--	--	--	--	--	--	--	--	--	--
C148	--	--	--	--	--	--	--	--	--	--	--	--
C149	--	--	--	--	--	--	--	--	--	--	--	--
C150	--	--	--	--	--	--	--	--	--	--	--	--
C152	--	--	--	--	--	--	--	--	--	--	--	--
C153	27.5	6.5	--	5.5	--	--	34.5	8	--	12.5	22	--
C155	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	R. maritima Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C156	--	--	--	--	--	--	46.5	34.5	28	--	--	--
C159	--	--	--	--	--	--	10	9	9.5	5	4.5	7
C160	40	27	33	34	24	42	42	64	54	34	40	44
C161	--	--	--	--	--	--	--	--	--	--	--	--
C165	--	--	--	--	--	--	--	--	--	--	--	--
C30	--	--	--	--	--	--	--	--	--	--	--	--
C32	--	--	--	--	--	--	--	--	--	--	--	--
C33	--	--	--	--	--	--	--	--	--	--	--	--
C36	--	--	--	--	--	--	--	--	--	--	--	--
C38	--	--	--	--	--	--	--	--	--	--	--	--
C41	--	--	--	--	--	--	--	--	--	--	--	--
C43	--	--	--	--	--	--	--	--	--	--	--	--
C48	--	--	--	--	--	--	--	--	--	--	--	--
C52	--	--	--	--	--	--	--	--	--	--	--	--
C60	19	18.5	23	14	18.5	20.5	30	33.5	24	23	28	24.5
C64	--	--	--	--	--	--	42.5	27	--	--	--	--
C67	--	--	--	--	--	--	--	--	--	--	--	--
C68	--	--	--	--	--	--	23	22	30	--	--	--
C72	--	--	--	--	--	--	--	--	--	--	--	--
C76	--	--	--	--	--	--	--	--	--	--	--	--
C80	--	--	--	--	--	--	--	--	--	--	--	--
C81	--	--	--	--	--	--	--	--	--	--	--	--
C84	--	--	--	--	--	--	--	--	--	--	--	--
C85	--	--	--	--	--	--	--	--	--	--	--	--
C88	--	--	--	--	--	--	--	--	--	--	--	--
C89	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C91	--	--	--	--	--	--	--	--	--	--	--	--
C92	--	--	--	--	--	--	--	--	--	--	--	--
C94	--	--	--	--	--	--	--	--	--	--	--	--
C96	--	--	--	--	--	--	--	--	--	--	--	--
C97	--	--	--	--	--	--	--	--	--	--	--	--
C98	--	--	--	--	--	--	--	--	--	--	--	--
C99	--	--	--	--	--	--	17	19	16	--	--	--
S201	--	--	--	--	--	--	--	--	--	--	--	--
S202	--	--	--	--	--	--	--	--	--	--	--	--
S203	--	--	--	--	--	--	--	--	--	--	--	--
S204	--	--	--	--	--	--	--	--	--	--	--	--
S205	--	--	--	--	--	--	--	--	--	--	--	--
S206	--	--	--	--	--	--	--	--	--	--	--	--
S207	--	--	--	--	--	--	--	--	--	--	--	--
S208	--	--	--	--	--	--	--	--	--	--	--	--
S209	--	--	--	--	--	--	--	--	--	--	--	--
S210	--	--	--	--	--	--	--	--	--	--	--	--
S211	--	--	--	--	--	--	--	--	--	--	--	--
S212	--	--	--	--	--	--	--	--	--	--	--	--
S213	--	--	--	--	--	--	--	--	--	--	--	--
S214	--	--	--	--	--	--	--	--	--	--	--	--
S215	--	--	--	--	--	--	--	--	--	--	--	--
S216	--	--	--	--	--	--	--	--	--	--	--	--
S217	--	--	--	--	--	--	--	--	--	--	--	--
S218	--	--	--	--	--	--	--	--	--	--	--	--
S219	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
S220	--	--	--	--	--	--	--	--	--	--	--	--
S221	--	--	--	--	--	--	--	--	--	--	--	--
S222	--	--	--	--	--	--	--	--	--	--	--	--
S223	--	--	--	--	--	--	--	--	--	--	--	--
S224	--	--	--	--	--	--	--	--	--	--	--	--
S225	--	--	--	--	--	--	--	--	--	--	--	--
S226	--	--	--	--	--	--	--	--	--	--	--	--
S227	15.5	16	26	26	23.5	16	9.5	--	--	20	20	19.5
S228	--	--	--	--	--	--	--	--	--	--	--	--
S229	--	--	--	--	--	--	--	--	--	--	--	--
S230	--	--	--	--	--	--	--	--	--	--	--	--
S231	--	--	--	--	--	--	--	--	--	--	--	--
S232	--	--	--	--	--	--	--	--	--	--	--	--
S233	--	--	--	--	--	--	--	--	--	--	--	--
S234	--	--	--	--	--	--	--	--	--	--	--	--
S235	--	--	--	--	--	--	--	--	--	--	--	--
S236	--	--	--	--	--	--	--	--	--	--	--	--
S237	--	--	--	--	--	--	--	--	--	--	--	--
S238	--	--	--	--	--	--	--	--	--	--	--	--
S239	--	--	--	--	--	--	--	--	--	--	--	--
S240	--	--	--	--	--	--	--	--	--	--	--	--
S241	--	--	--	--	--	--	--	--	--	22	17.5	17
S242	--	--	--	--	--	--	--	--	--	--	--	--
S243	--	--	--	--	--	--	--	--	--	--	--	--
S244	--	--	--	--	--	--	--	--	--	--	--	--
S245	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
S246	--	--	--	--	--	--	--	--	--	--	--	--
S247	--	--	--	--	--	--	--	--	--	--	--	--
S248	--	--	--	--	--	--	--	--	--	--	--	--
S249	--	--	--	--	--	--	--	--	--	--	--	--
S250	--	--	--	--	--	--	--	--	--	--	--	--
S251	--	--	--	--	--	--	--	--	--	--	--	--
S252	--	--	--	--	--	--	--	--	--	--	--	--
S253	--	--	--	12	32	21	--	--	--	12	10	9.5
S254	--	--	--	--	--	--	--	--	--	--	--	--
S255	--	--	--	--	--	--	--	--	--	--	--	--
S256	--	--	--	--	--	--	--	--	--	--	--	--
S257	11.5	9.5	20	10.5	16	15	14	10	30	11.5	14	7.5
S258	22	--	--	--	--	--	29	20.5	--	--	--	--
S259	--	--	--	--	--	--	--	--	--	--	--	--
S260	12	17	19	17.5	8	12	11	--	--	--	--	--
S261	27	16.5	17	16	9.5	7.5	28	11	7.5	10.5	12	19
S262	19	--	--	40.5	48.5	39	21.5	43	22.5	--	--	--
S263	4	7	--	--	--	--	1.5	0.5	3	--	--	--
S264	--	--	--	--	--	--	--	--	--	--	--	--
S265	--	--	--	--	--	--	--	--	--	--	--	--
S266	--	--	--	--	--	--	17	--	--	--	--	--
S267	31	26	32	24	25	31	29	28	30.5	25	35	42
S268	--	--	--	--	--	--	--	--	--	--	--	--
S269	--	--	--	--	--	--	--	--	--	--	--	--
S270	--	--	--	--	--	--	--	--	--	--	--	--
S271	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
S272	--	--	--	--	--	--	--	--	--	--	--	--
S273	--	--	--	--	--	--	--	--	--	--	--	--

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

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Appendix D

Survey Station Coordinates

Table D-1. Station Coordinates

Station ID	Lat	Long	Station ID	Lat	Long
C101	29.90365	-88.83431	**S203**	29.83164	-88.84133
C102	29.90932	-88.84174	**S204**	29.83347	-88.86866
C103	29.90827	-88.83225	**S205**	29.83600	-88.84726
C105	29.91266	-88.83865	**S206**	29.84282	-88.87116
C106	29.91284	-88.84734	**S207**	29.84336	-88.85456
C107	29.91466	-88.83007	**S208**	29.84456	-88.86300
C109	29.91983	-88.83905	**S209**	29.84523	-88.85418
C110	29.92412	-88.84770	**S210**	29.84651	-88.88432
C111	29.92513	-88.83080	**S211**	29.84809	-88.85961
C113	29.92695	-88.83356	**S212**	29.84833	-88.87510
C114	29.93256	-88.84474	**S213**	29.85199	-88.88078
C115	29.93188	-88.83106	**S214**	29.85345	-88.87611
C117	29.93762	-88.83875	**S215**	29.85464	-88.85909
C119	29.94001	-88.83600	**S216**	29.85503	-88.84894
C121	29.94052	-88.84055	**S217**	29.85599	-88.86586
C123	29.94623	-88.83916	**S218**	29.85864	-88.88296
C125	29.95087	-88.84160	**S219**	29.85986	-88.83799
C126	29.95238	-88.84450	**S220**	29.85993	-88.86998
C127	29.95115	-88.83575	**S221**	29.86499	-88.85034
C129	29.95794	-88.84112	**S222**	29.86580	-88.87531
C130	29.96039	-88.84584	**S223**	29.87933	-88.84143
C133	29.96334	-88.84247	**S224**	29.88093	-88.83004
C134	29.96797	-88.84436	**S225**	29.88971	-88.82999
C136	29.97170	-88.85176	**S226**	29.89521	-88.82934
C137	29.97144	-88.84027	**S227**	29.90335	-88.82726
C138	29.97974	-88.84335	**S228**	29.90701	-88.84689
C141	29.97757	-88.84110	**S229**	29.90760	-88.84286
C142	29.98152	-88.84600	**S230**	29.90771	-88.82406
C143	29.98698	-88.85777	**S231**	29.91428	-88.85374
C145	29.99496	-88.84318	**S232**	29.91557	-88.82378
C146	29.99957	-88.85286	**S233**	29.92180	-88.83067
C148	29.99938	-88.85947	**S234**	29.92482	-88.82375
C149	30.00001	-88.84569	**S235**	29.92560	-88.86001
C150	30.00301	-88.85736	**S236**	29.92999	-88.84113
C152	30.00935	-88.86631	**S237**	29.93154	-88.85086
C153	30.01000	-88.84907	**S238**	29.93155	-88.82369
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Station ID	Lat	Long	Station ID	Lat	Long
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C161	30.02605	-88.86812	**S243**	29.94523	-88.85544
C165	30.03624	-88.86672	**S244**	29.94618	-88.82434
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C32	29.82602	-88.86887	**S246**	29.95335	-88.83160
C33	29.82769	-88.85345	**S247**	29.95671	-88.85070
C36	29.83539	-88.88362	**S248**	29.95772	-88.83058
C38	29.82950	-88.85211	**S249**	29.96047	-88.83877
C41	29.84350	-88.84459	**S250**	29.96422	-88.85111
C43	29.83674	-88.86860	**S251**	29.96495	-88.83034
C48	29.84350	-88.84459	**S252**	29.97042	-88.84745
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C80	29.87509	-88.84184	**S260**	29.99069	-88.84025
C81	29.87721	-88.83492	**S261**	30.00076	-88.84275
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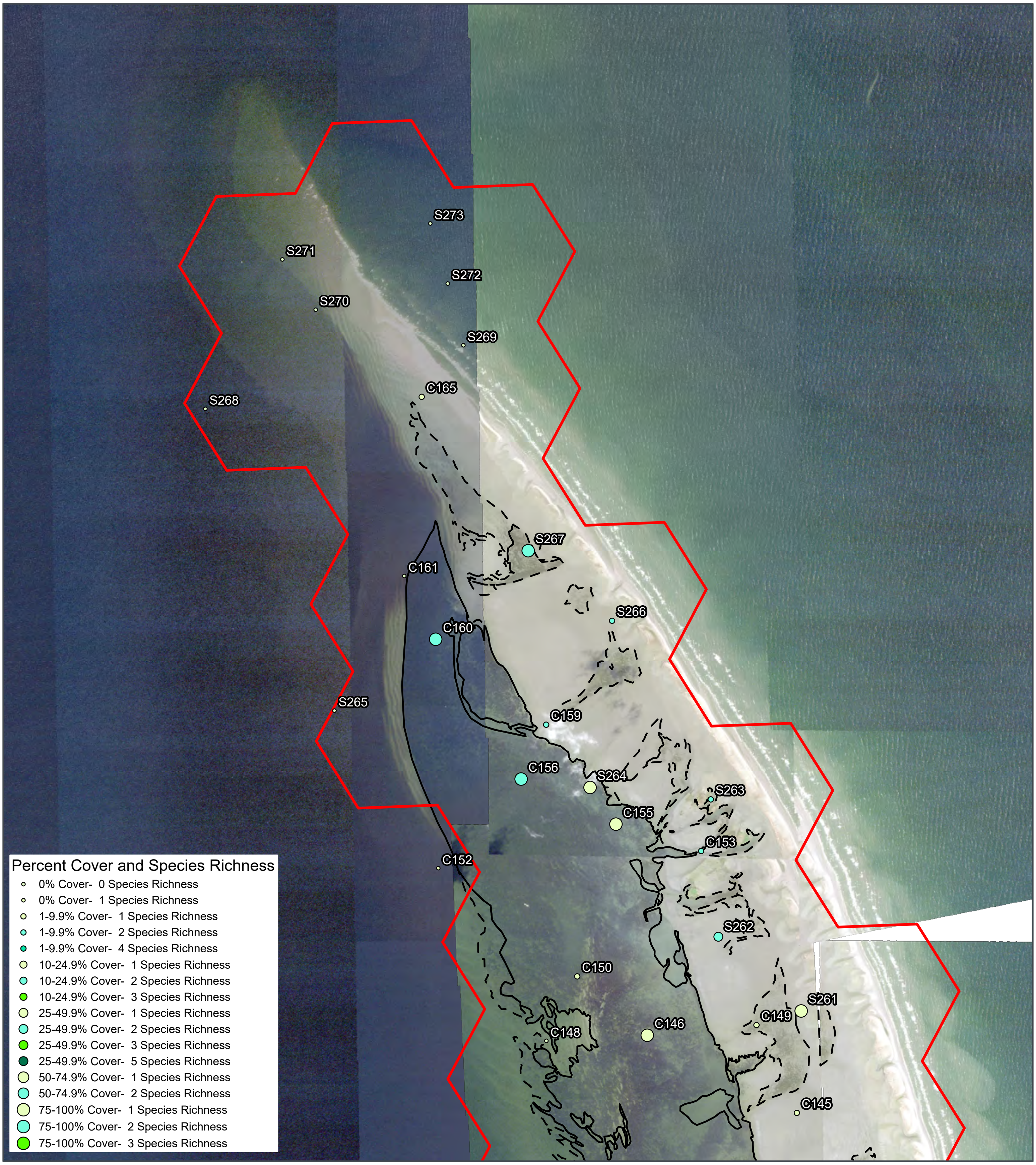
Appendix E

Seagrass Study Results Map Book



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 1 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
30.0255°N 88.8607°W

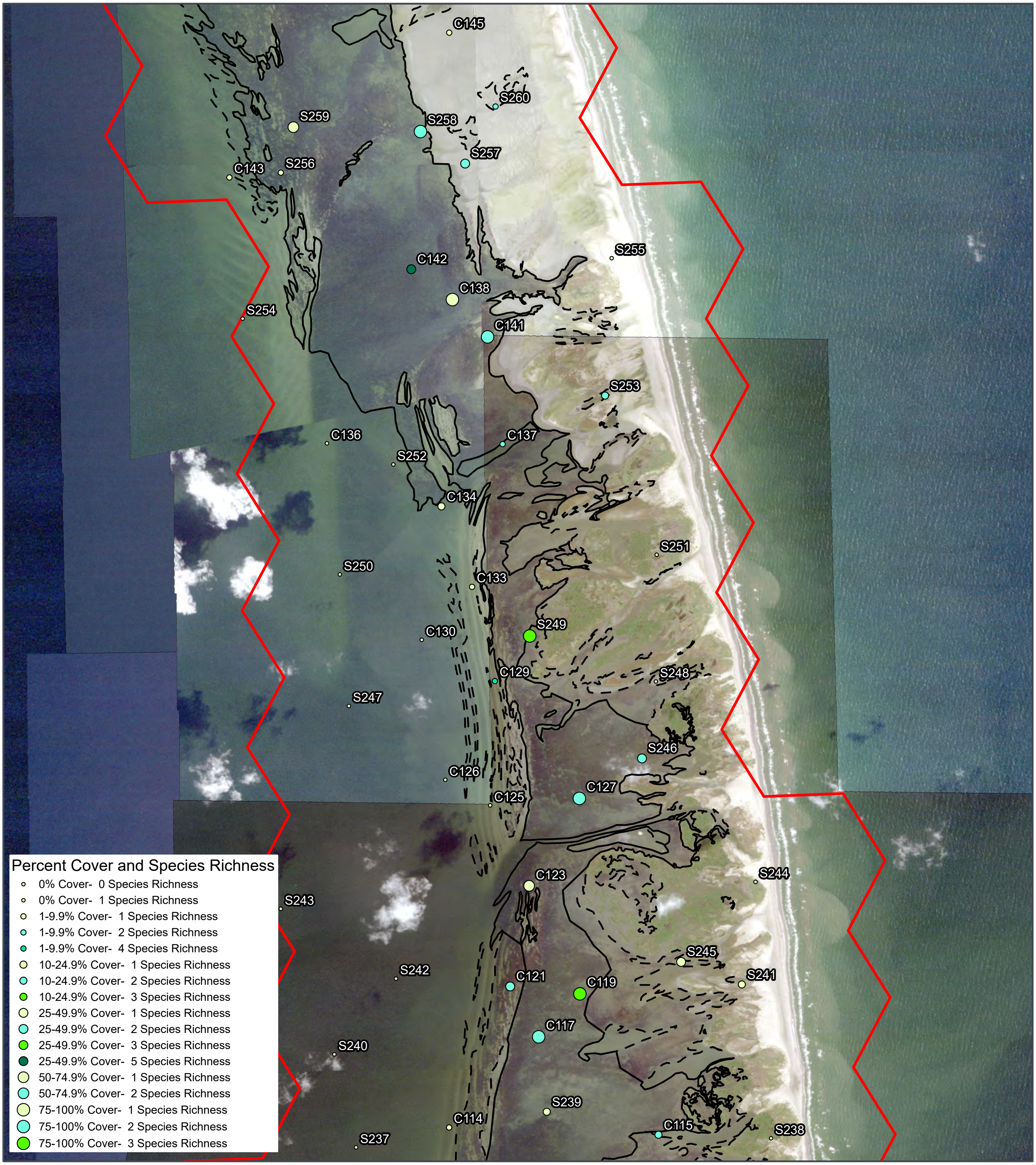
0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

SWCA ENVIRONMENTAL CONSULTANTS



CHANDELEUR ISLAND
RESTORATION PROJECT

Seagrass Study Results

Sheet 2 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
29.9635°N 88.8395°W

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0 330 660 Meters

N

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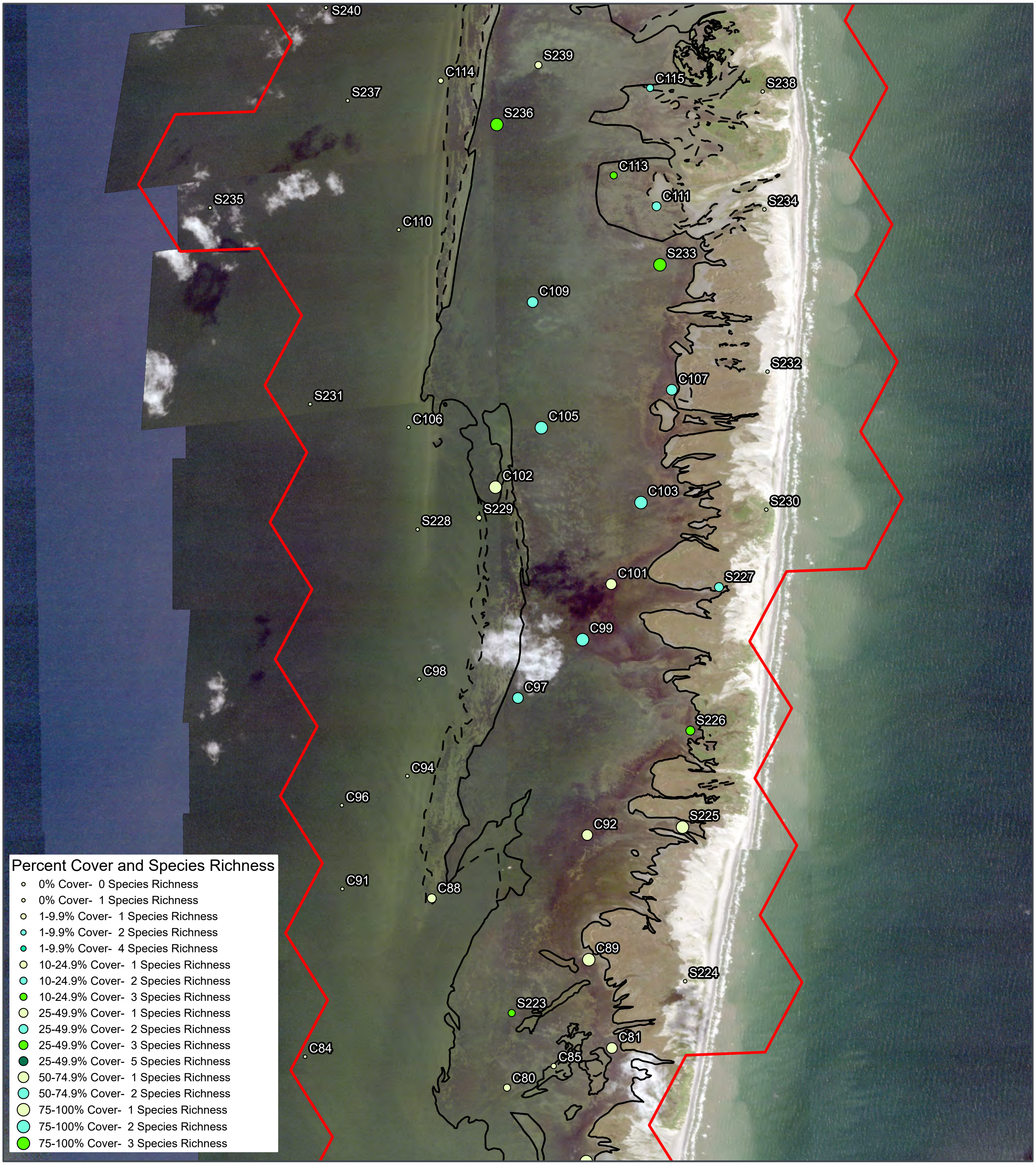
SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

SWCA ENVIRONMENTAL CONSULTANTS



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 3 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
29.9039°N 88.8404°W

0 1,000 2,000 Feet

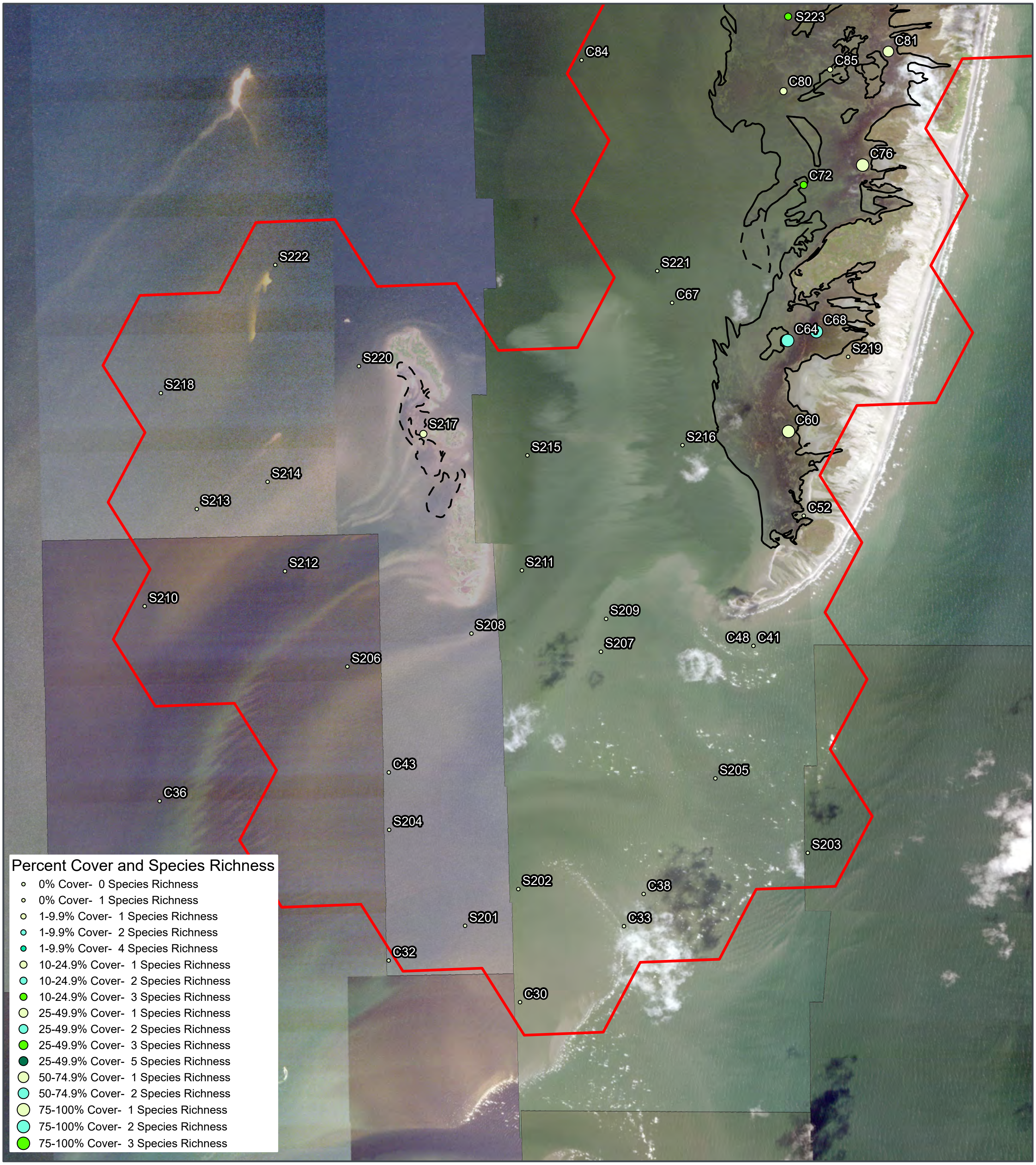
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

SWCA ENVIRONMENTAL CONSULTANTS



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 4 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
29.8474°N 88.8599°W

0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

SWCA ENVIRONMENTAL CONSULTANTS

Appendix G:

Biological Assessment

BIOLOGICAL ASSESSMENT

Chandeleur Islands Restoration Project
Chandeleur Islands, Louisiana

4/15/2025

Prepared for

Prepared by:

Edge Engineering and Science, LLC
16285 Park Ten Place; Suite 300
Houston, Texas 77084

TABLE OF CONTENTS

LIST OF ATTACHMENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

§	Section
°F	degrees Fahrenheit
µPa	microPascals
BA	Biological Assessment
BE	Biological Evaluation
BMP	Best Management Practice
CFR	Code of Federal Regulations
CPRA	Louisiana Coastal Protection and Restoration Authority
dB	decibel
dB re 1 µPa2s	decibels relative to 1 µPa squared normalized to 1 second
dB re 1µPa	decibels relative to 1 µPa
DOI	Department of the Interior
DPS	Distinct Population Segment
DWH	Deepwater Horizon
EBB	Eastern Berm Reach E4 project
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FGBNMS	Flower Garden Banks National Marine Sanctuary
FR	Federal Register
Gulf	Gulf of America
HPBA	Hewes Point Borrow Area
IPaC	Information for Planning and Consultation
Joint RP/EA #1	Joint Restoration Plan and Environmental Assessment #1: Chandeleur Islands - Wetlands, Coastal, and Nearshore Habitats, Fish and Water Column Invertebrates, Sea Turtles, Submerged Aquatic Vegetation, and Birds
kHz	kilohertz
LDWF	Louisiana Department of Wildlife and Fisheries
LSU	Louisiana State University
MHW	mean high water
MMPA	Marine Mammal Protection Act
mSAV	marine submerged aquatic vegetation
MsCIP	Mississippi Coastal Improvements Program
NAVD88	North American Vertical Datum of 1988
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWR	National Wildlife Refuge
OSI	Ocean Surveys, Inc.
Pa	Pascal

PDARP	Programmatic Damage Assessment and Restoration Plan
PEIS	Programmatic Environmental Impact Statement
Project	Chandeleur Island Restoration Project
RBO	Regional Biological Opinion
Regionwide RP/EA #1	Final Restoration Plan / Environmental Assessment 1: Birds, Marine Mammals, Oysters, and Sea Turtles
Restoration ZOI	North Chandeleur Island, with a 6-mile buffer, which includes New Harbor Island, the Hewes Point Borrow Area, and the offshore pump-out areas , collectively
RMS	root mean square
SELcum	cumulative sound exposure level
SPL	sound pressure level
TIG	Regionwide Trustee Implementation Group
U.S.C.	United States Code
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
Vessel Transit ZOI	vessel transit routes to ports in Venice, Louisiana, and/or Gulfport and Biloxi, Mississippi, collectively

EXECUTIVE SUMMARY

Following approval of funding from the Regionwide Trustee Implementation Group (TIG) in their Final Restoration Plan / Environmental Assessment 1: Birds, Marine Mammals, Oysters, and Sea Turtles (Regionwide RP/EA #1), the Louisiana Coastal Protection and Restoration Authority (CPRA) is managing efforts to engineer and design restoration activities on the Chandeleur Islands. This Project is referred to as the Chandeleur Island Restoration Project (Project). The Project team has conducted field investigations and developed engineering alternatives which the Louisiana and Open Ocean TIGs are jointly evaluating for implementation funding in Joint Restoration Plan and Environmental Assessment #1: Chandeleur Islands - Wetlands, Coastal, and Nearshore Habitats, Fish and Water Column Invertebrates, Sea Turtles, Submerged Aquatic Vegetation, and Birds (Joint RP/EA #1). The current design, as discussed below, includes multiple restoration activities along North Chandeleur and New Harbor Islands. Habitat creation/restoration would support marine life (including sea turtles) and numerous species of birds, as well as increase the longevity of the islands. This Biological Assessment (BA) has been developed to initiate formal Endangered Species Act (ESA) consultation with the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) regarding the proposed Project, and to satisfy the ESA obligations of the Louisiana and Open Ocean TIGs, should they authorize funding for the Project under Joint RP/EA #1.

The Action Area includes the area affected by restoration activities, including the transit area for construction vessels that would conduct the work, the sand borrow area, and offshore pump-out areas that may be used for beach, dune, marsh, and wetland habitat creation and protection purposes. The Action Area is North Chandeleur Island, with a 6-mile buffer, which includes New Harbor Island, the Hewes Point Borrow Area (HPBA), and the offshore pump-out areas (collectively referred to as the Restoration Zone of Influence [ZOI]). In addition, marine and estuarine species are considered along likely vessel transit routes to ports in Venice, Louisiana, and/or Gulfport and Biloxi, Mississippi (collectively referred to as the Vessel Transit ZOI). No new shore bases or mainland terrestrial impacts would occur; as such, no mainland terrestrial areas are included in the Action Area. Table ES-1 summarizes the impact determinations for listed species and critical habitat with the potential to occur in the Action Area.

Table ES-1. Summary of Effect Determinations

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	Effect Determination
Species Under U.S. Fish & Wildlife Service Jurisdiction			
Birds			
Black-capped Petrel	*Pterodroma hasitata*	Endangered	No effect
Eastern Black Rail	*Laterallus jamaicensis ssp. jamaicensis*	Threatened	No effect
Piping Plover	*Charadrius melodus*	Threatened	May affect, likely to adversely affect
Piping Plover critical habitat	--	Unit LA-7	May affect, not likely to adversely affect

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)	Effect Determination
Rufa Red Knot	*Calidris canutus rufa*	Threatened	May affect, likely to adversely affect
Rufa Red Knot critical habitat	--	Proposed, Unit LA-1	May affect, not likely to adversely affect
Mammals			
Tri-colored bat	*Perimyotis subflavus*	Proposed Endangered	No effect
West Indian manatee	*Trichechus manatus latirostris*	Threatened	May affect, not likely to adversely affect
Reptiles–terrestrial environment			
Alligator snapping turtle	*Macrochelys temminckii*	Proposed Threatened	No effect
Gopher tortoise	*Gopherus polyphemus*	Threatened	No effect
Green sea turtle, North Atlantic DPS	*Chelonia mydas*	Threatened	May affect, likely to adversely affect
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered	No effect
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	May affect, likely to adversely affect
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	No effect
Loggerhead sea turtle, Northwest Atlantic DPS	*Caretta caretta*	Threatened	May affect, likely to adversely affect
Fishes			
Gulf sturgeon	*Acipenser oxyrinchus*	Threatened	No effect
Gulf sturgeon critical habitat	--	CHU8	No effect
Pallid sturgeon	*Scaphirhynchus albus*	Endangered	No effect
Insects			
Monarch butterfly	*Danaus plexippus*	Proposed Threatened	No effect
Ferns and Allies			
Louisiana Quillwort	*Isoetes louisianensis*	Endangered	No effect
Species Under NOAA NMFS Jurisdiction			
Reptiles—marine environment			
Green sea turtle	*Chelonia mydas*	Threatened	May affect, likely to adversely affect
Green sea turtle critical habitat	--	Proposed, North Atlantic DPS	No effect
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered	May affect, not likely to adversely affect
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	May affect, likely to adversely affect
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	May affect, not likely to adversely affect
Loggerhead sea turtle, Northwest Atlantic DPS	*Caretta caretta*	Threatened	May affect, likely to adversely affect
Loggerhead sea turtle critical habitat	--	Northwest Atlantic DPS	No effect

Common Name	**Scientific Name**	**Federal Status (or critical habitat unit, if applicable)**	**Effect Determination**
Fish			
Giant manta ray	*Mobula birostris*	Threatened	May affect, not likely to adversely affect
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	Threatened	May affect, likely to adversely affect
Gulf sturgeon critical habitat	---	CHU 8	No effect
Oceanic whitetip shark	*Carcharhinus longimanus*	Threatened	No effect
Marine Mammals			
Rice’s whale	*Balaenoptera ricei*	Endangered	May affect, not likely to adversely affect
Rice’s whale critical habitat	---	Proposed	No effect

1. INTRODUCTION

Following approval of funding from the Regionwide Trustee Implementation Group (TIG) in their Final Restoration Plan / Environmental Assessment 1: Birds, Marine Mammals, Oysters, and Sea Turtles (Regionwide RP/EA #1), the Louisiana Coastal Protection and Restoration Authority (CPRA) is managing efforts to engineer and design restoration activities on the Chandeleur Islands. This Project is referred to as the Chandeleur Island Restoration Project (Project). The Project team has conducted field investigations and developed engineering alternatives which the Louisiana and Open Ocean TIGs are jointly evaluating for implementation funding in Joint Restoration Plan and Environmental Assessment #1: Chandeleur Islands - Wetlands, Coastal, and Nearshore Habitats, Fish and Water Column Invertebrates, Sea Turtles, Submerged Aquatic Vegetation, and Birds (Joint RP/EA #1). The current design, as discussed below, includes multiple restoration activities along North Chandeleur and New Harbor Islands. Habitat creation/restoration would support marine life (including sea turtles) and numerous species of birds, as well as increase the longevity of the islands.

The Project involves restoration of the North Chandeleur and New Harbor Islands in accordance with ecosystem restoration goals identified in the Deepwater Horizon (DWH) Oil Spill Final Programmatic Damage Assessment and Restoration Plan (PDARP) and Final Programmatic Environmental Impact Statement (PEIS). The Project includes restoring barrier island habitat along North Chandeleur Island through fill placement to restore beach, dune, and marsh habitat; restoration of marsh and mangrove habitat through fill placement on New Harbor Island; shoreline protection of New Harbor Island through construction of shoreline and detached rock breakwaters; and enhancement of the marine submerged aquatic vegetation, or seagrass (mSAV) beds through the added protection from offshore waves and storms afforded by the restoration of the beach and dune system on North Chandeleur Island.

1.1. Purpose and Need

The PDARP/PEIS identified a need for comprehensive integrated ecosystem restoration to address extensive and complex injuries to natural resources and their services across the Gulf of America (the Gulf) as a result of the DWH oil spill, consistent with the Oil Pollution Act. Based on this need, the Louisiana TIG and Open Ocean TIG have undertaken this restoration planning effort for the purpose of contributing to the compensation for and restoration of natural resources and their services injured, as described in the PDARP/PEIS, in the Louisiana and Open Ocean Restoration Areas. The Project is subject to evaluation under the National Environmental Policy Act through issuance of Joint RP/EA #1, which is consistent with the PDARP/PEIS and falls within the scope of the purpose and need identified therein.

The proposed Project addresses two of the programmatic goals identified in the Final PDARP/PEIS: “replenish and protect living coastal and marine resources” and “restore and conserve habitat.” Together, these goals are intended to benefit injured coastal and nearshore habitats, as well as many injured species throughout their life stages by providing food, shelter, breeding, and nursery habitat.

Section 7 of the Endangered Species Act (ESA) states that any project authorized, funded, or conducted by any federal agency should not "jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined…to be critical." This Biological Assessment (BA) has been developed to initiate formal ESA consultation with the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) regarding the proposed Project, and to satisfy the ESA obligations of the Louisiana and Open Ocean TIG, should they authorize funding for the Project under Joint RP/EA #1. This BA is prepared in accordance with the legal requirements set forth under Section 7 of the ESA (16 United States Code [U.S.C.] 1536 (c)).

1.2. Consultation History

The CPRA has coordinated with the USFWS and NMFS during development of the Project, including for the establishment of design criteria to ensure the Project is successful in providing bird nesting habitat, sea turtle nesting habitat, and mSAV habitat. The CPRA is a trustee in the Louisiana TIG. Records of relevant, recent consultations are included in Appendix B and are summarized below.

1.2.1. USFWS and NMFS

- January 10, 2022: Webinar with National Oceanic and Atmospheric Administration (NOAA) and USFWS to provide information on engineering and design efforts, anticipated ESA issues, and restoration strategies.
- October 17, 2024: Call between NOAA, USFWS, Department of the Interior (DOI), and CPRA contractors, regarding completion of the Biological Evaluation form, BA, and Essential Fish Habitat Assessment.
- October 22, 2024: The USFWS provided technical assistance to CPRA contractors regarding an existing BA for another island restoration project (the Mississippi Coastal Improvements Program [MsCIP] Barrier Island Restoration BA).
- November 4-5, 2024: Technical assistance from NOAA and the USFWS regarding the draft Biological Evaluation form.
- January 9, 2025: Provided draft of biological evaluation form and biological assessment to USFWS and NMFS for review.
- January 30, 2025: Received comments on the draft biological evaluation form and biological assessment from USFWS and NMFS.
- February 18, 2025: Provided a revised draft of biological evaluation form and biological assessment to USFWS and NMFS for review.

- March 5-7, 2025: Received comments on the draft biological evaluation form and biological assessment from USFWS and NMFS.

1.2.2. USFWS-Specific

- February 15, 2024: Webinar with USFWS to discuss nesting sea turtle survey results from last 2 years, the 2024 survey, and compliance concerns.

1.2.3. NMFS-Specific

- August 14, 2024: Webinar with NOAA on Essential Fish Habitat (EFH), sea turtle, Gulf sturgeon compliance issues and the compilation of the BA and Biological Evaluation (BE) forms.

2. DESCRIPTION OF THE PROPOSED ACTION

The Project is located within the Chandeleur Islands chain in St. Bernard Parish, Louisiana, and within the Breton National Wildlife Refuge (NWR; see Figure 2-1). The Chandeleur Islands comprise those lands between Chandeleur Sound and the Gulf, including Chandeleur Island (North and South), the Gosier Islands, the Grand Gosier Islands, the Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands. The restoration activities associated with this Project are focused on North Chandeleur Island, New Harbor Island, and the mSAV beds and water bottoms adjacent to these two islands. The proposed action includes the following features, as depicted Appendix A:

- North Chandeleur Island:
    - Beach, dune, and marsh fill
    - Feeder beach construction
    - Construction of seven sand reservoirs and/or pocket marshes
- New Harbor Island:
    - Marsh fill with shoreline protection features

2.1. Restoration Schedule

Construction is currently planned to commence in Q1 2026 and extend through Q2 2028. In-water work is likely to occur across the entire construction timeline. Bird abatement activities are anticipated to occur between March 1 and September 1 of each year of construction on North Chandeleur Island only; sea turtle nest surveys, nest marking, and relocation are anticipated to occur from April 1 through September 1 of each year of construction; with surveys extended through November 1 in areas of active construction.

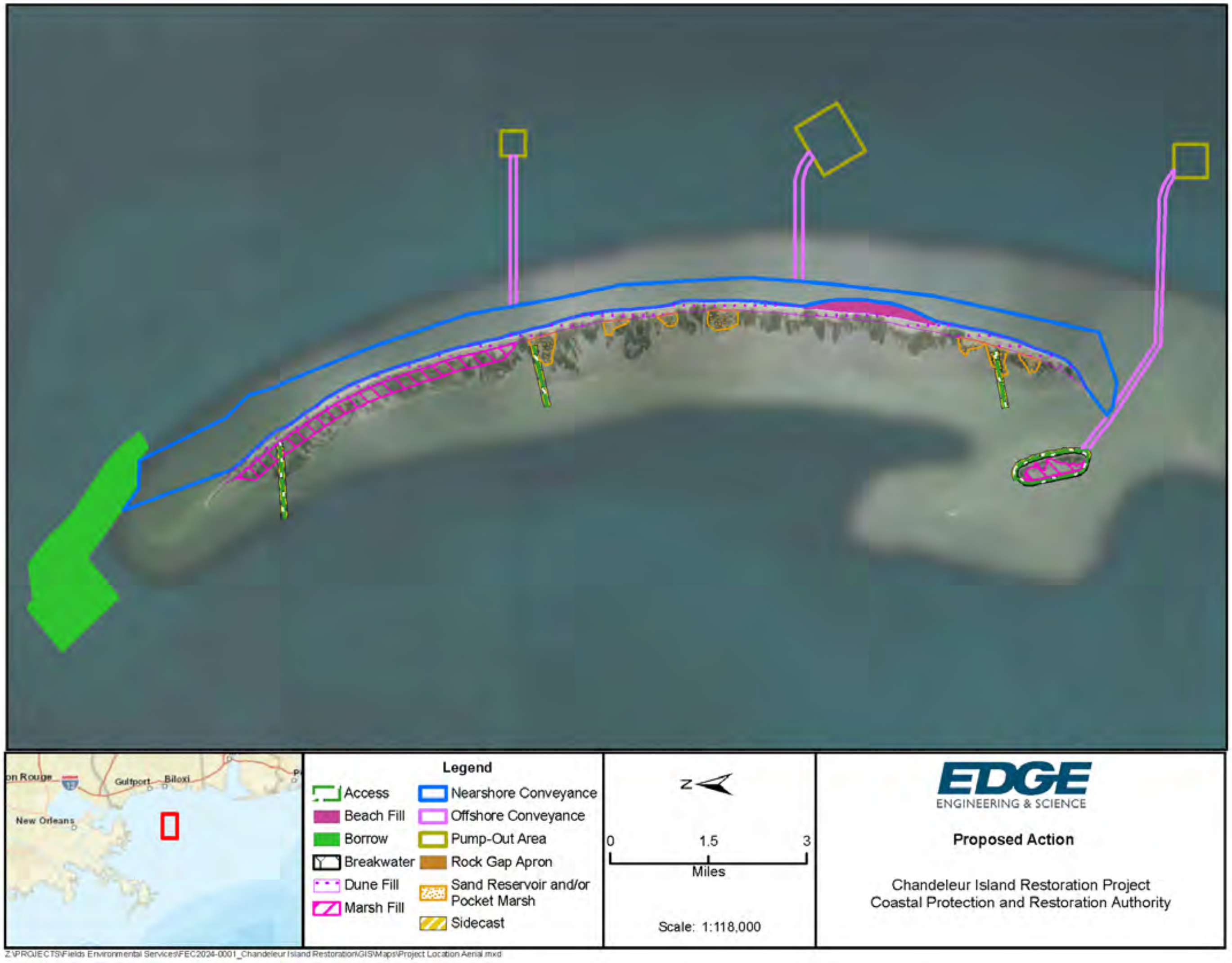


Figure 2-1. Proposed Action

2.2. Project Components

2.2.1. North Chandeleur Island

Restoration of North Chandeleur Island would consist of multiple restoration features. Beach and dune fill would be designed to provide and enhance habitat for nesting sea turtles and birds, as well as winter bird foraging habitat. Widening the island footprint would provide increased island longevity. Marsh fill and pocket marshes would involve the placement of sediment on the west side of the island, providing future marsh habitat. Sand reservoirs and the feeder beach would increase sediment available for land-building. Each of these features is depicted in Figure 2-1. Vegetative plantings on North Chandeleur Island are planned for dunes, marshes, pocket marshes, sand reservoirs, and mSAV beds. Currently anticipated plantings include bitter panicgrass (*Panicum amarum*), smooth cordgrass (*Sporobolus alterniflorus*, previously *Spartina alterniflora*), and various mSAV species, although the specific plantings would be chosen based on site conditions and/or construction variables. In addition, sand fences (porous barriers designed such that windblown sand accumulates on the fences) would be installed atop the restored dunes.

Beach and dune fill would be accomplished utilizing compatible sediments from Hewes Point Borrow Area (HPBA). Fill material would be placed at varying elevations and widths along the existing shoreline. Typical beach sections would be constructed to a target elevation of +4.5 feet[1] from the toe of the dune with a slope of 1V:200H extending seaward to an elevation of +3.2 feet. Here the slope would increase to 1V:50H down to mean high water (MHW) at an elevation of +1.2 feet where the slope would increase again to 1V:30H down to existing grade. Typical dune features would be constructed to a target elevation of +8.0 feet with side slopes of 1V:25H and a crest width of 100 feet. These elevations, slopes, and distances were selected because they have been shown to lend themselves best to habitat creation and sustainability for nesting sea turtles and birds. Specifically, the beach slopes were adopted from designs utilized for sea turtle nesting beaches in Florida, whereas the beach and dune profiles are comparable to those used on the North Breton Island Early Restoration (CEC 2024; OGE 2019).

Marsh fill would be initially constructed to a target elevation of +3.0 feet. The marsh fill would be completed on the north end of North Chandeleur Island behind the constructed beach and dune fill, where a narrow bare sandy beach and an expansive low-lying, nearly unvegetated, sandy intertidal platform currently exists. Marsh fill elevations were selected to provide bird foraging habitats as well as a stable platform to accept wash-over sediments enhancing the longevity of the Project. The marsh elevation may be refined once the geotechnical engineering settlement analysis is completed during the preliminary design phase of the Project.

[1] All elevations are in North American Vertical Datum of 1988 (NAVD88).

Seven areas along the west side of North Chandeleur Island were identified as potential locations for sand reservoir or pocket marsh construction. The sand reservoirs would function as future sediment supplies, dispersing sand into the system, as the island migrates westward. These sites were selected because of their degraded existing vegetation. Fill placement in these areas would provide twofold benefits: additional sediment input into the existing system over time and increased intertidal and supratidal habitat acres. The typical sand reservoir feature would be initially constructed to a target elevation of +4.0 feet with slopes of 1V:30H down to existing grade. Typical pocket marsh features would be initially constructed to a target elevation of +3.0 feet with a bay slope of 1V:30H down to existing grade. The marsh elevation may be refined once the geotechnical engineering settlement analysis is completed during the preliminary design phase of the Project. The final ratio of pocket marshes to sand reservoirs will be determined in later design stages; however, the total number and location of these features would be as shown in Figure 2-1 and on detailed engineering drawings provided in Appendix A.

A nodal zone that was identified along the central to south-central Gulf-facing shoreline of North Chandeleur Island presents an opportunity to provide a sustainable source of sediment to the system through the longshore transport processes. Placement of a feeder beach near the nodal zone would take advantage of longshore transport to the north and south of this point, thereby allowing natural processes to nourish the beach over time. This feeder beach feature widens the beach platform up to 800 feet at its widest point at a target elevation of +3.2 feet with a slope of 1V:50H down to MHW, then a slope of 1V:30H from MHW to the toe of fill. Final centroidal location of the feeder beach feature will be determined during the later design stages to maximize the feature's benefits to island longevity.

2.2.2. New Harbor Island

To protect existing mangrove habitat and restore eroded avian nesting habitat, a shoreline protection system would be constructed consisting of a detached rock breakwater on the eastern side of the island and a shoreline rock breakwater on the western side of the island. Approximately 250 feet from the eastern shoreline of the island, the detached rock breakwater would be constructed to a maximum elevation of +4.6 feet with side slopes of 1V:3H and five incorporated gaps. This detached breakwater is intended to protect existing habitat from erosion from wind and waves while maintaining hydrologic exchange and fisheries access. The shoreline rock breakwater off the western side of the island would also be constructed to a maximum elevation of +4.6 feet with side slopes of 1V:3H, with no incorporated gaps. Between the western shoreline rock breakwater and the existing island shoreline, sediment would be placed to a target elevation of +3.0 feet with a side slope of 1V:30H to intersect with the existing grade of the island, which would create about 145 acres of habitat for colonial nesting birds and migratory birds; this fill area would be planted with black mangrove (*Avicennia germinans*). Each of these features is generally depicted in Figure 2-1; detailed engineering drawings are provided in Appendix A.

2.2.3. Other Components

Project implementation would also involve activities at the HPBA, a nearshore conveyance corridor, three offshore pump-out areas and associated conveyance corridors, and access channels. The HPBA is a submerged shoal that is within one mile of the north end of North Chandeleur Island. The sand deposits within the 1,680-acre HPBA are sediment collected from longshore transport from North Chandeleur Island and are suitable for restoration purposes. The nearshore conveyance corridor would extend the full length of North Chandeleur Island (Gulf-facing side); from the corridor used during the construction of the Eastern Berm Reach E4 project (EBB) completed in 2010 in response to the DWH oil spill to the island's Gulf-side shoreline.

Three offshore pump-out areas and associated offshore conveyance corridors would allow for direct pump-out of sediments from a hopper dredge (with turtle exclusion devices) or scow barges via sediment pipeline corridors for sediment transport to North Chandeleur and New Harbor Islands. As shown in Figure 2-1, the pump-out areas are each about 2 to 4 miles from the Gulf-facing shore of North Chandeleur Island.

It is anticipated the methods of mining the HPBA and conveying it to North Chandeleur and New Harbor Islands are a hydraulic cutterhead dredge with booster pumps, hopper dredge, or cutterhead dredge-scow barge operation. Cutterhead dredges utilize a rotary excavating bit to loosen the sediment. The loosened slurry is pumped up to a large suction pump in the dredge hull, which also pumps it ashore through a submerged pipeline, often aided by the booster pump. With hopper dredge operation, the excavated sand would be moved to the vessel's hull and transported to the designated pump-out areas to be hydraulically unloaded. The third method involves use of a conventional cutterhead dredge, which would excavate the sand and transfer it through a spider barge distribution system into scow barges. The scows would be towed to the designated pump-out areas and hydraulically unloaded directly from the scow barges. With all three dredging and transport methods, the dredged material would be discharged into the restoration template where it would be graded using conventional earth moving equipment.

Temporary access channels may be dredged to provide construction access to North Chandeleur and New Harbor Islands for equipment and personnel. The temporary access channels would be utilized for the Project duration and would be backfilled upon Project completion. Three locations along North Chandeleur Island were identified that minimized impacts to submerged aquatic vegetation, specifically turtle grass (*Thalassia testudinum*). These access channels are positioned on the north end, central area, and south end on the bay-side of North Chandeleur Island. A fourth channel is also planned around the perimeter of New Harbor Island. The temporary access channels would be utilized for the Project duration and would be backfilled upon Project completion.

2.3. Restoration Procedures

Construction procedures to complete the habitat restoration proposed for the Project are described below. Any construction best management practices (BMPs) are incorporated into the construction procedures and are discussed in the applicable sections. Specific construction methodologies include dredging via hydraulic cutterhead dredge with booster pumps, hopper dredge, or cutterhead dredge-scow barge operation; fill activities, including the placement of rocks to install shoreline protection features around New Harbor Island; and limited (timber) pile-driving.

Fill to create the restoration features on North Chandeleur and New Harbor Islands would be completed using sediments transported from the HPBA. It is anticipated the methods of mining the HPBA and conveying it to North Chandeleur and New Harbor Islands could include a hydraulic cutterhead dredge with booster pumps, hopper dredge, or cutterhead dredge-scow barge operation across the construction timeline. With any of the three dredging and transport methods, the dredged material would be discharged into the restoration template where it would be graded using conventional earth moving equipment. In addition to the HPBA, three offshore pump-out areas and associated offshore conveyance corridors have been identified for use during the Project. The sediment pipeline installed within the conveyance corridors and pump-out areas would not require excavation for pipeline installation, as the sediment pipelines would be placed directly on the sea floor.

Several types of sea-borne equipment, land-based earth moving equipment, and transportation equipment are employed during a restoration project. Sea-borne equipment for the Project would likely include dredging vessels, booster pump(s), tugboats, scow barges, equipment ramp barges, and survey vessels. Land-based earth moving equipment would likely include bulldozers, marshbuggy excavators, tracked excavators, and articulated loaders. Transportation and support equipment would likely include crew and supply transport vessels, all-terrain vehicles, welding machines, air compressors, light plants, field survey office, field engineering office and quarters barges.

2.4. Maintenance Procedures

Once restoration activities are complete, no ongoing maintenance activities are planned or proposed; however, CPRA may occasionally revisit the area to ensure the success of revegetation and may conduct limited replantings and fence replacements/maintenance as needed. No further sand or sediment work would occur.

3. DESCRIPTION OF THE ACTION AREA

The Action Area, as defined in 50 Code of Federal Regulations (CFR) Section (§) 402.02, includes "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." This includes the area affected by restoration activities, including the transit area for construction vessels that would conduct the work and the sand borrow and offshore pump-out areas that may be used for beach, dune, marsh, and wetland habitat creation and protection purposes. The Action Area is North Chandeleur Island, with a 6-mile buffer, which includes New Harbor Island, the HPBA, and the offshore pump-out areas (collectively referred to as the Restoration ZOI). In addition, marine and estuarine species are considered along likely vessel transit routes to ports in Venice, Louisiana, and/or Gulfport and Biloxi, Mississippi (collectively referred to as the Vessel Transit ZOI). No new shore bases or mainland terrestrial impacts would occur; as such, no mainland terrestrial areas are included in the Action Area. Figure 3-1 depicts the Action Area. Section 4 identifies the species and critical habitat considered for the Restoration and Vessel Transit portions of the Action Area; existing conditions are presented in Section 5, and Section 6 discusses impacts on the federally listed species.

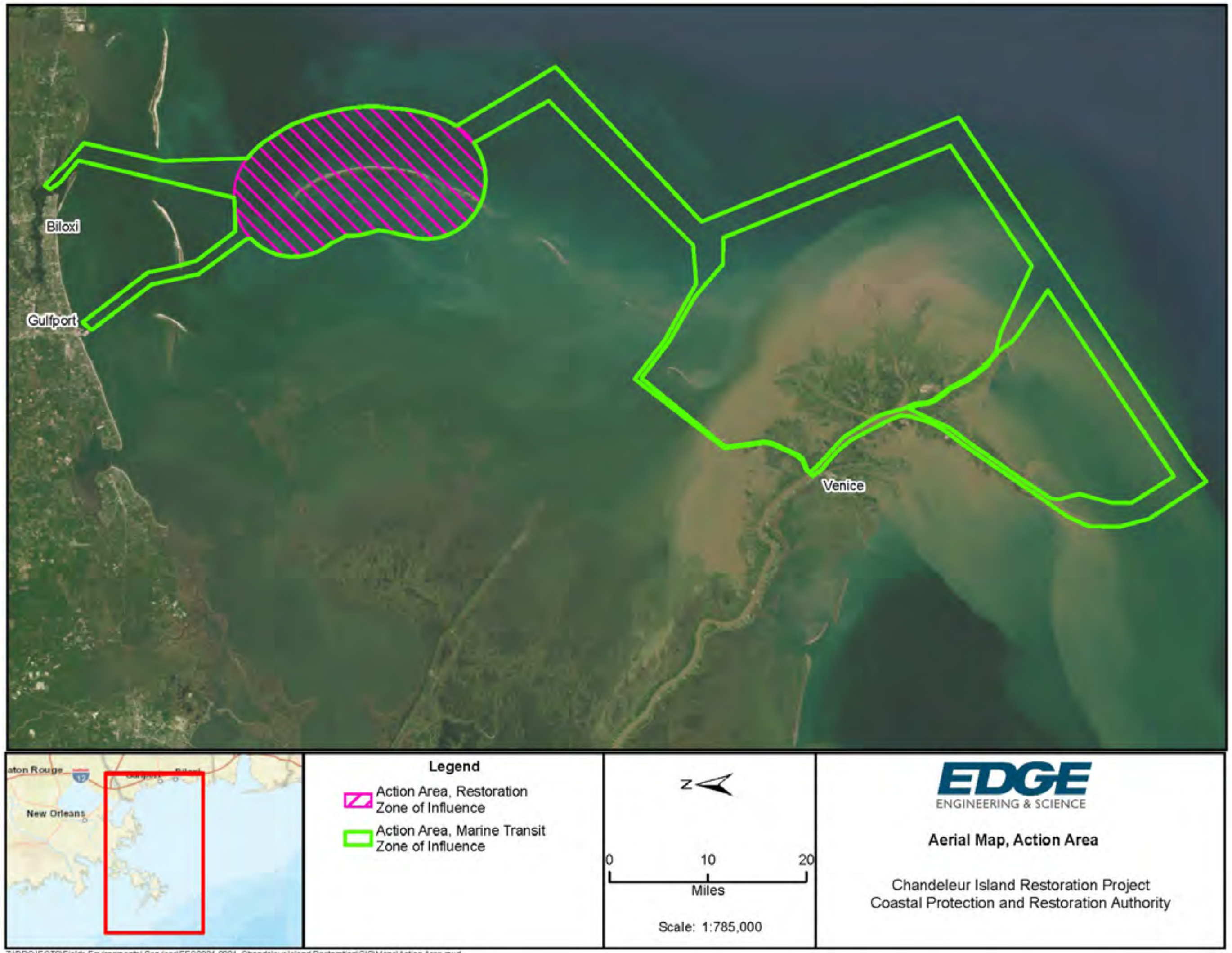


Figure 3-1. Action Area

4. SPECIES AND CRITICAL HABITAT CONSIDERED

During technical assistance discussions with the USFWS, CPRA's contractors were directed to pull an unofficial species list from the USFWS Information for Planning and Consultation (IPaC) website for species and critical habitat consideration, which was obtained on November 7, 2024, for the Project Action Area (see Appendix C). The NMFS Southeast Region ESA Section 7 Mapper was consulted on December 3, 2024, to identify federally listed, proposed, and candidate marine species and critical habitat with the potential to occur in the Action Area. Table 4-1 lists all species identified as potentially occurring in the Action Area, along with any designated or proposed critical habitat. A brief discussion of species that are not considered further in this BA (those species not expected to occur in the Action Area, or that are not vulnerable to Project impacts) is presented after the table, with more details on the species carried forward for analysis addressed in the subsequent sections. Figure 4-1 depicts the critical habitat within the Action Area and Figure 4-2 provides a detailed depiction of the critical habitat within the area affected by restoration activities.

Table 4-1. Federally Listed, Proposed, and Candidate Species and Critical Habitat Associated with the Project

Common Name	Scientific Name	Federal Status (or critical habitat unit, if applicable)
Species Under U.S. Fish & Wildlife Service Jurisdiction		
Birds		
Black-capped Petrel	*Pterodroma hasitata*	Endangered
Eastern Black Rail	*Laterallus jamaicensis ssp. jamaicensis*	Threatened
Piping Plover	*Charadrius melodus*	Threatened
Piping Plover critical habitat	--	Unit LA-7
Rufa Red Knot	*Calidris canutus rufa*	Threatened
Rufa Red Knot critical habitat	--	Proposed, Unit LA-1
Mammals		
Tri-colored bat	*Perimyotis subflavus*	Proposed Endangered
West Indian manatee	*Trichechus manatus latirostris*	Threatened
Reptiles–terrestrial environment		
Alligator snapping turtle	*Macrochelys temminckii*	Proposed Threatened
Gopher tortoise	*Gopherus polyphemus*	Threatened
Green sea turtle[a]	*Chelonia mydas*	Threatened
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Fish		
Pallid sturgeon	*Scaphirhynchus albus*	Endangered
Insects		
Monarch butterfly	*Danaus plexippus*	Proposed Threatened
Plants		
Louisiana quillwort	*Isoetes louisianensis*	Endangered

Common Name	**Scientific Name**	**Federal Status (or critical habitat unit, if applicable)**
Species Under NOAA NMFS Jurisdiction		
Reptiles—marine environment		
Green sea turtle	*Chelonia mydas*	Threatened
Green sea turtle critical habitat	--	Proposed, Unit NA01: *Sargassum* and Gulf Unit, North Atlantic DPS
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Loggerhead sea turtle	*Caretta caretta*	Threatened
Loggerhead sea turtle critical habitat	--	Unit LOGG-N-34, Nearshore Reproductive Habitat and LOGG-S-02 *Sargassum*
Fish		
Giant manta ray	*Mobula birostris*	Threatened
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	Threatened
Gulf sturgeon critical habitat	--	Unit 8 Lake Pontchartrain – Mississippi Sound
Oceanic whitetip shark	*Carcharhinus longimanus*	Threatened
Pallid sturgeon	*Scaphirhynchus albus*	Endangered
Marine Mammals		
Rice's whale	*Balaenoptera ricei*	Endangered
Rice's whale critical habitat	--	Proposed, Gulf Unit

[a] While the green sea turtle was not identified as occurring in the Restoration ZOI via a review of IPaC, the species is known to nest in the Action Area.

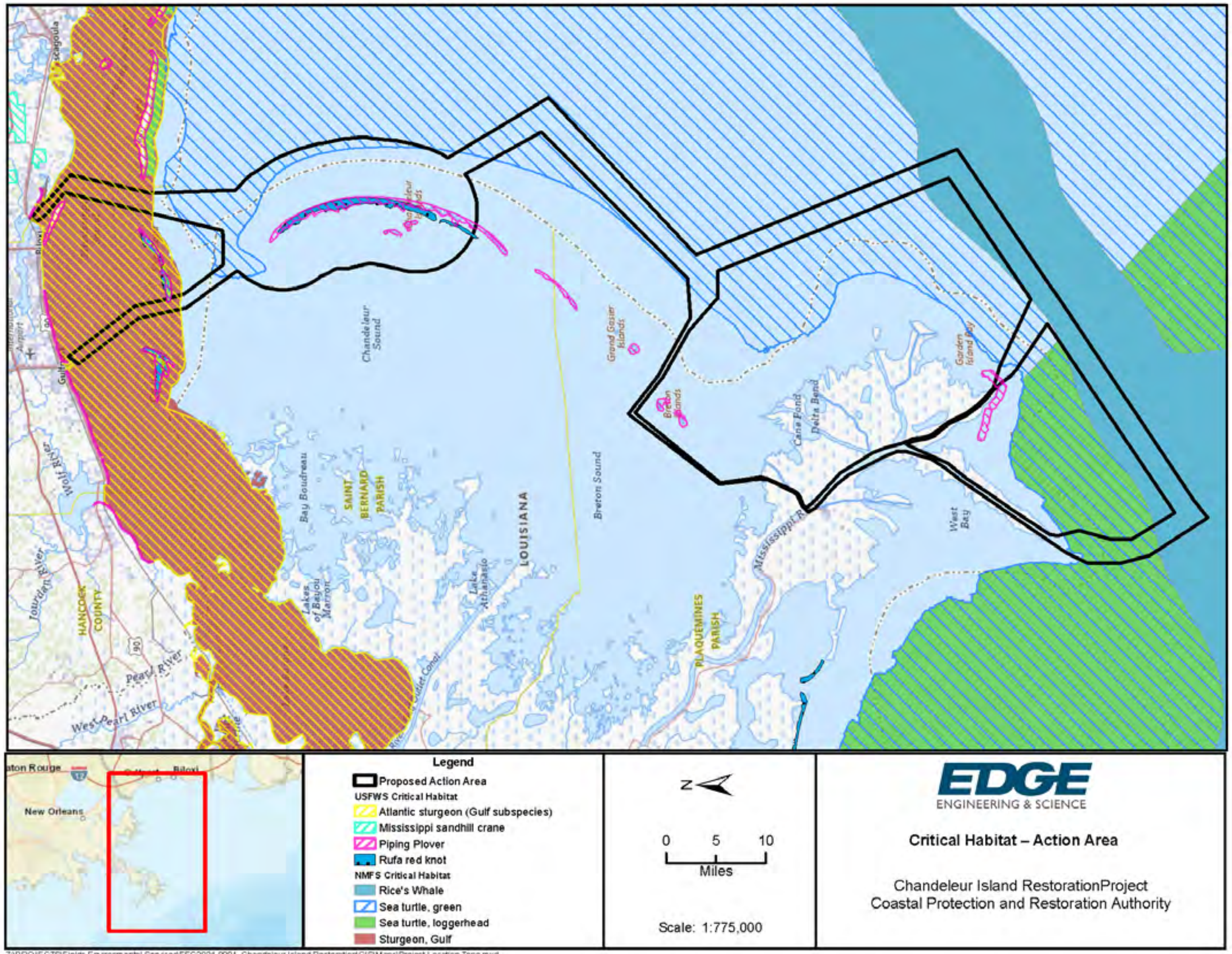


Figure 4-1. Critical Habitat – Action Area

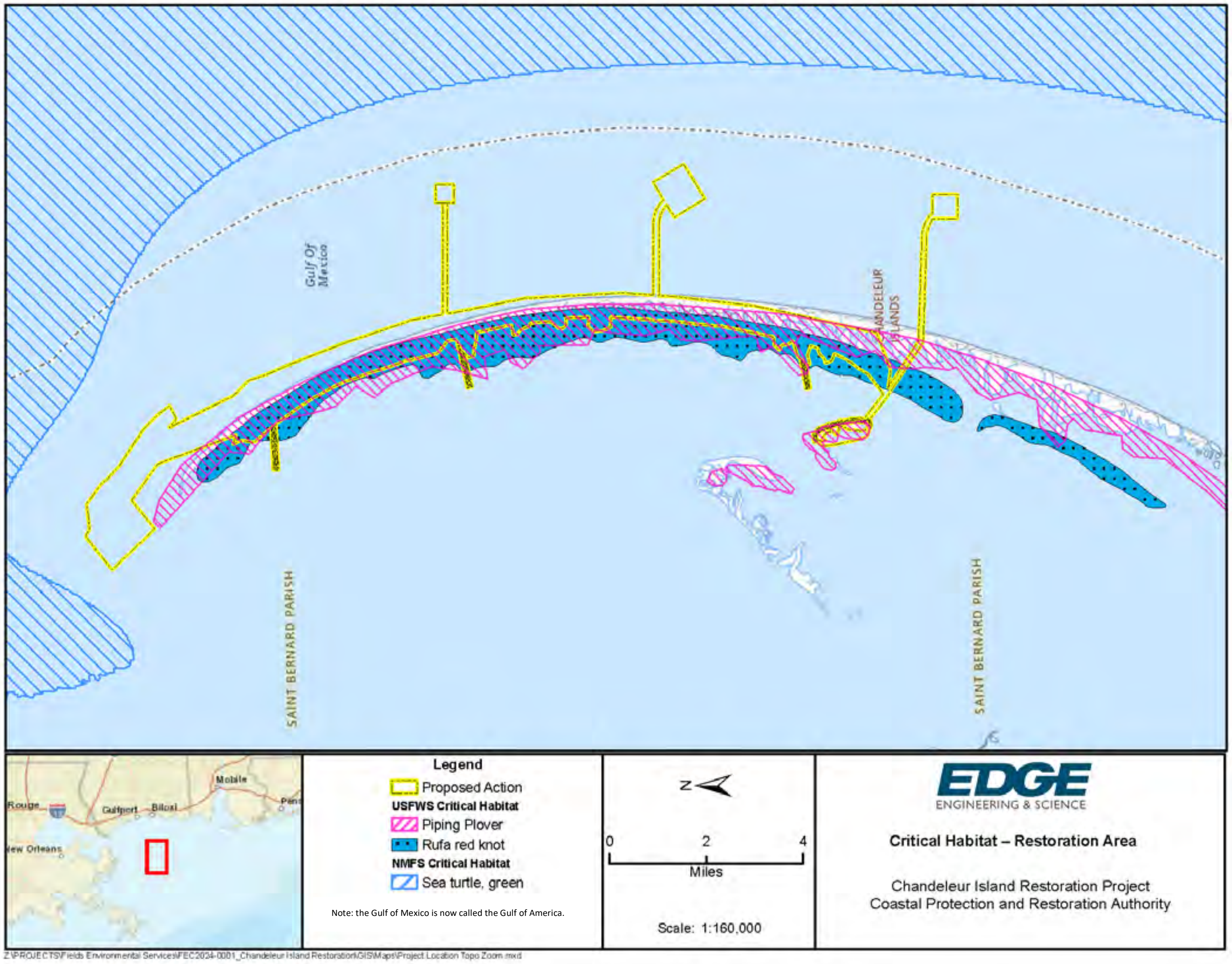


Figure 4-2. Critical Habitat – Restoration Area

4.1. Species and Critical Habitat Not Considered Further

Based on a review of available life history and occurrence information, species assessed in this section either are not known to occur in the Action Area or are not vulnerable to potential Project impacts. A brief summary of the *no effect* determination for each species with the potential to occur in the Restoration ZOI is included below. In addition, a review of IPaC data, and data from NMFS (see Appendix C) identified the tri-colored bat, pallid sturgeon, Black-capped Petrel, alligator snapping turtle, gopher tortoise, Louisiana quillwort, and oceanic whitetip shark along the Vessel Transit ZOI. As none of these species are subject to potential impacts from vessel strikes where vessels operate along existing shipping fairways and no terrestrial work or modification of terrestrial or marine habitat is proposed along vessel access routes, the Project will have no effect on these species, and they are not addressed further.

4.1.1. Eastern Black Rail

The Eastern Black Rail was federally listed as a threatened species under the ESA on November 9, 2020 (85 Federal Register [FR] 63764). The species listing included a final rule under Section 4(d) of the ESA that allows for incidental take associated with prescribed burns and vegetation management, provided suitable mitigation measures are employed, as well as take by federal or state conservation agencies operating a conservation program for black rails. No critical habitat has been proposed for this species.

One of five subspecies of black rail, the Eastern Black Rail is a secretive marsh bird that occurs in emergent wetland habitat and contiguous uplands (USFWS 2019). Wetlands dominated by mangroves, such as those predominant on North Chandeleur and New Harbor Island, are not suitable habitat for the species (USFWS 2019). The range of this species extends across the Gulf Coast. Louisiana is not currently known to support a breeding population of Eastern Black Rail, although individuals have been documented in western coastal Louisiana and breeding may occur in the state (Watts 2016; USFWS 2019). Further, Louisiana is considered to be on the periphery of known breeding areas for the species (Watts 2016, and noted in the final rule listing the species under 85 FR 63764). Given the Chandeleur Islands are offshore and outside areas of documented occurrences, it is unlikely that the Eastern Black Rail occurs in the Project area. As such, the Project would have no effect on this species, and it is not assessed further.

4.1.2. Monarch Butterfly

The monarch butterfly (*Danaus plexippus*) was proposed for federal listing as a threatened species on December 12, 2024 (89 FR 100662). The proposed rule also proposes to designate critical habitat in California, and to establish a Section 4(d) rule to allow incidental take in certain circumstances (such as vegetation management activities to remove milkweed when monarchs are not likely present).

Monarch butterflies use a wide range of habitats; adults require flowering plants for feeding, and milkweed (*Asclepias* spp.) is the obligate host plant for caterpillars (USFWS 2024a). While pollinator plant species may be present in terrestrial habitat in the Action Area, milkweed was not documented in vegetation assessments conducted in 2023, and suitable monarch butterfly or caterpillar habitat would not be directly affected by beach, dune, or marsh fill for the Project. As such, the Project would have no effect on this species, and it is not assessed further.

4.2. U.S. FISH AND WILDLIFE SERVICE JURISDICTION

A total of eight federally listed species under the jurisdiction of the USFWS potentially occur within the Action Area and could be affected by the Project, including five species that are under the joint jurisdiction of the USFWS and NMFS. The USFWS maintains jurisdiction over terrestrial lands and riverine habitat, whereas NMFS generally maintains jurisdiction of estuarine and marine waters. Because sea turtles occur on both nesting beaches and within the estuarine/marine waters of the Action Area, they fall under the jurisdiction of USFWS and NMFS. Therefore, the discussions below in Sections 4.2.4 through 4.2.8 apply to both agencies. Although primarily occurring in estuarine and marine waters, the West Indian manatee falls solely under the USFWS jurisdiction and is also discussed in Section 4.2.3.

4.2.1. Piping Plover

4.2.1.1. Species Status and Description

The Atlantic Coast and Northern Great Plains populations of the Piping Plover (*Charadrius melodus*) were federally listed as threatened in January 1986 (50 FR 50626); the population in the Great Lakes was listed as endangered. Critical habitat for wintering Piping Plovers was designated in 2001 (66 FR 36038).

The Piping Plover is a small, migratory shorebird; adults are about 7 inches (17 centimeters) long with a wingspan of 15 inches (38 centimeters). The Piping Plover is pale-colored, and its plumage blends with its sandy beach and shoreline habitat. Distinctive characteristics include two dark bands, one across the forehead and one around the neck. During the breeding season, legs are bright orange and the bill is orange with a black tip; in winter, the bill is black, the plumage bands fade, and the legs are a lighter orange (USFWS 2015).

Within the winter range, the greatest threats to Piping Plover are related to loss, modification, and degradation of habitat (including due to development and construction, inlet stabilization and relocation, dredging, seawalls and revetments) and impacts due to accelerating sea-level rise and other environmental changes , which can alter or result in the loss of habitat (USFWS 2015).

4.2.1.2. Life History, Habitat, and Range

The species winters along the Atlantic and Gulf Coasts, with the wintering range extending from North Carolina to Texas, including coastal Louisiana and the Chandeleur Islands (USFWS 2015, Stucker et al. 2010). Piping Plovers spend up to 10 months annually on their wintering grounds, and are typically present between mid-July and mid-May (USFWS 2015). Preferred wintering habitats include coastal sand spits, tidal flats, shoals, sandbars, and small islands; foraging habitats include sand and mud flats, ephemeral pools, overwash areas, and emergent seagrass beds where plovers feed on macroinvertebrates (USFWS 2015). Piping Plovers glean invertebrates from substrate; prey for wintering plovers include macroinvertebrates such as polychaete worms, crustaceans, insects, and bivalve mollusks (66 FR 36038). Foraging is typically on moist or wet sand, mud, or fine shell, and wintering plovers spend a majority of their time foraging (66 FR 36038). High site fidelity has been documented in wintering plovers (Drake et al. 2001).

Historically, breeding populations are associated with three geographic regions: the Northern Great Plains from Alberta to Manitoba and south to Nebraska; the Great Lakes beaches; and the Atlantic coast from Newfoundland, Canada south to North Carolina (USFWS 2024b, 66 FR 36038). Breeding sites are generally found on islands, lake shores, coastal shorelines, and river margins, on open sand, gravel, or cobble beaches.

4.2.1.3. Presence in the Action Area

Piping Plover are known to use the designated critical habitat in the Action Area. Wintering bird surveys conducted on North Chandeleur Island between September 2023 and April 2024 observed a total count of 445 Piping Plovers (CEC et al. 2024; SEG Environmental 2024).

4.2.1.4. Piping Plover Critical Habitat

The physical or biological features essential to Piping Plover conservation and used in the designation of critical habitat to support foraging, roosting, and sheltering Piping Plover include intertidal beaches and flats (between annual low tide and annual high tide) and associated dune systems and flats above annual high tide. Intertidal flats include mud and sand flats with sparse to no emergent vegetation and, occasionally, algal mats. Adjacent habitat above the high tide line is important for roosting (66 FR 36038). North Chandeleur and New Harbor Islands are within Louisiana Unit 7, which is inclusive of the Breton Islands and Chandeleur Island Chain, and both islands support the constituent elements essential to species survival.

4.2.2. Rufa Red Knot

4.2.2.1. Species Status and Description

The Rufa Red Knot was federally listed as threatened in January 2015 (79 FR 73705). A medium-sized (9- to 11-inch long) shorebird, the Rufa Red Knot has distinctive red plumage during the breeding season. Upper parts of the bird are dark brown with white and red feather edges; the face, eye stripe, breast, and upper belly are rufous-red to salmon. Female coloration is typically more buff and less intense (USFWS 2020).

Within the winter range, the greatest threats to Rufa Red Knot are related to habitat loss (including due to sea-level rise, coastal engineering, and coastal development); reduced prey availability; and impacts due to environmental changes, including mis-matches in the timing of annual migration relative to food availability and favorable weather conditions (USFWS 2020; 79 FR 73705).

4.2.2.2. Life History, Habitat, and Range

Similar to the Piping Plover, wintering habitat for the Rufa Red Knot is within coastal marine and estuarine habitats with exposed, intertidal sediments to support foraging for invertebrates. Prey are predominantly bivalve mollusks, although Rufa Red Knots would opportunistically feed on other invertebrates. Habitats include sand spits, shoals, and sandbars; Rufa Red Knots also winter along mangrove-dominated shorelines (USFWS 2020). Rufa Red Knots that winter in Louisiana typically migrate along the Mississippi River Basin. Studies in Texas show that birds that winter on the Gulf Coast spend most of their time in wintering habitat, leaving breeding habitat beginning in July and staying in Texas until mid-May; juveniles may remain in non-breeding habitat in June and July (USFWS 2020). The seasonal use of wintering habitat in Louisiana is expected to be similar. The species breeds in slightly elevated, dry tundra habitat with sparse vegetation; nest sites are located near freshwater wetlands.

4.2.2.3. Presence in the Action Area

Rufa Red Knot are known to use the habitat in the Action Area. Wintering bird surveys conducted on North Chandeleur Island between September 2023 and April 2024 observed a total count of at least 4,750 Rufa Red Knot (CEC et al. 2024; SEG Environmental 2024).

4.2.2.4. Rufa Red Knot Proposed Critical Habitat

Critical habitat is currently proposed for the species, including on North Chandeleur and New Harbor Islands (88 FR 22530). The physical or biological features essential to Rufa Red Knot conservation and those used in the identification of proposed critical habitat to support foraging, roosting, and sheltering Rufa Red Knots include beaches with tidal flats; upper beach areas; ephemeral coastal features (such as shoals, used for foraging and roosting); ocean vegetation deposits or wrack; intertidal peat banks; and areas landward of the beach that support the species. Artificial habitat that mimics natural conditions and exhibits these features may also be identified as critical habitat (88 FR 22530). North Chandeleur Island is within proposed Louisiana Unit 1, which is inclusive of the Chandeleur Islands and adjacent sand shoals and supports the constituent elements essential to species survival.

4.2.3. West Indian Manatee

4.2.3.1. Species Status and Description

The West Indian manatee (*Trichechus manatus*) (manatee) was initially listed as an endangered species in 1967 and reclassified as threatened under the ESA in 2017 (USFWS 2008a, 82 FR

16668). The manatee is also federally protected under the Marine Mammal Protection Act (MMPA).

Manatees are large marine mammals, with skin that is typically grayish brown in color, wrinkled, and rubber-like. This species is known for its large, barrel-shaped size and docile behavior. Adult manatees average about 9.8 feet in length and 2,200 pounds in weight. Manatees have two paddle-like forelimbs (i.e., flippers) and a large, horizontally flattened, and round spatula-shaped tail. Manatees are often observed with unique markings or scarring on their backs that is due to vessel strikes (USFWS 2024c, LDWF 2024).

This species occurs in the southeastern region of the United States, eastern Mexico, and in patchy distribution throughout the Caribbean, but predominantly occurs in Florida. The total range-wide population of manatees is estimated at 13,000. Current anthropogenic threats to manatees include vessel strikes, habitat loss, and entanglement in fishing gear. Natural threats to manatees include cold temperatures, harmful algae such as red tide blooms, and extreme weather such as tropical storms and hurricanes (USFWS 2008a).

4.2.3.2. Life History, Habitat, and Range

Manatees inhabit estuaries, saltwater bays, slow-moving rivers and river mouths, canals, and coastal areas alike. Manatees are typically found in warmer waters with depths of less than 33 feet (Miksis-Olds et al. 2007). The species will migrate to warmer waters during winter months as they cannot tolerate water temperatures below 68 degrees Fahrenheit (°F) for prolonged periods of time. In the Gulf, manatees most commonly occur in Florida, although they occasionally occur in Georgia, Mississippi, Louisiana, and as far west as Texas (USFWS 2024c).

In Louisiana, manatees typically occur during the summer months when coastal waters are at their warmest. The Louisiana Department of Wildlife and Fisheries (LDWF) has taken precautions to protect manatees near the Louisiana coast by installing signs at boat docks near coastal waterways to warn boaters to proceed with caution. Most Louisiana manatee sightings occur east of the Mississippi River (Wilson 2003).

Male manatees reach reproductive maturity between 3 and 5 years of age and females can reproduce at 4 to 5 years of age; however, most are successful after 7 to 9 years of age. The gestation period for this species is approximately 13 months. Manatees give birth every 2 to 5 years; usually a single calf is born but twins do occur. Calves may be born at any time of the year and remain with their mother for up to 2 years. Manatees are herbivorous; after nursing, their diet consists solely of aquatic vegetation such as cordgrass, eelgrass, and seagrasses (USFWS 2008a).

4.2.3.3. Presence in the Action Area

Very limited reports of manatee occurrence at the Chandeleur Islands have been recorded (Slone et al. 2022). However, a 2005 study on manatee occurrence in the northern Gulf, west of

Florida, recorded various manatee sightings in the waters of Louisiana from 1943 to 2004, one of which was reported in the Chandeleur Islands. This sighting occurred in 2003, where a single manatee was observed feeding on a weed line at the water's surface, in open water at the southwestern tip of the Chandeleur Islands (Fertl et. al. 2005). However, an incidental sighting in the mSAV beds of North Chandeleur Island was reported in July of 2024; this sighting will undergo verification from the LDWF (Weigel 2024).

4.2.3.4. Critical Habitat

The Project area is not within designated critical habitat for the West Indian manatee.

4.2.4. Green Sea Turtle

4.2.4.1. Species Status and Description

Green sea turtles (*Chelonia mydas*) in the Gulf are part of the North Atlantic Distinct Population Segment (DPS), which was listed as threatened in 2016 (81 FR 20057). This species is identified in the field by their large size (the average adult is 3 to 4 feet long weighing from 300 to 350 pounds) and their distinct shell markings, displaying five scutes down the middle of their shells. Green sea turtles have shell coloration that varies from dark brown, gray, or olive on top to a much lighter yellow to white on the underside (NMFS 2024a).

Current threats to green sea turtles include bycatch in fishing gear, targeted harvest of turtles and eggs, loss and degradation of nesting and foraging habitat, vessel strikes, ocean pollution and marine debris, environmental changes, predation of eggs and hatchlings by native and non-native predators, and disease (NMFS 2024a).

4.2.4.2. Life History, Habitat, and Range

Green sea turtles are found worldwide; in the Gulf, they are generally found along the coast in inshore and nearshore waters and utilize beaches with steep slopes, high above the tide line, with lightweight, medium coarse sand for nesting (Fuller et al. 1987). Green sea turtles occur in nearshore waters off the Louisiana coast, although they are relatively rare (LDWF 2004).

Adults are herbivorous, primarily consuming seagrasses and algae. Hatchlings and juveniles have a more varied diet and have been recorded to forage on jellyfish, sponges, and discarded fish (NMFS 2024a, LDWF 2004). Adults migrate between foraging grounds and nesting beaches every 2 to 5 years, returning to their natal beaches, where they typically nest alone and primarily at night. Hatchlings emerge from their nests and swim to offshore habitats, where they will remain for several years, relying on *Sargassum* mats for protection and food. As juveniles, they leave open ocean habitats and migrate to shallow coastal areas, where they mature and spend the remainder of their lives (NMFS 2024a).

In the continental United States, green sea turtles nest predominantly in Florida, although annual nesting also occurs in Georgia, North and South Carolina, and Texas (NMFS 2024a, NWF 2024). Although nesting in Louisiana was not previously known (LDWF 2004), Project-specific surveys conducted in 2023 and 2024 identified the presence of green sea turtle nesting on North Chandeleur Island (see Section 4.2.4.3). Nesting within the United States generally occurs between June and September, with hatchling emergence occurring about 2 months after the nest was laid (NMFS 2024a, NPS 2024). Crawl data (indicative of nesting activity) recorded on North Chandeleur Island indicated similar trends, with crawls observed between early May and mid-August, and hatchling emergence identified between late June and mid-September. Females can lay up to seven clutches per year, with each clutch containing up to 136 eggs (NPS 2024).

4.2.4.3. Presence in the Action Area

The beaches of the Chandeleur Islands have historically been utilized by various species of sea turtles as nesting habitat for egg laying while the expansive mSAV beds on the west side are valuable sea turtle foraging grounds. The green sea turtle is one of the species of sea turtles that is known to nest on North Chandeleur Island, and green sea turtle crawls were observed during Project-specific surveys in 2023 and 2024 (see Table 4-2). In addition to known nesting, they are likely to be occasionally present within the mSAV beds and open waters in and around North Chandeleur and New Harbor Islands. Nesting is not believed to occur on New Harbor Island.

Table 4-2. Sea Turtle Crawls Identified on North Chandeleur Island (2022-2024)

Survey Year	Sea Turtle Crawl Inventory				
	Green	Kemp's Ridley	Loggerhead	Unknown Species	Total
2022	0	22	20	12	54
2023	1	30	22	1	54
2024	2	8	17	1	28
Total	**3**	**60**	**59**	**14**	**136**

4.2.4.4. Critical Habitat

On July 19, 2023, NMFS proposed to designate critical habitat for six DPSs for the green sea turtle; habitat for the North Atlantic DPS occurs within the Gulf (88 FR 46572). Although the USFWS also proposed to designate critical habitat for the North Atlantic DPS (88 FR 46376), the closest proposed areas are along the panhandle of Florida. The areas proposed by NMFS for designation for the North Atlantic DPS are based on reproductive, migratory, foraging, and resting habitat requirements for various green sea turtle life stages, and include:

- Sufficiently dark, unobstructed nearshore waters directly adjacent to nesting beaches, extending from the MHW line to a 66-foot (20-meter) depth, to support reproducing and migratory turtles (as well as benthic foraging and resting).

- Underwater refugia (for example, sandy troughs and hard-bottom substrates) and food resources (including seagrass, invertebrates, and marine algae), from the MHW line to a 66-foot (20-meter) depth to support benthic foraging and resting.
- *Sargassum* habitat, from 33 feet (10 meters) deep to the outer boundary of the Exclusive Economic Zone (EEZ), including the Project vicinity, to support the foraging and resting of post-hatchlings and surface-pelagic juveniles.

Although the Project itself would not be within proposed critical habitat for the green sea turtle, the outer extent of the Restoration ZOI and a portion of the Vessel Transit ZOI would have minor overlap with designated areas (see Figure 4-1).

4.2.5. Hawksbill Sea Turtle

4.2.5.1. Species Status and Description

The hawksbill sea turtle (*Eretmochelys imbricata*) was listed as endangered in 1970 (35 FR 8491). This species is recognized by its tapered, pointed, V-shaped head, which gives it a distinct, hawk-like appearance. Its shell typically features serrated edges, overlapping scutes, and a mottled multi-colored pattern. The hawksbill sea turtle can reach a shell length of 2 to 3 feet and weigh between 100 and 150 pounds as an adult (NMFS 2024b).

Current threats to hawksbill sea turtles include bycatch in fishing gear, targeted harvest of turtles and eggs, loss and degradation of nesting and foraging habitat, vessel strikes, ocean pollution and marine debris, environmental changes, predation of eggs and hatchlings by native and non-native predators, and disease (NMFS 2024b).

4.2.5.2. Life History, Habitat, and Range

The hawksbill sea turtle is a circumtropical species that is found in coral reefs, rocky areas, lagoons, and shallow coastal areas, as well as mangrove-fringed bays and estuaries (NMFS 2024b). In the United States jurisdictional waters, hawksbill sea turtles are primarily recorded near Puerto Rico and the U.S. Virgin Islands; within the Gulf, they are less prevalent but are observed along the coasts of Texas and Southern Florida with some regularity (NMFS and USFWS 1993). Hawksbill sea turtles occur in nearshore waters off the Louisiana coast, although they are relatively rare (LDWF 2009).

Hawksbill sea turtles are omnivorous, primarily consuming seagrasses, sponges, algae, corals, crustaceans, jellyfish, and small fish (NMFS 2024b). Females migrate to nesting beaches every 1 to 5 years, returning to the general areas where they hatched (NMFS 2024b); in Florida, nesting generally occurs between June and August (FFWCC 2024). Hawksbills typically nest at night on small beaches with minimal sand, a rocky approach, and often high up on the beach, under or in vegetation. Hatchlings emerge from their nests after approximately 48 to 91 days and swim to offshore habitats where they rely on *Sargassum* mats for protection and food (FFWCC 2024, Gower and King 2011, NMFS 2024b).

4.2.5.3. Presence in the Action Area

The beaches of the Chandeleur Islands have historically been utilized by various species of sea turtles as nesting habitat for egg laying while the expansive mSAV beds on the west side are valuable sea turtle foraging grounds. Hawksbill sea turtles were not observed during Project-specific surveys conducted between 2022 and 2024 (see Table 4-2) and are not expected to nest on North Chandeleur or New Harbor Islands. They may be occasionally present in the marine and estuarine waters within the Action Area, but their occurrence is believed to be rare.

4.2.5.4. Critical Habitat

The USFWS has designated critical habitat for the hawksbill sea turtle; however, it does not overlap with the Action Area and is restricted to areas near Puerto Rico.

4.2.6. Kemp's Ridley Sea Turtle

4.2.6.1. Species Status and Description

The Kemp's ridley sea turtle (*Lepidochelys kempii*) was listed as endangered in 1970 (35 FR 18319). The Kemp's ridley is the smallest sea turtle species in the world. Its carapace is typically as wide as it is long, with a grayish-green coloration on top and a pale, yellowish bottom shell (plastron). Hatchlings are darkly colored on both sides. The Kemp's ridley has a triangular-shaped head with a slightly hooked beak (NMFS 2024c).

Current threats to Kemp's ridley sea turtles include bycatch in fishing gear, targeted harvest of turtles and eggs, loss and degradation of nesting and foraging habitat, vessel strikes, ocean pollution and marine debris, environmental changes, predation of eggs and hatchlings by native and non-native predators, and disease (NMFS 2024c).

4.2.6.2. Life History, Habitat, and Range

Kemp's ridley sea turtles are found throughout the Gulf and along the U.S. Atlantic coast from Florida to New England. In the Gulf, adults are primarily found in nearshore coastal habitats with muddy or sandy sea bottoms, where their diet consists predominantly of crabs (NMFS 2024c).

Kemp's ridley sea turtles generally engage in arribada nesting (with large groups of females gathering offshore and coming ashore to nest all together) and maintain strong nest site fidelity. Unlike other sea turtle species, Kemp's ridleys nest during daylight hours. Females typically nest every 1 to 3 years, laying an average of 2 to 3 clutches per nesting season, with each clutch containing an average of 100 eggs (NMFS 2024c). Nesting occurs on sandy beaches between April and July, with hatchlings leaving the nesting beach between late-May and August, with a peak in June (NMFS 2024c, Shaver et al. 2016). Crawl data (indicative of nesting activity) recorded on North Chandeleur Island indicated similar trends, with crawls observed between early May and mid-August, and hatchling emergence identified between late June and mid-September. Once hatchlings enter the ocean they travel offshore rapidly with the currents; juveniles utilize floating *Sargassum* algae as areas of refuge and foraging, feeding on small plants and animals for 1 to 2 years during developmental stages.

Nearshore Gulf waters are critical migratory habitat for the species, for travel between foraging grounds and nesting habitat, particularly in nearshore areas an average of 16 miles from the mainland coast, with average water depths of about 65 feet (Shaver et al. 2016). These waters (including waters in the Project area) are important foraging and migratory pathway areas for juvenile and post-nesting Kemp's ridley sea turtles and are identified as "core-use" areas for the species (Coleman et al. 2016). Juveniles that forage in the Mississippi Sound between March and November have been documented using Louisiana waters seasonally during the winter months (Coleman et al. 2016). Satellite telemetry showing foraging sites selected by different turtles over a 13-year tracking period indicates that these areas represent critical foraging habitat, particularly in waters off Louisiana. Furthermore, the wide distribution of foraging sites indicates that a foraging corridor exists for Kemp's ridleys in the Gulf between primary nesting habitat in Texas and Mexico and foraging sites along the northern Gulf (Shaver et al. 2013).

4.2.6.3. Presence in the Action Area

The beaches of the Chandeleur Islands have historically been utilized by various species of sea turtles as nesting habitat for egg laying while the expansive softbottom habitats in the vicinity of the islands provide valuable foraging grounds. The Kemp's ridley sea turtle is one of the species of sea turtles that is known to nest on North Chandeleur Island, and Kemp's ridley crawls were observed during each year (2022, 2023, and 2024) of Project-specific surveys (see Table 4-2, above). In addition to known nesting, they are likely to be occasionally present within the marine and estuarine waters of the Action Area. Nesting is not believed to occur on New Harbor Island.

4.2.6.4. Critical Habitat

Critical habitat has not been designated for the Kemp's ridley sea turtle.

4.2.7. Leatherback Sea Turtle

4.2.7.1. Species Status and Description

The leatherback sea turtle (*Dermochelys coriacea*) was listed as endangered in 1970 (35 FR 8491). The leatherback is the largest species of sea turtle in the world, and unlike other sea turtles, it lacks scales and a hardshell. Instead, its carapace is composed of small, interlocking dermal bones covered by a rubbery, black skin with pinkish-white coloring on the underside. Leatherbacks possess proportionally longer front flippers and paddle-shaped rear flippers, adaptations that enable long-distance foraging migrations (NMFS 2024d).

Current threats to leatherback sea turtles include bycatch in fishing gear, targeted harvest of turtles and eggs, loss and degradation of nesting and foraging habitat, vessel strikes, ocean pollution and marine debris, environmental changes, predation of eggs and hatchlings by native and non-native predators, and disease (NMFS 2024d).

4.2.7.2. Life History, Habitat, and Range

The leatherback has the widest range of all sea turtle species and was once found in all oceans except the Arctic and Antarctic (NMFS 2024d). This species is migratory, and individuals spend most of their lives in the open ocean, foraging at the edges of continents and areas of upwelling and deep-water eddies, but will sometimes forage in coastal waters (NMFS and USFWS 2020). Leatherbacks primarily feed on soft-bodied prey such as jellyfish and salps (NMFS 2024d).

Leatherback sea turtles grow more quickly than other hard-shelled sea turtles, although there is uncertainty regarding the age at which they reach sexual maturity, with estimates ranging from 9 to 20 years. While their life expectancy remains unclear, they are believed to be long-lived, potentially reaching 45 to 50 years or more. Leatherbacks undertake the longest migrations between breeding and foraging grounds of any sea turtle species, with some averaging 3,700 miles each way. Female leatherbacks nest at night on tropical and subtropical beaches, where they dig large body pits and lay their eggs in deep nests (NMFS 2024d). In the U.S. and Caribbean, nesting occurs from March to July, with U.S. nesting restricted to Florida. Females typically return to nest every 2 to 4 years to lay clutches of 20 to100 eggs at 8- to 12-day intervals during the nesting season. The eggs incubate for approximately 2 months before hatchlings emerge and move out to sea where they swim continuously away from land; unlike other sea turtles, leatherback hatchlings are not known to associate with *Sargassum* (NMFS 2024d; NMFS and USFWS 2020; Carr 1987).

4.2.7.3. Presence in the Action Area

The beaches of the Chandeleur Islands have historically been utilized by various species of sea turtles as terrestrial nesting and aquatic foraging habitat. Leatherback sea turtles were not observed during Project-specific surveys conducted between 2022 and 2024 (see Table 4-2) and are not expected to nest on North Chandeleur Island or New Harbor Island. Although they could occasionally be present in the marine and estuarine waters within the Action Area, their preference for deepwater habitats further from shore indicate a low likelihood of occurrence.

4.2.7.4. Critical Habitat

The Project is not located within designated critical habitat for the leatherback sea turtle.

4.2.8. Loggerhead Sea Turtle

4.2.8.1. Species Status and Description

The loggerhead sea turtle (*Caretta caretta*) was listed as threatened throughout its range in 1978, and the Northwest Atlantic DPS was officially determined threatened in 2011 (43 FR 32800, 76 FR 58868). Loggerhead sea turtles have a slightly heart-shaped, reddish-brown carapace with a pale-yellow plastron, dull brown to reddish-brown flippers, and distinctive, large heads with powerful jaws. Hatchlings are dark brown, with white- to gray flipper margins and a yellowish or tan plastron (NMFS 2024e).

Current threats to loggerhead sea turtles include bycatch in fishing gear, targeted harvest of turtles and eggs, loss and degradation of nesting and foraging habitat, vessel strikes, ocean pollution and marine debris, environmental changes, predation of eggs and hatchlings by native and non-native predators, and disease (NMFS 2024e).

4.2.8.2. Life History, Habitat, and Range

Loggerhead sea turtles are found worldwide in subtropical and temperate waters of the Atlantic, Pacific, and Indian Oceans and generally occur in waters over the continental shelf but regularly enter marshes and estuaries (NMFS 2024e). Loggerhead sea turtles are primarily carnivorous. Hatchling and juvenile sea turtles rely on *Sargassum* mats for protection and food. Oceanic loggerhead sea turtles consume floating prey while older juveniles and adults in shallow coastal waters prey on benthic invertebrates including mollusks and crabs (NMFS 2024e, USFWS 2024d).

Adults migrate between foraging grounds and nesting beaches every 2 to 3 years, returning to beaches near their hatching location. Females typically nest alone and primarily at night on high-energy, coarse grained sandy beaches with steep slopes (NMFS 2024e). Individual loggerheads may nest between 1 and 7 times per season (USFWS 2024d). Hatchlings emerge from their nests and swim to offshore habitats. Hatchlings and juveniles live in open ocean habitat for 7 to 15 years before migrating to nearshore coastal areas where they mature and forage as adults (NMFS 2024e).

The North Atlantic DPS of loggerhead sea turtles nest along the eastern beaches of Florida, North and South Carolina, and Georgia, and in the Gulf on the beaches of Alabama (USFWS 2024d). The species has also been documented as nesting in the Action Area. The nesting season for loggerhead sea turtles in the U.S. is from April through September, and peaks in June and July (USFWS 2024d). Crawl data (indicative of nesting activity) recorded on North Chandeleur Island during 2022, 2023, and 2024 indicated similar trends, with crawls observed between early May and mid-August, and hatchling emergence identified between late June and mid-September. Clutch sizes are about 100 eggs; in the Atlantic population, individual nests have been documented to contain between 43-198 eggs (NMFS 2024e, Dodd 1988).

4.2.8.3. Presence in the Action Area

The beaches of the Chandeleur Islands have historically been utilized by various species of sea turtles as terrestrial nesting and aquatic foraging habitat. The loggerhead sea turtle is one of the species of sea turtles that is known to nest on North Chandeleur Island, and loggerhead crawls were observed annually during Project-specific surveys (see Table 4-2). In addition to known nesting, they are likely to be occasionally present within the marine and estuarine waters of the Action Area. Nesting is not believed to occur on New Harbor Island.

4.2.8.4. Critical Habitat

In July 2014, NMFS published the final rule designating critical habitat for loggerhead sea turtles (see Figure 4-1). The marine habitats include six different habitat types, including foraging habitat, winter habitat, nearshore reproductive habitat, breeding habitat, constricted migratory habitat, and *Sargassum* habitat. The nearshore reproductive and *Sargassum* habitat types are within the Action Area but restricted to the Vessel Traffic ZOI.

4.3. National Marine Fisheries Service Jurisdiction

A total of nine federally listed species under the jurisdiction of the NMFS potentially occur within the Action Area and could be affected by the Project; six of these species (five sea turtles and the Gulf sturgeon) are under the joint jurisdiction of the USFWS and NMFS. The five species of sea turtles are discussed in Section 4.2 based on the presence of nesting beaches in the Project area; however, because the Gulf sturgeon would only overlap in range with Project activities in its NMFS-jurisdictional estuarine and marine habitats, impacts are not considered further in habitats falling under USFWS jurisdiction.

4.3.1. Giant Manta Ray

4.3.1.1. Species Status and Description

The giant manta ray (*Mobula birostris*) was effectively listed as threatened under the ESA in 2018 (83 FR 2916). Giant manta rays are characterized by their large diamond-shaped bodies, long wing-like pectoral fins, ventral gill slits, laterally-placed eyes, and wide, terminal mouths. Giant manta rays are the largest type of ray, with a wingspan that can reach 29 feet. Giant manta rays exhibit two color types: chevron (black dorsal surface with a white bellow) and black (almost entirely black). Each manta ray has distinctive spot patterns on its belly that can be used for individual identification (NMFS 2024f).

The global population size of this species is unknown, and population estimates in the Gulf are limited and uncertain. While exact numbers in the northern Gulf remain unknown, the giant manta ray has been impacted by fishing pressures from commercial fishing, vessel strikes, entanglement, and recreational fishing interactions. The most significant of these being commercial fishing, as giant manta rays are caught as both bycatch and targeted for harvest for international trade (NMFS 2024f).

4.3.1.2. Life History, Habitat, and Range

This species inhabits tropical, subtropical, and temperate waters and can be found in productive coastal areas, estuarine waters, oceanic inlets, intercoastal waterways, and bays. Giant manta rays exhibit flexibility in their use of habitat depths, aggregating in shallow waters less than approximately 32.8 feet deep during feeding. However, they are also capable of diving to depths of between 656.2 to 1,476.4 feet (NMFS 2024f). Their migratory movements correspond with current circulation, seasonal upwelling, water temperatures, and location of food source (NMFS 2024f).

The primary diet of the giant manta ray consists of planktonic organisms or zooplankton. Giant manta rays have among the lowest reproductive rates of all elasmobranchs, typically giving birth to one pup every 2 to 3 years after a gestation period of about one year. While they can live up to 45 years of age, little is known about their growth, development, or specific nursery areas. These nursery areas are identified by certain characteristics, such as consistent use over time, with giant manta rays returning to or staying in these areas for extended periods of time, often across multiple years. More research is needed to better understand the species' life history and the habitats crucial to their survival (NMFS 2024f, Miller and Klimovich 2017).

Using this definition of a nursery area, the Flower Garden Banks National Marine Sanctuary (FGBNMS), located more than 300 miles southwest of the Project area, is the only area identified as potentially important habitat for juvenile manta rays in the Gulf (Stewart et al. 2018, Setyawan et al. 2022). Though rarely found across the globe, juvenile manta rays commonly occur at FGBNMS for days or months at a time and the same individuals have been identified at the sanctuary across years. The location of the FGBNMS provides easy access to abundant food resources in the deep, pelagic waters of the Gulf while the sanctuary offers an area of relatively shallow but protected warmer water that would allow manta rays a place to recover body temperature after deep foraging dives into colder waters (Stewart et al. 2018).

4.3.1.3. Presence in the Action Area

Giant manta rays utilize water depths ranging from shallow nearshore waters to deep pelagic waters. Juvenile manta rays are abundant at FGBNMS, which is far removed from the Action Area. Because giant manta rays are a migratory species and occur throughout the Gulf, they have the potential to be present in the waters off the Chandeleur Islands chain and elsewhere within the Action Area.

4.3.1.4. Critical Habitat

No critical habitat has been designated for the giant manta ray (84 FR 66652).

4.3.2. Gulf Sturgeon

4.3.2.1. Species Status and Description

The Gulf sturgeon (*Acipenser oxyrinchus desotoi*) was listed as threatened under the ESA in 1991 (56 FR 49653). This species is described as a large, cylindrical, primitive fish, with bony plates or scutes embedded along its body. The Gulf sturgeon's snout is extended and bladelike and has four fleshy barbels in front of its mouth. Adult Gulf sturgeons range from 4 to 8 feet in length, with adult females growing larger than the males. The Gulf sturgeon is brown to dark brown in color and pale underneath (USFWS and GSMFC 1995). Although this species is under shared jurisdiction with the USFWS and NMFS, no riverine habitat is within the Action Area and any potential overlap of the species and Project activities would occur in NMFS' jurisdictional waters.

During the 20th century, this species faced significant threats from overfishing and habitat loss due to the construction of water control structures, such as dams and sills, which impeded access to historic migration routes and spawning areas. Additional threats to the Gulf sturgeon include modifications to habitat associated with dredge material disposal, de-snagging (removal of trees and their roots), and poor water quality associated with contamination by pesticides, heavy metals, and industrial contaminates (USFWS 2009).

4.3.2.2. Life History, Habitat, and Range

This species inhabits coastal rivers from Louisiana to Florida during the warmer months and overwinters in estuaries, bays, and Gulf waters (USFWS 2009). Historically, this species was found from the Mississippi River east of Tampa Bay; however, its current range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi east to the Suwannee River in Florida (USFWS 2009). This species has also been sporadically recorded as far west as the Rio Grande River between Texas and Mexico, and as far east and south as Florida Bay (USFWS 2009). While the species is known to use the barrier islands, recent unpublished data also indicated that the north side of North Chandeleur Island is also being actively used by the species as a wintering ground.

Seven rivers are known to support reproducing populations of the Gulf sturgeon including the Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, Apalachicola, and Suwannee Rivers (USFWS 2022). The Gulf sturgeon can be found in the vicinity of the Mississippi Sound barrier islands, utilizing habitats with sand substrate and an average depth of 6.2 to 19.4 feet.

The Gulf sturgeon is an anadromous fish, meaning that it migrates up rivers from marine and estuarine waters to breed in freshwater (USFWS 2009). After spawning, the Gulf sturgeon remains in freshwater habitats for approximately 10 to 12 months, feeding on aquatic invertebrates. The Gulf sturgeon juvenile stage occurs from 1 to 6 years of age, when it is found foraging at the mouths of rivers within estuary habitats. Subadult and adult Gulf sturgeon forage in marine and estuarine habitats, and are considered opportunistic feeders, primarily on benthic invertebrates. This species reaches sexual maturity between 10 and 28 years of age and may live up to 60 years old.

4.3.2.3. Presence in the Action Area

North Chandeleur and New Harbor Islands provide habitat to the threatened Gulf sturgeon; adult Gulf sturgeon from the Pearl River, Pascagoula River, and Mobile River breeding stocks winter at the Chandeleur Islands (CPRA 2024). Gulf sturgeons were detected on an array of acoustic monitoring equipment near the Chandeleur Island chain deployed by Dr. Michael Dance from the Louisiana State University (LSU) Department of Oceanography and Coastal Sciences. At least 14 Gulf sturgeon were observed from December 2021 through March 2023; roughly half of the individuals observed were tagged in the Pearl River in Louisiana and the rest in the Pascagoula River in Mississippi (Constant 2023).

4.3.2.4. Critical Habitat

Critical habitat for the species was designated in 2003 (63 FR 13370). Riverine critical habitat units for the Gulf sturgeon in Louisiana include the Pearl River system in St. Tammany and Washington Parishes and the Bogue Chitto River in St. Tammany Parish. Estuarine and marine critical habitat units for the Gulf sturgeon include Lake Borgne and up to one nautical mile offshore of the barrier islands of the Mississippi Sound (IEI 2003). However, critical habitat is limited to the Vessel Transit ZOI and does not include the North Chandeleur or New Harbor Islands. Critical habitat for the Gulf sturgeon is located approximately 9.6 nautical miles north of the northernmost point of North Chandeleur Island and within the Vessel Transit ZOI (NMFS 2023a; see Figure 4-1).

4.3.3. Rice's Whale

4.3.3.1. Species Status and Description

Rice's whale (*Balaenoptera ricei*) was listed as endangered under the ESA in 2019 (84 FR 15446; April 15, 2019) under its previous taxonomic classification as a Gulf subspecies of Bryde's whale; the current taxonomic classification and nomenclature were officially revised in 2021 (86 FR 47022). In congruence with their depleted status under Title II of the MMPA, NMFS estimates the abundance of this species is likely less than 100 individuals per the 2017-2018 surveys of the northeastern Gulf (NMFS 2024g). During marine mammal vessel surveys conducted by NMFS in the Gulf in 2023 and 2024, additional sighting data of the Rice's whale was collected; however, this data has not yet been used to update population estimates for the species (NMFS 2023b, 2024g).

Similar to the Bryde's whale, the Rice's whale is smaller than the sei whale, and displays three distinct ridges in front of its blowhole. Its body is uniformly dark gray and sleek, with slender, pointed pectoral fins and a pale to pinkish belly. The dorsal fin, positioned about two thirds of the way along its body, is notably pointed and sharply hooked (NMFS 2024g).

The Rice's whale is vulnerable to a variety of threats due to their depleted stock and the limited amount of data available on the species. The most significant current threats to this species include oil spills and spill response, vessel strikes, energy exploration and development, ocean noise, ocean debris, aquaculture, entanglement in fishing gear, and limited genetic diversity.

4.3.3.2. Life History, Habitat, and Range

Rice's whales, unlike most baleen whale species, do not migrate long distances and are the only species of the baleen whale family that resides in the Gulf year-round (NMFS 2023b, 2024g). This species is consistently found along the continental shelf in the northeastern Gulf, in water depths ranging from approximately 328 to 1,312 feet, an area designated by NMFS as their core distribution zone. This region is characterized by seasonal advection of low salinity and high planktonic productivity, which leads to persistent upwelling driven by both winds and interactions with the loop current. However, Rice's whales have been observed or detected throughout deeper waters of the Gulf in all seasons, including a confirmed siting off the coast of Texas in 2017, at a depth of approximately 738 feet (Rosel et al. 2021); two observed individuals in depths of 735 feet in April 2024, offshore of Corpus Christi Texas (NMFS 2024h); acoustic detection of individuals between station depths of 853 and 892 feet at various locations between the Texas/Louisiana border and the panhandle of Florida, year-round between 2016 and 2017 (Soldevilla et al. 2022); regular acoustic detection throughout the year in locations offshore of Corpus Christi, Texas (depths of 823 feet) and the Texas/Louisiana border (591 feet) between 2019 and 2020 (Soldevilla et al. 2024); and acoustic detections at deepwater monitoring sites (3,717 to 4,085 feet, but within range of the 1,312-foot isobath) along the Mexican continental slope between 2020 and 2022 (Soldevilla et al. 2024).

Baleen whales are filter feeders, engulfing large amounts of water to catch prey. Limited data is available on the diet of this species although studies suggest that Rice's whales selectively forage on high-energy schooling fish, including the silverrag driftfish (*Ariomma bondi*), at or near the seafloor during the day.

Similarly, limited data is available on communication specific to the Rice's whale. Baleen whales typically produce a variety of low-frequency tonal and broadband calls within the 20 Hz to 30 kilohertz (kHz) range for communication purposes; it is presumed that their best hearing ability also falls within the same frequency range. Vocalizations and hearing are likely critically important for the Rice's whales to perform essential life functions such as locating prey, maintaining group structure and relationships, avoiding predators, and navigation (NMFS 2024g, Rosel et al. 2016).

4.3.3.3. Presence in the Action Area

Rice's whale could potentially occur in the Vessel Traffic ZOI adjacent to the Mississippi River Delta, where designated fairways overlap with critical habitat for the species. As discussed above, acoustic surveys conducted between 2016 and 2017 recorded multiple calls of Rice's whales in the western Gulf, suggesting persistent occurrence of the species over a broader range than the previously identified northeastern Gulf shelf (Soldevilla et al. 2022). The closest acoustic monitoring site (approximately 61.4 nautical miles southeast of North Chandeleur Island), did not record any calls from Rice's whales over the deployed period of 62 days (Soldevilla et al. 2022). However, the lack of acoustic recordings at this site could be a result of signal masking by noise within the surrounding environment or minimal/lack of calling by present individuals and does not necessarily mean that the whales were not present in the surrounding waters.

4.3.3.4. Critical Habitat

Critical habitat for the Rice's whale is proposed to include all waters between the 100- and 400-meter isobaths (328-foot to 1,312-foot depths) within the Gulf (88 FR 47453). North Chandeleur and New Harbor Islands are not located within the area proposed as critical habitat for the species; only the potential vessel transit routes would pass through areas of proposed critical habitat (see Figure 4-1).

5. EXISTING CONDITIONS

This section presents an overview of the environmental setting in the Action Area. Maps of the Restoration and Marine Access Route Action Areas are included as Figure 3-1.

5.1. Restoration Action Area

The Chandeleur Islands can be categorized into two subsets, the northern island chain and the southern island chain. The two subsets resulted from a breach in Chandeleur Island that formed as a result of Hurricane Katrina in 2005 now called the Katrina Cut. The northern island chain includes North Chandeleur Island, New Harbor Island, which fall within the Restoration Action Area and are proposed for restoration action associated with the Project. The Project area also includes several Project features including the HPBA, which is a submerged shoal located within one mile on the north end of the North Chandeleur Island that would be used as a sand resource for the restoration Project. Three offshore pump-out areas and associated offshore conveyance corridors that provide locations for direct pump-out of sediments from a hopper dredge or barges via sediment pipeline corridors for sediment transport to North Chandeleur and New Harbor Islands are located within the Project area. Additionally, temporary access channels would be dredged to provide construction access to the north end, central area, and south end of North Chandeleur Island and around the perimeter of New Harbor Island.

5.1.1. Geology

The Chandeleur Islands are the oldest barrier island system in the Mississippi River Delta plain that is still emergent. Barrier islands are characterized by their typically low landform and narrow width that are elongated in the alongshore direction (Miner et al. 2021). As barrier islands, the Chandeleur Islands chain is in a constant state of change due to natural processes. However, geologic processes no longer contribute to new sediment for island growth and instead the islands have experienced accelerating land loss during the last decade, resulting in an average of 31 feet of shoreline change per year, which is three times the Louisiana state average (Flocks et al. 2022). These changes are influenced by severe storm events (i.e., Hurricane Camille and Hurricane Katrina), which can be exacerbated by sea-level rise and scarcity of sediments that could be used to nourish the island chain, resulting in increased erosion and the inability to maintain many island subaerial features (Suir et al. 2016; Suir and Sasser 2019). Hurricane Katrina segmented the island arc into multiple small marsh islets separated by wide hurricane-cut tidal passes, resulting in much less vegetation (mangroves) and elevation (dunes) on the islands that impede overwash processes (Miner et al. 2021; Flocks et al. 2022).

5.1.2. Soils and Sediments

In 2023, borings were performed at different sites within the Project area. These borings revealed that the east side of Chandeleur Island consists of loose to firm sandy soils with some silt and clays extending from 14 to 33 feet below the surface. The shallow water areas contain sandy soil with silt and clay extending from 14 to 58 feet below the surface of the water bottom. Borings performed in the Chandeleur Sound contain mostly loose to dense sand with silt and clays. Additionally, borings performed near New Harbor Island showed 2 to 8 feet of loose sandy silt overlaying very soft to soft clay with some silt and sand (GeoEngineers 2024).

Results from a high resolution geophysical and survey (Ocean Surveys, Inc. [OSI] Report No. 23ES011) performed in the Project area found that the shallow subsurface of the pump-out area is characterized by unconsolidated sediments composed primarily of varying assemblages of silt and clay with a slight buildup of sand nearshore and in the vicinity of a shoal encroaching into the conveyance corridor near New Harbor Island. The HPBA has a 93% sand content that is greater than the #200 sieve and has a median grain size of 0.13 millimeter. Other sediments in this area include silt and organic rich and gaseous clay (Flocks et al. 2022; OSI 2024).

5.1.3. Terrestrial Wildlife and Habitat

5.1.3.1. North Chandeleur Island

North Chandeleur Island is approximately 14 miles in length with an average width of 0.5 mile. Its topography varies from north to south with the northern expanses being bare sandy beaches at or near intertidal elevations. As the island progresses to the south, the beaches become narrower with broken vegetated dunes and overwash locations. From the Gulf-facing beach extending westward, the island is characterized by sparsely vegetated sand mounds and dunes, with more dense cover and species typically associated with barrier island coastal dune grasslands and shrub thickets as the island progresses westward and elevation increases (LDWF-LNHP 2009). These upland habitats extend into salt flats, and smooth cordgrass and black mangrove dominate the back marshes at the westernmost extent of the island. Coastal dune grasslands and coastal mangrove-marsh shrublands are classified as critically imperiled and imperiled natural communities in Louisiana, respectively (LDWF 2019).

In November of 2023, soil and vegetation characteristics along select survey transects were documented to characterize wildlife habitat on North Chandeleur Island (CEC et al. 2024). Vegetation observed on the sparsely vegetated beach faces and extending west into the dunes and salt flats behind the dune line include shoreline purslane (*Sesuvium portulacastrum*), black bog-rush (*Schoenus nigricans*), groundsel bush (*Baccharis halimifolia*), beach morning glory (*Ipomoea pes-caprae*), saltmeadow cordgrass (*Sporobolus pumilus*, previously *Spartina patens*), saltgrass (*Distichlis spicata*), bitter panicgrass, seaside goldenrod (*Solidago sempervirens*), and largeleaf pennywort (*Hydrocotyle bonariensis*). Stands of Roseau cane (*Phragmites australis*), a non-native species that has become established in Louisiana, are also present on the island. Smooth cordgrass and black mangrove dominate the back marshes of the island; groundsel bush is also present. Marsh and mangrove habitat are also discussed in Section 5.1.4, along with mSAV beds and open water habitats.

5.1.3.2. New Harbor Island

New Harbor Island is exposed to Katrina Cut, a breach in Chandeleur Island formed as a result of Hurricane Katrina in 2005, which created North and South Chandeleur Islands. Due to this, New Harbor Island is exposed to winds and wave action that increase its vulnerability to land and habitat loss from erosion and inundation. Mangroves are the dominant species on the island with few herbaceous salt marsh species intermixed. New Harbor Island is currently a mangrove stand of approximately 35 acres; no uplands are present.

5.1.3.3. Wildlife Species

Breton NWR was established to provide a refuge and breeding ground for migratory birds and other wildlife. Birds dominate the terrestrial wildlife community on the refuge, which provides important habitat for wading, marsh, and shorebirds, including supporting large colonies of nesting waterbirds (USFWS 2008b). Barrier islands in Louisiana provide isolated nesting sites protected from predators (such as terrestrial mammals) and are therefore important for successful reproduction for many avian species (Remsen et al. 2019). The Chandeleur Islands are designated as a Globally Significant Important Bird Area given their historic significance as a breeding area for colonial waterbirds, as well as an important wintering area for Redheads (*Aythya americana*) and other species using the Mississippi Flyway (National Audubon Society 2024). Predominant nesting species include the Brown Pelican (*Pelecanus occidentalis*), Black Skimmer (*Rynchops niger*), Laughing Gull (*Leucophaeus atricilla*), and Royal and Sandwich Terns (*Thalasseus maximus* and *Thalasseus sandvicensis*, respectively) (CEC et al. 2024). Overall, the colonial waterbird nests in the Chandeleur Islands are estimated to represent more than 20 percent of nests in Louisiana (CEC et al. 2024).

5.1.4. Wetlands, Marine Submerged Aquatic Vegetation, and Marine Waters

Emergent marshes, including tidal wetlands and salt marshes, within the Project area consists of *Spartina* marshes along North Chandeleur Island and salt marshes intermixed with mangrove habitat within New Harbor Island, as described above. Mangroves are also present along the west side of North Chandeleur Island (see Figure 5-1).

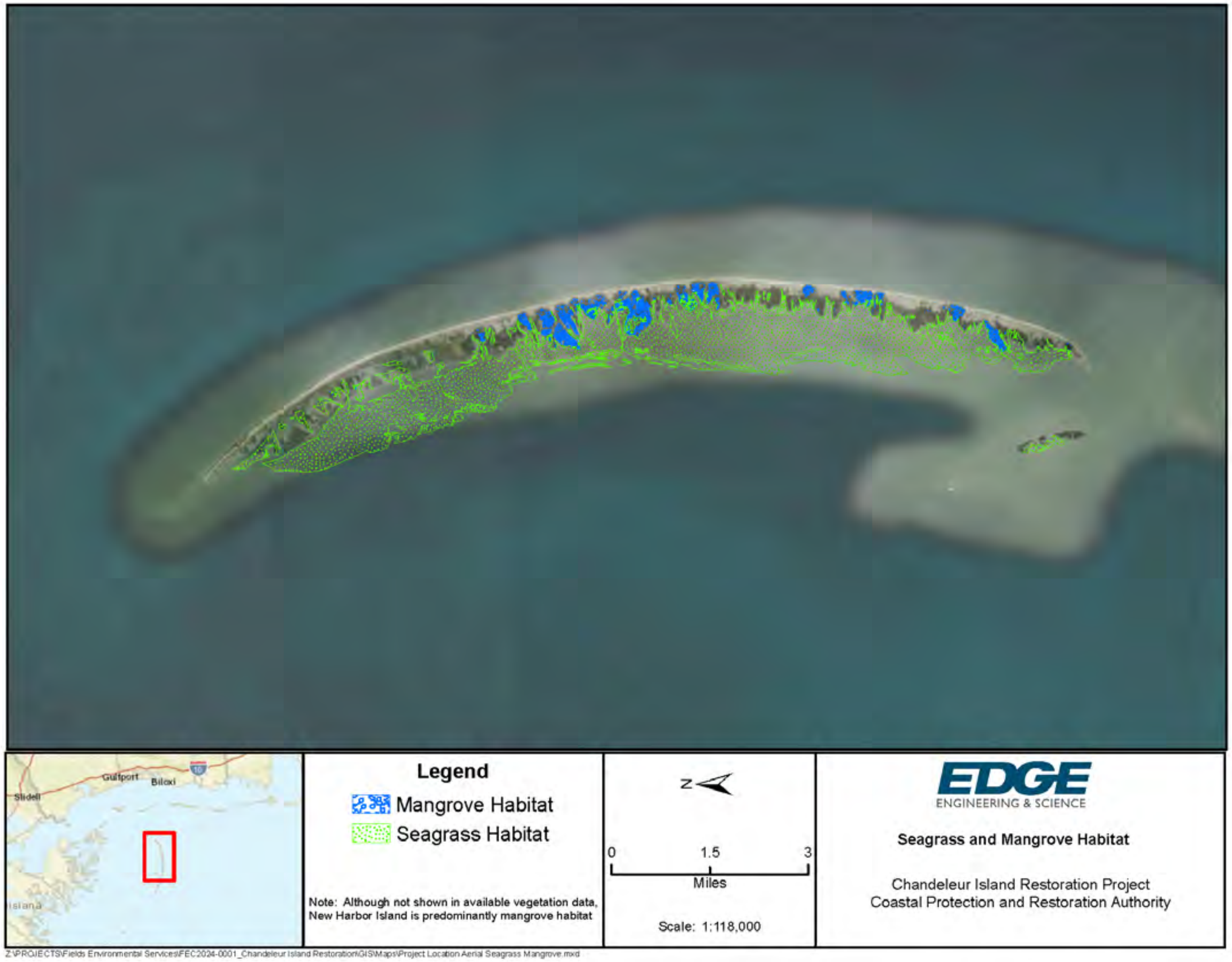


Figure 5-1. Seagrass and Mangrove Habitat

Marine seagrass beds are a highly productive and ecologically important habitat for a variety of invertebrates, fish, reptiles, and mammals, serving as foraging and nursery habitat. Within Louisiana, mSAV are limited to the leeward side of the Chandeleur Islands where the clear, high-salinity, low-nutrient waters are suitable for their growth (Poirrier 2007). As summarized in Project-specific mSAV surveys (SWCA 2023, Appendix D), decades of studies have reported varying coverage of mSAV along the Chandeleur Islands; however, the species composition has remained fairly consistent and includes turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*) (Poirrier and Handley 2007, Kenworthy et al. 2017). Areas that are sheltered from storm damage are dominated by dense turtle grass meadows (Franze 2002; Poirrier and Handley 2007). Areas subject to higher levels of damaging forces have some turtle grass, but mainly manatee grass and shoal grass. Star grass was also found to be present in disturbed areas but was quite rare (Handley et al. 2007). Furthermore, a comparison of aerial mapping efforts at the Chandeleur Islands from 1992 to 2005 documented rapid rates of land loss and declining mSAV coverage along the islands, supporting the causation between land loss and declining mSAV coverage (Pham et al. 2014).

Project-specific mSAV surveys (SWCA 2023, Appendix D) conducted along the bay-side of North Chandeleur Island in 2022 identified a higher coverage of shoal grass in the northern and southern portions of North Chandeleur Island, as well as isolated patches of widgeon grasses in the southern areas; turtle grass was not dominant in these zones and manatee grass was limited to one identified location. Only one location supporting seagrass was identified at New Harbor Island, which included a relatively low coverage of shoal grass.

Outside of the islands and mSAV beds, the Project area is characterized by open water, with measured salinities during Project-specific mSAV surveys ranging from 21.8 to 35.9 parts per thousand. The open waters of North Chandeleur Island include both estuarine habitat within the Chandeleur Sound and marine habitat along the Gulf-facing side of the island. The bay-side of the island contains the mSAV beds and relatively calm waters when compared to the Gulf-facing side, which is subject to more wave action and higher salinities. Water depths vary within the Project area; open water areas are mostly shallow as the waterbottom approaches islands and shoals, and become deeper with distance either into the Gulf or toward the mainland. Depths within the nearshore conveyance corridor gradually increase from the shoreline to approximately 40 feet at the offshore extent in the pump-out area. In the segment of the offshore conveyance corridor leading from North Chandeleur Island to New Harbor Island, depths range from about 15 feet at the eastern end to about 3 feet along the New Harbor Island shoreline (OSI 2024). Significant wave heights in the Project area have a peak of 1.5 feet on average, with less frequent waves higher than 3.3 feet occurring approximately 4% of the year and waves higher than 6.6 feet occurring approximately 1% of the year (Miner et al. 2021).

5.1.5. Land Use and Recreation

The Chandeleur Islands are uninhabited and only accessible by water or air. North Chandeleur Island is dominated by sandy beaches, submerged vegetation areas, and open water. There are no buildings or development directly on the island and no roadway or recreational trail system exists within the Project area. However, a variety of recreational activities occur on and around the Breton NWR, including sport fishing, charter vessels and planes that provide access to the area, and offshore lodging cabins moored around North Chandeleur Island.

5.1.6. Air and Noise

The National Ambient Air Quality Standards are established by the United States Environmental Protection Agency (USEPA) for six criteria pollutants that are common and considered harmful, to protect ambient air quality. St. Bernard Parish, Louisiana is designated as nonattainment for sulfur dioxide and in attainment for all other criteria pollutants (USEPA 2024). However, the parish is classified as a Clean Air Act Section 185A maintenance area for the 1979 1-hour ozone standard, which was revoked. Further, Breton NWR is designated as a Class I Wilderness Area as noted in 40 CFR § 81.412 and is therefore subject to the most stringent air quality and visibility protections under the Clean Air Act. Given its isolated, offshore location, industrial development with the potential to impact air quality due to stationary emissions sources is not present in the immediate vicinity. Similarly, given the undeveloped nature of the Project area, anthropogenic sources of noise are generally limited to noise generated by transient sources operating off-site, such as passing boating vessels or aircraft (including seaplanes).

5.2. Marine Access Routes

Vessels, including sea-borne equipment, supporting vessels, and crew, are expected to travel to the Project area along existing, established waterways. As such, marine access routes proposed for the Project are in open water of the Gulf and up the Mississippi River along existing vessel transit routes to ports in Venice, Louisiana, and/or Gulfport and Biloxi, Mississippi.

6. EFFECTS OF THE ACTION

This section describes the potential beneficial and adverse, direct and indirect impacts of the proposed action on listed species and their habitat within the Action Area. Potential impacts on individual species are addressed in Section 6.2, below. Specific construction methodologies include dredging via hydraulic cutterhead dredge with booster pumps, hopper dredge, or cutterhead dredge-scow barge operation; fill activities; and limited (timber) pile-driving. Following construction, no further disturbance is proposed, and the Project is designed to restore and protect habitat on North Chandeleur and New Harbor Islands. The Restoration Plan/Environmental Assessment for this Project provides additional detail on the alternatives evaluated and restoration design for the proposed Project; however, this BA focuses on the impacts of the Preferred Alternative, which would have the greatest range of both adverse and beneficial impacts.

6.1. General Effects of the Action

6.1.1. Land-Based Construction Activities

Land-based construction activities would include the operation of earth moving equipment (bulldozers, marshbuggy excavators, tracked excavators, and articulated loaders) to support the placement of sand for beach and dune nourishment and placement of the feeder beach, as well as the placement of marsh fill. Land-based activities would result in temporary habitat disturbance and loss, as well as smothering and mortality of invertebrates present in areas of Project disturbance. Timeframes projected for benthic recruitment and re-establishment following sand and marsh material placement are from 3 months up to 2.5 years (Brooks et al. 2004, Wilber et al. 2008). Land-based activities, such as site preparation, materials staging, and dredged material placement, would temporarily disturb and displace existing vegetation. Vessels and construction equipment used to support restoration activities may result in temporary soil and sediment disturbance, including potential leaks from vehicle fuels and fluids. The placement of fill on North Chandeleur and New Harbor Islands, within and adjacent to mangrove habitat could cause some localized vegetation mortality; however, mangrove habitat would not be lost or converted to open water or uplands as a result of construction. Noise and light from the operation of vessels and equipment could disrupt species present in the vicinity of active construction.

Best management practices, including equipment maintenance and implementation of a Spill Prevention, Response, and Reporting Plan, would be implemented to minimize the potential for spills and leaks of hazardous materials to impact habitats. Construction debris would be disposed of properly, and construction activities will comply with applicable permit conditions, including any requirements for the protection of water quality.

6.1.2. Dredging and Marine Habitat Loss and Alteration

It is anticipated the methods of mining the HPBA and conveying it to North Chandeleur and New Harbor Islands are a hydraulic cutterhead dredge with booster pumps, hopper dredge, or cutterhead dredge-scow barge operation. Cutterhead dredges utilize a rotary excavating bit to loosen the sediment. The loosened slurry is pumped up to a large suction pump in the dredge hull, which also pumps it ashore through a submerged pipeline, often aided by booster pump(s). With hopper dredge operation, the excavated sand would be moved to the vessel's hull and transported to the designated pump-out areas to be hydraulically unloaded. The third method involves use of a conventional cutterhead dredge, which would excavate the sand and transfer it through a spider barge distribution system into scow barges. The scows would be towed to the designated pump-out areas and hydraulically unloaded directly from the scow barges. Sediment pipelines would be placed within the nearshore conveyance corridor adjacent to the Gulf-facing side of North Chandeleur Island, and within the offshore conveyance corridors associated with the offshore pump-out areas; these conveyance corridors and pump-out areas would not require excavation for pipeline installation, as the sediment pipelines would be placed directly on the sea floor. With all three dredging and transport methods, the dredged material would be discharged into the restoration template where it would be graded using conventional earth moving equipment.

In addition to the conveyance corridors, up to four temporary access channels may be dredged. Three access channels (each of which could be up to 150-feet wide, with up to an additional 150 feet on each side for spoil storage) would be dredged to provide construction access to North Chandeleur Island for equipment and personnel (see Figure 2-1 and Appendix A). The fourth temporary access channel (also up to 150-feet wide, but with spoil storage limited to 150 feet on one side) would be dredged along the perimeter of New Harbor Island. The temporary access channels would be utilized for the Project duration and would be backfilled upon Project completion.

Adverse impacts would occur in benthic habitats that are actively dredged, where shoreline protection features are installed, or in which the sediment pipelines are laid directly on the sea floor. Some areas of mSAV habitat would be filled with dredged material to construct elevated marsh habitat; most of the filled mSAV habitat would be of the lower quality seagrass beds around New Harbor Island (see Section 5.1.4). The Project would impact an estimated 159 (3%) acres of mSAV. Surveys to document mSAV in the vicinity of the Project were conducted and are provided in Appendix D. Sediment disturbance and dredging would also increase suspended sediment concentrations, causing a localized decrease in water quality during active restoration (see Section 6.1.4, below). Following restoration, the Project is expected to protect mSAV beds and provide habitat benefits as further described in Section 6.1.7, below.

Mechanical, hopper, and hydraulic/cutterhead dredges may be used to support Project construction. The use of cutterhead dredges would minimize the potential for entrainment of protected species, including sea turtles, as most mobile species are expected to avoid active dredging. Further, in accordance with the measures in the PDARP/PEIS, to minimize the risk to protected species, pumps would be disengaged when the cutterhead is not in the substrate, and operators would avoid pumping water from the bottom of the water column. However, hopper dredges move rapidly and can therefore injure or kill sensitive species due to entrainment within the hopper dredge or impingement on the draghead. Specifically, and as described further in Section 6.2, sea turtles and Gulf sturgeon (particularly juveniles) are susceptible to take from hopper dredging (NMFS 2007). The potential for dredging to injure or kill sensitive species, including sea turtles and Gulf sturgeon, are described further below.

Finally, it is possible for some protected species, including Gulf sturgeon, to become entrapped in coastal waters of construction sites. To avoid the potential for entrapment and associated harm or mortality to this species, the measures in NMFS' Southeast Regional Office Measures for Reducing Entrapment Risk to Protected Species (2012) would be implemented, including instructing personnel regarding the potential for listed species and associated entrapment risk; monitoring during the construction of any structure that may enclose listed species; and conducting a pre-closure clearance survey to determine the absence of listed species.

6.1.3. Artificial Lighting

Artificial lighting may be required to ensure safe construction of the Project, including during any nighttime construction or vessel operations and to mark the sediment pipeline and construction workspaces in accordance with any United States Coast Guard (USCG) requirements. While Project construction is underway, lighting would be limited to the minimum needed to safely implement the Project and is expected to be minimal overall. Artificial lighting may disorient sea turtles and some birds, which may use natural light sources and patterns for migration, and lighting of surface waters could cause marine organisms that typically use the sun or moonlight as a behavioral cue to locally aggregate, attracting predators.

6.1.4. Water Quality

Waterbottom disturbance due to dredging and the placement of fill and other material would result in suspended sediments and increased turbidity. The fine fraction of sediments (including silt and clay) has the greatest potential to become suspended in the water column; however, the material that would be dredged from the borrow areas is predominantly sand, with larger, denser particles unlikely to remain suspended in the water column. As such, water quality impacts from sediment disturbance due to dredging and materials placement would be temporary, minor, and consistent with other, similar disturbance events in the Gulf (such as storms or maintenance or borrow dredging activity). Anchors from vessels and equipment operating in nearshore areas could also result in temporary, minor impacts on total suspended sediments and turbidity. Conditions are expected to return to pre-disturbance levels quickly at any single location.

Accidental spills of hazardous materials could also occur during construction activities, and potentially adversely affect water quality. As described above, BMPs, including equipment maintenance and implementation of measures in a Spill Prevention, Response and Reporting

Plan, would be implemented to minimize the potential for spills and leaks of hazardous materials to impact habitats. These measures would limit the potential for water quality impacts on listed species, including exposure to hazardous materials.

6.1.5. Vessel Strikes

Vessels supporting construction activities may encounter listed species in material transport routes, dredging areas, and in other areas within the restoration template. Access to the Action Area would likely follow federally designated shipping fairways to the extent practicable, particularly in areas closer to the mainland; shipping fairways serve to concentrate and direct vessel traffic. Vessels in transit to the Project area are likely to originate in Venice, Louisiana, and/or Gulfport and Biloxi, Mississippi. Table 6-1 identifies the types and quantities of vessels that are anticipated to travel to the Project site during each phase of construction (mobilization, construction, and demobilization). On average, approximately four vessels (or vessel sets, where barges are accompanied by tugboats) will travel to and from the Project site each day; these vessels may travel from Venice, Louisiana, and/or Gulfport and Biloxi, Mississippi, although the specific allocation of vessels from each port will be dependent on vessel availability at the time of construction.

Table 6-1. Estimated Vessel Traffic during Project Implementation

Vessel	Associated Tugboats	Number of Round-trips during Project Phase		
		Mobilization (approx. 30 days)	Construction (approx. 633 days)	Demobilization (approx. 60 days)
Dredge	2	1	0	1
Deck Barge 1	2	21	42	21
Deck Barge 2	2	21	0	21
Quarter Barge	1	1	0	1
Survey Vessel	0	30	633	60
Crewboat 1	0	30	633	60
Crewboat 2	0	30	633	60
Crane Barge (Rock Placement)	1	1	2	1
Rock Barge 1	1	0	60	0
Rock Barge 2	1	0	60	0
Rock Barge 3	1	0	60	0
Rock Barge 4	1	0	60	0
Crane Barge	1	1	4	1
Fuel Barge	1	0	42	0
Total Round-trips		**136**	**2229**	**226**
Average Daily Round-trips		**4**	**4**	**4**

Vessels operating in these areas would follow NMFS' Southeast Regional Office Vessel Strike Avoidance Measures (2021) and Protected Species Construction Conditions (2021), as well as the USFWS' Standard Manatee Conditions for In-Water Activities (2011) to limit the potential for impacts from vessel strikes on marine mammals and sea turtles.

6.1.6. Underwater Noise

Underwater noise associated with vessel traffic, dredging, and pile-driving would temporarily increase sound levels in the Action Area during Project construction. Noise from vessels and dredging is expected to be consistent with other, ongoing vessel activity in the vicinity. Continuous noise from vessel transits and dredging would contribute to the sound levels near the Project, but noise impacts would be intermittent over the construction period and dependent on the specific construction activity.

The greatest potential for impacts from underwater noise would occur during impact pile-driving to install 30 timber piles for rock breakwater warning signs near New Harbor Island, and potentially for submerged pipeline warning markers or submerged spoil markers along the temporary access channels. Impacts from pile-driving would be temporary and limited to the duration of pile installation. While Project construction is underway, it is likely that it would take no more than a day to drive each individual pile, such that the maximum duration of pile-driving is estimated to be about 30 days. Pile-driving would be limited to daylight hours. It is anticipated that species will naturally move away from any noise disturbances and avoid any significant, prolonged exposure to harmful noise levels. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (2021).

Because sound consists of variations in pressure, the unit for measuring sound is referenced to a unit of pressure, the Pascal (Pa). A decibel (dB) is defined as the ratio between the measured sound pressure level (SPL) in microPascals (μPa) and a reference pressure. In water, the reference level is "dB re 1 μPa," which is decibels relative to 1 microPascal. NMFS has developed guidelines for noise thresholds likely to either cause behavioral effects via disturbance or injury via hearing loss to marine mammals, fish, and sea turtles, as presented in Table 6-2 (NMFS 2024i, 2023d). Noise impacts on marine mammals are based on the species' functional hearing group; sirenians (such as the West Indian manatee) and baleen whales (including Rice's whale) are classified in the low-frequency cetacean hearing group for the purposes of this analysis (NMFS 2024j). Thresholds have been established for impulsive sound sources (those sounds, such as impact pile-driving, that produce a transient, brief, broadband sound with a high peak pressure and rapid decay), as well as continuous sound sources. Because pile-driving for the Project could exceed applicable thresholds for protected species, the potential for impacts from impulsive sound due to pile-driving are presented herein.

NMFS has also developed calculation tools to identify the distances at which those thresholds may be exceeded. Table 6-3 summarizes the applicable thresholds and isopleth distances based on the available multi-species and marine mammal acoustic tools, and Appendix E includes an output of multi-species acoustic tool (NMFS 2024k, l). While the specific details of pile-driving are not known, a conservative scenario based on driving 15, 12-inch-diameter timber piles per day using 360 strikes per pile was used to assess potential impacts. As noted above, pile-driving is likely to extend over a longer period, resulting in fewer strikes per day and a smaller region of influence.

Table 6-2. Thresholds for Injury and Behavioral Disturbance from Impulsive Noise and Pile-Driving Sound Levels

Species / Hearing Group	Permanent Injury Criteria, Peak SPL (dB re 1µPa)	Permanent Injury Criteria, SELcum (dB re 1 µPa^{2}s)	Behavioral Response, RMS SPL (dB re 1µPa)
Marine Mammals			
Low-frequency cetaceans[a]	222	183	160
Sea Turtles	**232**	**204**	**175**
Fish			
Fish (≥ 2 grams)	206	187	150
Fish (< 2 grams)	206	183	150
Pile-Driving Sound Level			
Source sound level, 12-inch timber pile at 10 m (33 feet)	182	157	167

Source: Caltrans 2020, NMFS 2023c, 2024i-l

dB = decibels; dB re 1 µPa = decibels relative to 1 microPascal; dB re 1 µPa2s = decibels relative to 1 microPascal squared normalized to 1 second; NA = not applicable (source level does not exceed threshold); peak = peak sound pressure, RMS = root mean square; SELcum = cumulative sound exposure level; SPL = sound pressure level.

[a] In the Action Area, these include Rice's whale and the West Indian manatee. NMFS 2024k includes sirenian (manatee) audiogram data to derive composite audiogram parameters and threshold of best hearing for low-frequency cetaceans. Therefore, for the purpose of this analysis, manatees were grouped with the low-frequency cetaceans functional hearing group.

Table 6-3. Isopleth Distances to Injury and Behavioral Disturbance from Impulsive Noise, Meters (feet)

Species / Hearing Group	Permanent Injury Criteria, Peak SPL meters (feet)	Permanent Injury Criteria, SELcum meters (feet)	Behavioral Response, RMS SPL meters (feet)
Marine Mammals			
Low-frequency cetaceans[a]	0.0 (0.1)	56.6 (185.7)	29.3 (96.1)
Sea Turtles	0.0 (0.0)	2.3 (7.4)	2.9 (9.6)
Fish			
Fish (≥ 2 grams)	0.3 (0.8)	29.3 (96.1)	135.9 (446.0)
Fish (< 2 grams)	0.3 (0.8)	29.3 (96.1)	135.9 (446.0)

Source: NMFS 2023c, 2024i-l

dB = decibels; dB re 1 µPa = decibels relative to 1 microPascal; dB re 1 µPa2s = decibels relative to 1 microPascal squared normalized to 1 second; NA = not applicable (source level does not exceed threshold); peak = peak sound pressure, RMS = root mean square; SELcum = cumulative sound exposure level; SPL = sound pressure level.

[a] In the Action Area, these include Rice's whale and the West Indian manatee. NMFS 2024k includes sirenian (manatee) audiogram data to derive composite audiogram parameters and threshold of best hearing for low-frequency cetaceans. Therefore, for the purpose of this analysis, manatees were grouped with the low-frequency cetaceans functional hearing group.

6.1.7. Habitat Benefits

By restoring North Chandeleur and New Harbor Islands and providing shoreline protection and sand resources via several design features, the Project is expected to prolong the existence of essential barrier island habitat, supporting nesting birds, foraging migratory birds, nesting sea turtles, and the mSAV beds. Habitat on North Chandeleur and New Harbor Islands is subject to continuous loss due to relative sea-level rise, wind and wave action, and other coastal processes. The Project would result in long-term benefits to both terrestrial and aquatic habitats within the Action Area by increasing the total quantity of available barrier island habitat. In addition, the placement of beach, dune, and marsh fill would increase the elevation of North Chandeleur and New Harbor Islands, reducing the long-term susceptibility of the Project area to habitat loss. Areas of fill would also protect mSAV beds from further loss and erosion. The fill areas were designed to create sustainable beach slopes that meet slope requirements for sea turtle nesting beaches; marsh fill would be placed to create new marsh habitat on an existing, sandy intertidal platform that is sparsely vegetated. Vegetative plantings on North Chandeleur and New Harbor Islands, would prevent erosion and enhance dune and wetland vegetation. Sand fences (porous barriers designed such that windblown sand accumulates on the fences) would increase sand deposition and associated dune elevations, as well as protect vegetated plantings.

Where proposed, the sand reservoirs would provide sediment supplies as North Chandeleur Island changes over time and would increase the area of sandy shoreline habitat. Similarly, the pocket marshes would provide a sediment source for future conditions, while increasing the elevation of existing marsh areas with degraded vegetation and providing foraging habitat for birds. The feeder beach would be used to provide an immediate source of sediment, allowing longshore transport to nourish beach sediment over time and sustain existing sandy beach habitat. Under the proposed action, habitat creation on North Chandeleur and New Harbor Islands would include up to an estimated 1,841 acres of beach and dune habitat and 740 acres of marsh would be created. Of that, the placement of fill on New Harbor Island would create an estimated 145 acres of marsh; New Harbor Island is currently about 35 acres and dominated by mangroves. Shoreline protection features, including shoreline and a detached rock breakwater, would support habitat longevity on New Harbor Island by reducing potential erosion due to currents and wave action.

6.2. Direct, Indirect, and Beneficial Impacts on Species and Critical Habitat

6.2.1. U.S. Fish and Wildlife Service Jurisdiction

One marine mammal, five sea turtle species,[2] and three birds listed as threatened or endangered, as well as one candidate for listing, under USFWS jurisdiction may occur within the Project area

[2] While the green sea turtle was not identified as occurring in the Restoration ZOI via a review of IPaC, the species is known to nest in the Action Area.

and be subject to overlap with Project activities (see Table 4-1). Direct effects are those direct or immediate effects of a project on the species and/or its habitat; indirect effects are those that are caused by or result from the proposed action, are later in time, and are reasonably certain to occur; and beneficial effects are wholly positive.

6.2.1.1. Piping Plover and Rufa Red Knot and Critical Habitat

Because the Piping Plover and Rufa Red Knot are both shorebird species that winter in the Project area and use similar shoreline and intertidal habitat, impacts on both species are assessed concurrently. Activities that disturb roosting and foraging birds, affect critical habitat, or alter species' use of optimal habitat, may affect the ability of birds to rest and store energy for migration and therefore affect the survival and recovery potential of the species. The effects on these species may be direct and indirect during and following construction; once the Project is complete, benefits to habitat quality and availability are expected.

Piping Plover and Rufa Red Knots are highly mobile and would likely avoid areas of active construction activity; as such, the Project is not expected to directly harm individual birds. Measures to ensure that birds are absent within areas to be disturbed by construction may include bird abatement (typically the use of raptors, mylar ribbons/balloons, or other hazing techniques to cause bird avoidance) to reduce the potential for incidental take that results in mortality. Construction of the Project is expected to occur when the birds are present in their overwintering habitat, and the wintering birds may be disturbed by the operation of heavy equipment and machinery or placement of fill material. Typical roosting and foraging activities may be disrupted, and birds may expend additional energy relocating to undisturbed habitat elsewhere in, or outside of, the Project area during restoration activities. Although the vast majority of the Gulf-facing beach habitat would be affected by beach and dune restoration activities, with sand placement and equipment movement occurring throughout the construction period, the beach activities along North Chandeleur Island would occur sequentially, along three segments. The three segments would vary in length, with Segment 1 affecting about 5.7 miles of beach at the northern end of the island, Segment 2 affecting the central 5.1 miles, and Segment 3 affecting about 3.2 miles at the southern end of the island. Because restoration activities along the Gulf-facing beach would be segmented, about 8.3 miles of beach (or more) would always be absent of direct construction activities.

The placement of fill material for beach, dune, and marsh nourishment and establishment of the feeder beach would affect critical habitat for both species in the Restoration ZOI, as depicted in Figure 4-2. Due to the dynamic nature of North Chandeleur and New Harbor Islands, the mapped boundaries of critical habitat do not align with the current location of the islands, as shown in associated figures. However, all terrestrial habitat in the Restoration ZOI is considered to be critical habitat for the Piping Plover or proposed critical habitat for the Rufa Red Knot. Habitat impacts from construction are summarized in Table 6-4. Temporary impacts would include the loss of wrack, disruption or loss of overwash areas due to sediment placement and smothering and mortality of invertebrates that provide forage for shorebirds. Wrack would be restored following normal tidal activity; storm events would continue to affect barrier island structure and would be expected to eventually create and modify overwash areas; and benthic fauna would be recruited and become re-established within areas of disturbance.

Table 6-4. Existing Vegetation and Habitat Impacts from Project Construction[a]

Alternative	Upland Vegetation (Acres)	Intertidal Vegetation (Acres)	Mangrove Vegetation (Acres)	mSAV (Acres)
Existing Vegetation	25	944	197	5,243
Project Impacts	19	315	47	159

[a] The represented acreage is estimated and would be affected in a phased manner, such that undisturbed (or post-restoration) vegetation would always be available elsewhere in the Project area.

Until the disturbed benthic community recovers and new overwash fans are created, a temporary and localized decrease in prey items and roosting habitat may indirectly result in a decrease in the survival of plovers and Rufa Red Knots on wintering grounds in the Action Area due to lack of optimal fat storage and energy conservation on wintering habitat. While sub-optimal wintering conditions could also contribute to decreased survival or breeding productivity once shorebirds migrate away from the Action Area and back to breeding grounds, such effects would be temporary and are expected to be superseded by the habitat benefits described below, particularly when considering that at least 8.3 miles of critical habitat on North Chandeleur Island would always remain free of active construction and would be available for foraging.

Following construction of the Project's restoration features, human disturbance or presence is not expected to change since no development to support recreation is proposed for the Project. The remote location of the Project and limited mainland access restricts regular use of the area by people and therefore limits the potential for an indirect increase in long-term potential for human disturbance due to the Project.

As described in Section 6.1.7, by restoring North Chandeleur and New Harbor Islands, and providing shoreline protection and sand resources via the feeder beach, the Project is expected to prolong the existence of essential barrier island habitat, including critical habitat that provides the physical and biological features essential to Piping Plover and Rufa Red Knot survival. In addition to the active restoration actions, added sand via the feeder beach would allow for natural maintenance and formation of sand flats, mud flats, and intertidal habitats associated with the barrier island system. The restoration and preservation of these habitats is essential for the restoration of protected shorebird population levels. An estimated 1,841 acres of beach and dune habitat and 740 acres of marsh habitat would be created or enhanced for the Project. Table 6-5, below, provides the total acreage of habitat types projected to be present on North Chandeleur and New Harbor Island over a 20-year period based on a modeling analysis, including changes due to coastal processes such as erosion, sea-level change, subsidence, and wash overs. The analysis of habitat longevity is based on habitat elevation, rather than vegetation class; however, in general, supratidal habitats include beach and dune areas, while subtidal and intertidal habitats include sand flats, marsh, and mangroves. Overall, the benefits from the Project to the creation and preservation of barrier island habitat far outweigh any impacts from construction.

Table 6-5. Habitat Sustainability on North Chandeleur and New Harbor Islands

Alternative	Target Year[a]	Subtidal Habitat	Intertidal Habitat	Supratidal Habitat	Dune Habitat	Total Acres in the Project Area
		Acres at Elevation -1.5 feet to 0.0 feet	Acres at Elevation 0.0 feet to 2.0 feet	Acres at Elevation 2.0 feet to 5.0 feet	Acres at Elevation > 5.0 feet	
North Chandeleur Island	TY-0	1,430	1,475	1,805	410	5,120
	TY-5	1,420	1,447	1,539	410	4,816
	TY-10	1,397	1,311	1,929	0	4,637
	TY-15	1,381	1,307	1,739	0	4,427
	TY-20	1,371	1,300	1,565	0	4,235
New Harbor Island	TY-0	6	69	111	0	187
	TY-5	6	180	0	0	186
	TY-10	6	180	0	0	185
	TY-15	5	180	0	0	185
	TY-20	5	179	0	0	184

[a] TY-0 is representative of the expected beach profile and conditions immediately following Project implementation, TY-5 is representative of the expected conditions 5 years after Project implementation, etc.

6.2.1.2. West Indian Manatee

The West Indian manatee, if present in the Action Area during construction, could be disturbed by Project activities. The greatest potential for impacts on the West Indian manatee would be associated with injury or mortality due to vessel strikes, as well as noise from pile-driving. To minimize contact and potential injury to manatees in shallow water areas, the USFWS' Standard Manatee Conditions for In-Water Activities (2011) would be implemented. These measures include provisions for instructing the Project team regarding the potential presence of manatees; measures to stop-work if manatees are in the immediate vicinity of the work radius; and restricting vessel speeds in the Project area, particularly in the event a manatee is observed or while in water where the vessel draft provides less than a four-foot clearance from the bottom. Due to the infrequency of manatee occurrence in the Action Area, and with the documented occurrences limited to lone individuals, and implementation of these conservation measures, the risk of a boat striking a manatee is low.

Marine mammals use sound to communicate, find prey, avoid predators, and for navigation. Underwater noise can disturb or injure marine mammals, including manatees. Manatees would likely avoid areas of active construction but could transit through nearby areas; noise from vessels and dredging is expected to be consistent with other, ongoing activities in the Gulf.

Section 6.1.6 describes the thresholds for behavioral impacts and injury from pile-driving noise on low-frequency cetaceans, including manatees. As presented in Table 6-3, the isopleth distances to injury and behavioral impacts are both estimated to be within about 186 feet of pile-driving noise. The injury threshold is based on a cumulative sound exposure level (i.e., an individual would need to remain within 186 feet of the piles being driven throughout the entire day in order to suffer from cumulative noise injuries). Because, in the unlikely event a manatee is present during active pile-driving, it would likely avoid active construction activity, and given the time needed to set a pile and maneuver pile-driving equipment prior to beginning pile-driving, manatees are expected to be absent within the potential impact area. Although CPRA has committed to stop all work if a manatee were observed within 50 feet of active Project work per the Standard Manatee Conditions for In-Water Activities, CPRA would further instruct personnel to be alert for listed species in the vicinity of pile-driving locations prior to beginning pile-driving and, if a manatee is observed, avoid commencing pile-driving activities until it has left the area of its own accord. Further, Because of the low likelihood of manatee occurrence within the Action Area, the relatively short duration expected for pile-driving, and CPRA's commitment to delaying pile-driving activities if manatees are present in the impact zone, the potential for injury due to pile-driving noise is low.

Manatees are herbivorous, with a diet of aquatic vegetation. Construction of the Project would impact an estimated 159 acres of mSAV, which represents a relatively small proportion of the available mSAV in the Project are (more than 5,200 acres, see Table 6-4). As such, construction of the Project would temporarily reduce the total available area of mSAV to support manatee foraging when present in the Project area. However, given the infrequent occurrence of manatees in the Project area, available forage is expected to be sufficient for any individuals occurring in or migrating through the Restoration ZOI.

Following implementation of the Project, areas of fill are expected to protect mSAV beds from further loss and erosion due to storm and wave activity. As such, the Project is expected to provide a long-term benefit to the total available area and the longevity of mSAV beds, ultimately benefitting manatees that may occur in the Restoration ZOI.

6.2.1.3. Sea Turtles

Five federally listed sea turtles occur in the Gulf and nest on Gulf beaches from Mexico to Florida (see Section 4.2). While NMFS has lead responsibility over sea turtles in the marine environment, USFWS has lead responsibility over sea turtle nesting beaches. Nesting sea turtles on mainland beaches adjacent to the Project area are rare for any of the five species, and are limited to two loggerhead sea turtles nesting on Grand Isle in 2015 and false crawls on Elmer's Island (LDWF 2016); however, nesting has been identified for three species of sea turtles on North Chandeleur Island, including the green, Kemp's ridley, and loggerhead sea turtles. Hawksbill and leatherback sea turtles do not nest in the area; therefore, there would be ***no effect*** on these two species on nesting beaches and further discussion of their potential for impact in the marine environment is discussed in Section 6.2.2.1, below.

Restoration activities would occur on nesting beaches during the nesting and hatchling season; therefore, there could be both adverse effects on sea turtles from nesting beach disturbance and potential take of green, Kemp's ridley, and loggerhead sea turtles (adults and hatchlings) and nests during restoration activities. The vast majority of the Gulf-facing beach habitat would be affected by beach and dune restoration activities, with sand placement and equipment movement occurring throughout the construction period. The beach activities along North Chandeleur Island would occur sequentially, along three segments. The three segments would vary in length, with Segment 1 affecting about 5.7 miles of beach at the northern end of the island, Segment 2 affecting the central 5.1 miles, and Segment 3 affecting about 3.2 miles at the southern end of the island. Because restoration activities along the Gulf-facing beach would be segmented, about 8.3 miles of beach (or more) would always be absent of fill placement construction activities.

Restoration activities on North Chandeleur Island could result in displacement of nesting turtles to non-affected beach segments, harassment (disturbance or interference) of turtles attempting to nest within the construction area, and/or destruction of nests during restoration activities. Incidental take could also be caused by pedestrian and vehicular traffic, as well as natural factors such as predation, wind, rainfall, and tides. Emerging hatchlings could also be affected by construction lighting, particularly if it results in movement towards construction equipment along other portions of the beach; however, the intensity of lighting would be reduced to the minimum standard required for general construction area safety and nighttime lighting is anticipated to be minimal for the Project.

Prior to construction, CPRA plans to conduct daily nest surveys along the island and relocate identified nests that fall within the construction footprint over the subsequent 90 days. These surveys would occur between April 1 and September 1 during each year of construction. Although nest relocation would minimize the potential for mortality during construction, take may still occur from the movement of eggs, and mortality could occur if eggs are mishandled during relocation efforts. In addition, any missed nests during the survey could result in an incidental take during restoration activities. To further minimize potential impacts to sea turtle nests, CPRA would extend daily surveys through November 1 within active construction areas to monitor for potential hatchling emergence from unidentified nests. Nest survey and relocation protocols would be determined in consultation with the USFWS, but relocation is anticipated to occur in undisturbed habitat elsewhere on North Chandeleur Island. Although appropriate measures would be implemented to avoid impacts to nesting turtles, due to the nature of the construction work required for island restoration, there could be unavoidable adverse impacts to a few nesting turtles on North Chandeleur Island. However, the overall benefits from restoring the island (i.e. restoring and sustaining nesting habitat) are far greater than potential adverse impacts to the sea turtles, as the Project would construct about 179 acres of sea turtle nesting habitat (between elevations of +4 and +5.5 feet NAVD88 would be available at TY-0 and maintained for the life of the Project. By comparison, 48 acres of sea turtle nesting habitat are projected to be available at TY-0 if the Project is not implemented with 0 acres remaining by TY-5).

Beach and dune fill would be accomplished utilizing compatible sediments from the HPBA. Because the HPBA consists of sand deposits collected from longshore transport from North Chandeleur Island, they are suitable for restoration purposes and would be similar to the existing character of the beach sand. CPRA would also ensure that the compaction of placed sand is within acceptable compaction levels during and prior to construction demobilization. Typical beach sections would be constructed to a target elevation of +4.5 feet NAVD88 from the toe of the dune with a slope of 1V:200H, extending seaward to an elevation of +3.2 feet NAVD88. The slope would then increase to 1V:50H down to MHW at an elevation of +1.2 feet NAVD88 where the slope would increase again to 1V:30H down to existing grade. These elevations, slopes, and distances were selected because they have been shown to lend themselves best to habitat creation and sustainability and, specifically, the beach slopes were adopted from designs utilized for sea turtle nesting beaches in Florida (CEC 2024). The beach and dune profiles are comparable to those used on the North Breton Island Early Restoration (OGE 2019).

6.2.2. National Marine Fisheries Service Jurisdiction

One marine mammal, five species of sea turtles (Kemp's ridley, green, loggerhead, leatherback, and hawksbill sea turtles), and three species of fish (giant manta ray and Gulf sturgeon) under NMFS jurisdiction may occur within the Project area or marine vessel transit routes (see Table 4-1) and have the potential to be affected by the Project. Additionally, critical habitat for loggerhead sea turtles (*Sargassum* and nearshore reproductive habitat), and proposed critical habitat for the green sea turtle and Rice's whale are also present in either the Restoration or Vessel Transit ZOIs.

6.2.2.1. Sea Turtles

While highly mobile, all five species of sea turtles could be present in the marine environment of the Action Area and therefore could be disturbed by Project activities; however, only the green, Kemp's ridley, and loggerhead are believed to occur with any regularity in the Action Area. Potential impacts on turtles present in the Action Area during restoration may include injury and mortality due to dredging; injury or mortality due to vessel strikes; disturbance due to noise, including from pile-driving; and marine debris.

<u>Dredging and Fill Activities</u>

Cutterhead dredges (like other non-hopper dredges) are not likely to adversely affect turtles, which would likely avoid areas of active construction due to disturbance and noise. The Project is not expected to affect normal behavioral patterns given the ability of sea turtles to avoid immediate areas of disturbance, and due to the short-term nature of construction. Hopper dredges are known to result in the entrainment and impingement of sea turtles and could cause injury or death to individuals present during dredging by entrainment in the suction dragheads; however, hopper dredges would likely not be used across the entire construction schedule.

The proposed action would utilize a combination of cutterhead and/or hopper dredges for borrow and placement activities. The existing Regional Biological Opinion (RBO) on hopper dredging in the Gulf waters has established that non-hopper type dredging methods have discountable effects on, or are not likely to adversely affect, currently listed sea turtles (I/SER/2006/02953; I/SER/2006/01096, which updates the 2003 RBO (F/SER/2000/0 1 2 87)). Sea turtles are highly mobile and would likely avoid areas of active dredging due to Project activity and noise. Normal behavior patterns of sea turtles are not likely to be significantly disrupted by active dredging operations at the HPBA or offshore pump-out locations because of the localized nature of those activities and the ability of sea turtles to avoid the immediate area. Further, it is unlikely that more than one or two dredge vessels (or scows) would be on-site at any given time, such that only or two of the areas (the HPBA or three offshore pump-out areas) would likely be in use at any given time.

Finally, it is possible for sea turtles to become entrapped in coastal waters of construction sites, particularly in the area around New Harbor Island, where shoreline protection features would be installed to contain fill material. To avoid the potential for entrapment and associated harm, the measures in NMFS' Southeast Regional Office Measures for Reducing Entrapment Risk to Protected Species (2012) would be implemented as described in Section 6.1.2, above. Given the implementation of these measures, impacts on sea turtles from entrapment within Project workspaces are not expected. Fill in and around New Harbor Island, as well as fill associated with the restoration features of North Chandeleur Island, would affect approximately 159 acres of existing mSAV habitat. While the loss of 159 acres (3%) of mSAV habitat would decrease the forage for sea turtles, it is a small percentage of the total mSAV in the Action Area (about 5,200 acres), and the restoration activities would result in increased habitat longevity and quality once completed.

<u>Vessel Strikes</u>

Sea turtles are vulnerable to vessel strikes. Recent Florida research found that 21.5 percent of all strandings were associated with a definitive vessel strike injury (Foley et al. 2019). All five federally listed turtle species could be present along vessel transit routes. Vulnerability to collision would be greatest while sea turtles feed, swim, and rest near the surface of the water. Vessels traveling to and from the Project site would operate at higher speeds and would pose the greatest risk to turtles; while at the site vessels would be moving at lower speeds and adult sea turtles would be expected to avoid the immediate areas where construction activity is occurring. To minimize contact and potential injury to sea turtles during vessel operations and transits, NMFS' Southeast Regional Office Vessel Strike Avoidance Measures (2021) would be observed. These measures include (but are not limited to) provisions for operating at minimum safe speeds and maintaining a vigilant watch for protected species, including sea turtles; following deep-water routes and marked channels where possible; operating at idle speeds in shallow waters and when protected species are observed; and maintaining a 150-foot buffer and reduced speed in the event any protected species are sighted.

<u>Underwater Noise</u>

Data regarding the behavioral response of sea turtles to noise is limited; however, behavioral responses to noise have been observed and noise from pile-driving can result in injury to sea turtles (NMFS 2023c). Sea turtles would likely avoid areas of active construction but could transit through nearby areas; noise from vessels and dredging is expected to be consistent with other, ongoing activities in the Gulf. Section 6.1.6 describes the thresholds for behavioral and injury impacts of pile-driving noise on sea turtles. Pile-driving activities would be limited to that required for the installation of timber-pile signage. As presented in Table 6-3, the isopleth distances to injury (from cumulative sound effects) and behavioral impact are both estimated to be within 10 feet of pile-driving noise. As discussed for manatees in Section 6.2.1.2, CPRA would instruct personnel to assess the areas within 50 feet of pile-driving locations prior to beginning pile-driving and, if a federally listed species is observed, avoid commencing pile-driving activities until it has left the area of its own accord. Therefore, while underwater noise during construction (and including pile-driving) may disturb sea turtles or cause avoidance behavior, injury would not occur.

<u>Marine Debris and Entanglement</u>

Marine debris is a significant threat to sea turtles in the Gulf, particularly hatchlings and juveniles that rely on floating *Sargassum* for food and shelter, which may also attract debris (NMFS 2020). Sea turtles can mistake floating plastic particles and waste for food, leading to ingestion, which can cause digestive issues, internal bleeding, nutrient deficiency, and decreased feeding urges. CPRA would ensure that construction contractors are trained on the dangers of marine debris to sea life and would ensure that all construction materials and construction worker rubbish is removed from the island and properly loaded onto the vessels and disposed of onshore.

<u>Critical Habitat</u>

Green Sea Turtle Critical Habitat

As discussed in Section 4.2.4.4, the Project itself would not be within the proposed critical habitat and overlap with the Action Area would be restricted to the outer extent of the Restoration ZOI and a portion of the Vessel Transit ZOI (see Figure 4-1). Because the only effects of the action within those overlapping areas would be limited to vessel transit, which would be similar to the existing uses, no impacts are likely.

Loggerhead Sea Turtle Critical Habitat

As discussed in Section 4.2.8.4, the Project itself would not be within the critical habitat and overlap with the Action Area would be restricted to the Vessel Transit ZOI (see Figure 4-1). Because the only effects of the action within the Vessel Transit ZOI would be limited to vessel transit, which would be similar to the existing uses, no impacts are likely.

6.2.2.2. Giant Manta Ray

If present in the Action Area during construction, the giant manta ray could be disturbed by Project activities. The species is known to use both shallow and deep marine waters to feed; however, manta rays are highly mobile and would likely avoid active construction activities. As described in Section 6.1.3, artificial lighting during construction could cause marine organisms that typically use the sun or moonlight as a behavioral cue to locally aggregate, attracting predators. It is possible that protected fish could be attracted to prey aggregation, increasing the risk of vessel strikes; however, nighttime lighting and activity associated with the Project is expected to be minimal and, given manta rays are expected to avoid active construction, adverse impacts are not anticipated.

As described above for marine mammals and sea turtles, the greatest potential for noise impacts on listed fish are expected to be associated with pile-driving. Manta rays and sturgeon would likely avoid areas of active construction but could transit through nearby areas; noise from vessels and dredging is expected to be consistent with other, ongoing activities in the Gulf. Section 6.1.6 describes the thresholds for behavioral and injury impacts of pile-driving noise on fish. As presented in Table 6-3, the isopleth distances to injury impact are estimated to be within about 29 feet of pile-driving noise. The level of impact on individual fish depends on the proximity to pile-driving. However, the likelihood that the manta ray, a solitary species, would be within the impact radius for injury so low as to be discountable given the depth of water within 29 feet of the expected pile-driving location (approximately 8 feet or less); manta rays and other protected fish are expected to avoid active construction activity. Further, as an oceanic species, manta rays are more likely to be present off the continental shelf or at the FGBNMS than in the Project vicinity, both of which are well away from the Project. Therefore, while underwater noise during construction (including pile-driving) may disturb listed fish or cause avoidance behavior, injury would not occur.

6.2.2.3. Gulf Sturgeon

Gulf sturgeon could be disturbed by Project activities and would likely be present in the Action Area (particularly near the north end of North Chandeleur Island) periodically during construction. As discussed above (see Section 6.2.2.1), the Project would use cutterhead and hopper dredges for dredging within the 1,680-acre HPBA and subsequent material placement, and hopper dredges have the potential to affect the Gulf sturgeon (particularly juveniles, which are not anticipated to be in the Project area). Although the species has been identified as using the north end of North Chandeleur Island, which may include overlap with the HPBA, the species is mobile and would likely avoid areas of active construction. In addition, as described above for the manta ray, noise from impact pile-driving would also produce noise capable of injuring fish within about 29 feet of pile-driving activity, but given the species' mobility and seasonal potential for occurrence in the Action Area, noise from pile-driving is not expected to result in injury to Gulf sturgeon.

Finally, it is possible for Gulf sturgeon to become entrapped in coastal waters of construction sites. To avoid the potential for entrapment and associated harm (such as when the shoreline protection features are enclosed), the measures in NMFS' Southeast Regional Office Measures for Reducing Entrapment Risk to Protected Species (2012) would be implemented as described in Section 6.1.2, above. Given the implementation of these measures, impacts on Gulf sturgeon from entrapment within Project workspaces are not expected.

Gulf Sturgeon Critical Habitat

As discussed in Section 4.3.2.4, the Project itself would not be within the critical habitat and overlap with the Action Area would be restricted to the Vessel Transit ZOI (see Figure 4-1). Because the only effects of the action within the critical habitat would be limited to vessel transit, which would be similar to the existing uses, no impacts on the critical habitat are expected.

6.2.2.4. Rice's Whale

The potential for occurrence of Rice's whale is limited to the Vessel Transit ZOI, where vessels would transit deeper water including proposed critical habitat that may support the species. Project construction, including pile-driving and associated noise, would be limited to Restoration ZOI where Rice's whale would not occur; as such, construction would not affect the species. Therefore, similar to the West Indian manatee, the greatest potential for Project-related impacts on Rice's whale would be associated with injury or mortality due to vessel strikes. To minimize contact and potential injury to Rice's whale, NMFS' Southeast Regional Office Vessel Strike Avoidance Measures (2021) would be observed. These measures include (but are not limited to) provisions for operating at minimum safe speeds and maintaining a vigilant watch for protected species, including marine mammals; following deep-water routes and marked channels where possible; operating at idle speeds in shallow waters and when protected species are observed; and maintaining a 300-foot buffer and reduced speed in the event any whales are sighted. Due to the infrequency of Rice's whale occurrence in the Action Area, which would be limited to the vessel routes, and implementation of these conservation measures, the risk of a boat striking a whale is low.

Rice's Whale Critical Habitat

As discussed in Section 4.3.4.4, the Project itself would not be within the proposed critical habitat and overlap with the Action Area would be restricted to the Vessel Transit ZOI (see Figure 4-1). Because the only effects of the action within the critical habitat would be limited to vessel transit, which would be similar to the existing uses, no impacts on the critical habitat are expected.

6.2.3. Cumulative Impacts

For ESA Section 7 consultation, cumulative effects are defined as "those effects of future state or private activities, not involving federal activities, which are reasonably certain to occur within the Action Area of the Federal action subject to consultation" (50 CFR § 402.02). The proposed Project would be implemented on federally-owned lands and state-owned waterbottoms subject to jurisdiction under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Future federal actions that are unrelated to the proposed action are not considered because they require separate consultation pursuant to Section 7 of the ESA. Further, any other actions undertaken by individuals, states, or private entities, such as dredge or fill activities, would require federal authorization and would therefore be subject to review under Section 7 of the ESA.

Following construction of the Project's restoration features, human disturbance or presence is not expected to change since no development to support recreation is proposed for the Project. The remote location of the Action Area and limited mainland access restrictions regular use and limits the potential for an indirect increase in long-term potential for human disturbance due to the Project. Thus, cumulative effects to the listed species and their habitats are not anticipated.

7. CONSERVATION MEASURES

The following conservation measures would be implemented for dredging and material placement, as well as vessel operations and the operation of equipment during Project implementation.

Applicable to all or multiple species:

- To minimize the risk to protected species during operation of cutterhead dredges, and in accordance with the measures in the PDARP/PEIS, pumps would be disengaged when the cutterhead is not in the substrate, and operators would avoid pumping water from the bottom of the water column.
- Hopper dredges (and turtle relocation trawlers) would have Protected Species Observers onboard during dredging activities.
- All man-made debris would be moved out of the fill footprint prior to fill placement.
- Best management practices would be used during the placement of material to minimize the potential for impacts on sensitive habitats due to misplacement or migration of materials into areas not planned for Project impacts.
- Best management practices, including equipment maintenance and implementation of a Spill Prevention, Response, and Reporting Plan, would be implemented to minimize the potential for spills and leaks of hazardous materials to impact habitats.
- Construction debris would be disposed of properly, and construction activities would comply with applicable permit conditions, including any requirements for the protection of water quality.
- Vessels operating in these areas would follow NMFS' Southeast Regional Office Vessel Strike Avoidance Measures (2021) and Protected Species Construction Conditions (2021), as well as the USFWS' Standard Manatee Conditions for In-Water Activities (2011) to limit the potential for impacts from vessel strikes on marine mammals and sea turtles.
- During pile-driving, CPRA would instruct personnel to assess the areas within 50 feet of pile-driving locations prior to beginning pile-driving and, if a manatee (or other protected species) is observed, avoid commencing pile-driving activities until it has been seen leaving the area of its own accord, or 20 minutes have passed since the animal was last seen in the area. CPRA would further instruct personnel to be alert for listed species in the vicinity of pile-diving.
- To minimize the potential for entrapment of listed species in any enclosures (such as the final shoreline restoration features), the measures in NMFS' Southeast Regional Office Measures for Reducing Entrapment Risk to Protected Species (2012) would be implemented.
- To minimize impacts on mSAV beds and the species that use them, all access corridors and placement areas have been located in areas that would avoid impacts on sensitive mSAV species such as turtle grass, manatee grass, and star grass.

Applicable to birds:

- Do not disturb foraging or roosting Red Knots/Piping Plovers to the maximum extent practicable. A qualified biologist should survey the Project area (i.e., operational site, access points, travel corridors, staging areas) for the presence of Red Knot/Piping Plovers or optimal habitat features (i.e., inlets, bay-side sand and mud flats, tidal pools, wrack lines). Educate personnel on avoiding those areas being used by the birds.
- When Red Knots/Piping Plovers are identified, vehicle and foot traffic should not occur within 150 feet of the birds. Outside of active construction zones, vehicle and foot traffic should not occur within 10 feet of optimal habitat features (even when birds are not present). Personnel and vehicles should follow existing/established travel and access corridors and maintain a maximum speed of 10 mph to avoid disturbing birds.
- Stay as far away from high tide roosting areas as possible, including from large flocks of shorebirds when possible, as Red Knots/Piping Plovers may occur in mixed flocks, except when conducting monitoring activities for shorebirds and sea turtles. If birds in the area are repeatedly being flushed (i.e., flying away), then you are too close and need to back away.
- Designate access points and travel corridors away from known shorebird foraging and roosting areas outside the active construction area and keep all personnel, vehicles, and equipment within those designated corridors to minimize disturbance to birds and beach topographic alterations. Add staking and flagging, as needed, to designate shorebird foraging and concentrated roosting sites outside of construction zones.
- While outside of construction areas, avoid driving up and down the shoreline to the maximum extent practicable to minimize disturbance to birds and to prevent altering beach topography. Keep all personnel, vehicles, and equipment within the designated work area/Project footprint and access corridors.
- Staging areas and waste collection areas located outside of active construction areas should be located to avoid dunes, inlets, and ephemeral tidal pools.
- Maintain a clean work site and remove all trash and work-related debris on a daily basis.
- Avoid disturbing the wrack line while traveling to and from the Project site to the maximum extent possible. If the wrack line must be crossed by equipment or vehicles, gently rake the wrack out of the way to establish a designated travel corridor for crossing the wrack line.
- Avoid hovering or landing aircraft near dunes and bird concentration areas (i.e., foraging and roosting areas).
- Contractors/workers/other personnel should not bring pets into the Project area.

Applicable to sea turtles:

- Hopper dredges would be equipped with turtle exclusion devices, and both the hopper dredges and relocation trawlers would have Protected Species Observers onboard during dredging activities.

- Prior to construction, CPRA plans to conduct sea turtle nest surveys along the island and relocate identified nests that fall within the construction footprint over the subsequent 90 days. Nest survey and relocation protocols would be determined in consultation with the USFWS.
- Construction equipment and materials would be stored in a manner that would minimize impacts to nesting and hatchling sea turtles to the maximum extent practicable. Equipment would be stored in designated areas. Prior to equipment being moved or driven, the vicinity would be checked for the presence of sea turtles.
- Direct lighting of the beach and nearshore waters would be limited to the immediate area of active construction. Lighting on offshore and onshore equipment would be minimized by reducing the number of fixtures, shielding, lowering the height and appropriately placing fixtures to avoid excessive illumination of the water's surface and sea turtle nesting beach. The intensity of lighting would be reduced to the minimum standard required for general construction area safety. Shields would be affixed to the light housing on dredges, booster pumps, hydraulic unloaders, and land-based lights and would be large enough to block lamp light from being transmitted outside the construction area or to the adjacent marine sea turtle nesting beach. The Contractor may also consider use of long wavelength (greater than 560 nanometers and absent wavelengths below 560 nanometers) light sources such as amber, orange, or red LEDs without the use of filters, gels, or lenses to help minimize lighting impacts on sea turtle nesting.
- Beach quality sand suitable for sea turtle nesting, successful incubation, and hatchling emergence would be used for sand placement.
- Beach compaction would be monitored and tilling (non-vegetated areas) of beach built within the last 12 months would be conducted if needed after completion of the sand placement work, prior to the next nesting season to reduce the likelihood of impacting sea turtle nesting and hatching activities, and prior to demobilization of equipment at the completion of Project construction.
- Escarpment formation would be monitored and leveling of beach built within the last 12 months would be conducted if needed after completion of the sand placement work, prior to the next nesting season to reduce the likelihood of impacting nesting and hatchling sea turtles, and prior to demobilization of equipment at the completion of Project construction.
- During the marine turtle nesting season, the Contractor shall not advance the beach fill more than 500 feet along the shoreline between dusk and the following day, until the daily nesting survey is completed, and the beach has been cleared for fill advancement. If the 500-foot advancement limitation is not feasible, CPRA would hire monitors with sea turtle experience to patrol the beach at night in the Project area when nighttime construction activities occur during the nesting season.
- The USFWS would be notified if a sea turtle adult, hatchling, or egg is harmed or destroyed as a direct or indirect result of the Project.
- CPRA would mark and stake the Project boundary in the vicinity of active Project construction and maintain it for the duration of Project construction activities in that area to ensure habitat outside of the boundary markers would not be impacted.

- Any vegetative planting included in the Project would be designed and conducted to minimize impacts to sea turtles.

8. EFFECT DETERMINATIONS

The determination of effect is a finding of a federal agency based on their assessment of resources protected under the ESA. The listed resources (species or critical habitat) in the Action Area are assigned one of three effect determinations: *no effect*, *not likely to adversely effect*, and *likely to adversely effect*.

1. **No effect –** The project will have no adverse or beneficial effects on the listed or proposed species or designated critical habitat.

2. **Not likely to adversely affect –** The direct and indirect effects of the project (including any interrelated and interdependent activities) will be discountable (extremely unlikely to occur), insignificant (cannot be meaningfully measured and does not result in a take), or beneficial.

3. **Likely to adversely affect –** The direct or indirect effects of a project (including any interrelated or interdependent actions), will have adverse effects on listed species or designated critical habitat, and these effects are not discountable, insignificant, or wholly beneficial.

A fourth finding is possible for species or critical habitat that is proposed for listing:

4. **Likely to jeopardize –** A project is likely to jeopardize the continued existence of a proposed species or adversely modify the proposed critical habitat.

For the proposed Project, determinations consider: 1) correspondence with the USFWS, NMFS, and state wildlife agencies, 2) habitat requirements and known distribution of these species within the Action Area, 3) analysis of potential habitat for each species in the Action Area, and/or 4) field surveys and known occurrence data for these species. See Section 4.1 for additional discussion of the species on which the Project would have no effect. Project determinations are included in Table 8-1.

To ensure authorized take is not exceeded, the LA TIG is working with USFWS and NMFS to establish a Long-term Monitoring Plan for this Project. Section 7(a)(1) of ESA encourages federal agencies to enter into agreements to establish such management plans for the conservation and recovery of listed species. Within the Long-term Monitoring Plan, monitoring efforts will be conducted (pre/post and active construction) for listed species, including migratory birds (Piping Plover and Red Knot), sea turtles (nesting), and, if needed, for benthic habitats potentially affected within the Chandeleur Islands Habitat Restoration areas. Monitoring efforts will include the relocation of turtle nests that could be directly affected by the Project.

Table 8-1. Effect Determinations

Common Name	**Scientific Name**	**Federal Status (or critical habitat unit, if applicable)**	**Effect Determination**	**Justification**
Species Under U.S. Fish & Wildlife Service Jurisdiction				
Birds				
Black-capped Petrel	*Pterodroma hasitata*	Endangered	No effect	The species range overlaps within only the Vessel Transit ZOI. It is not subject to potential impacts from vessel strikes, and no modification of marine habitat is proposed along vessel access routes.
Eastern Black Rail	*Laterallus jamaicensis ssp. jamaicensis*	Threatened	No effect	The Chandeleur Islands are outside areas of documented species occurrences, and, given the islands' location offshore, the species is not expected to occur in the Project area.
Piping Plover	*Charadrius melodus*	Threatened	May affect, likely to adversely affect	The species is known to occur in the Action Area. Construction would cause temporary short-term disturbance and displacement from the localized foraging and resting areas within the footprint of active construction. Available, undisturbed habitat would be present elsewhere on North Chandeleur Island during construction and, following restoration, the Project would benefit the species due to an increase in available wintering habitat.
Piping Plover critical habitat	--	Unit LA-7	May affect, not likely to adversely affect	While the Project would involve the placement of fill on some areas of critical habitat, overall, the Project would expand the area of available critical habitat, as well as barrier island longevity. Newly restored habitats are expected to present the essential physical and biological features needed to support Piping Plover.
Rufa Red Knot	*Calidris canutus rufa*	Threatened	May affect, likely to adversely affect	The species is known to occur in the Action Area. Construction would cause temporary short-term disturbance and displacement from the localized foraging and resting areas within the footprint of active construction. Available, undisturbed habitat would be present elsewhere on North Chandeleur Island during construction and, following restoration, the Project would benefit the species due to an increase in available wintering habitat.
Rufa Red Knot critical habitat	--	Proposed, Unit LA-1	May affect, not likely to adversely affect	While the Project would involve the placement of fill on some areas of proposed critical habitat, overall, the Project would expand the area of available habitat, as well as barrier island longevity. Newly restored habitats are expected to present the essential physical and biological features needed to support Rufa Red Knots.

Common Name	**Scientific Name**	**Federal Status (or critical habitat unit, if applicable)**	**Effect Determination**	**Justification**
Mammals				
Tri-colored bat	*Perimyotis subflavus*	Proposed Endangered	No effect	The species range overlaps within only the Vessel Transit ZOI. It is not subject to potential impacts from vessel strikes, and no terrestrial work or modification of terrestrial habitat is proposed along vessel access routes.
West Indian manatee	*Trichechus manatus latirostris*	Threatened	May affect, not likely to adversely affect	The species has been documented in the mSAV beds around North Chandeleur Island (sighting currently unverified) and is an occasional or seasonal visitor to the Action Area. Construction activities may temporarily disturb or displace individuals, if present, but agency-recommended Best Management Practices (BMPs), such as the USFWS' Standard Manatee Conditions for In-water Work (2011) would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (2021).
Reptiles–terrestrial environment				
Alligator snapping turtle	*Macrochelys temminckii*	Proposed Threatened	No effect	The species range overlaps within only the Vessel Transit ZOI. It is not subject to potential impacts from vessel strikes, and no terrestrial work or modification of terrestrial or riverine habitat is proposed along vessel access routes.
Gopher tortoise	*Gopherus polyphemus*	Threatened	No effect	The species range overlaps within only the Vessel Transit ZOI. It is not subject to potential impacts from vessel strikes, and no terrestrial work or modification of terrestrial habitat is proposed along vessel access routes.
Green sea turtle, North Atlantic DPS	*Chelonia mydas*	Threatened	May affect, likely to adversely affect	The species is known to nest on North Chandeleur Island. Nests present would be marked and avoided, or relocated prior to construction, but any nest not discovered and relocated could be lost. Impacts would also occur from the temporary disruption/reduction of nesting habitat. Long-term benefits due to increased nesting habitat would occur following implementation of the Project.
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered	No effect	The species does not nest in the Action Area.

Common Name	**Scientific Name**	**Federal Status (or critical habitat unit, if applicable)**	**Effect Determination**	**Justification**
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	May affect, likely to adversely affect	The species is known to nest on North Chandeleur Island. Nests present would be marked and avoided, or relocated prior to construction, but any nest not discovered and relocated could be lost. Impacts would also occur from the temporary disruption/reduction of nesting habitat. Long-term benefits due to increased nesting habitat would occur following implementation of the Project.
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	No effect	The species does not nest in the Action Area.
Loggerhead sea turtle, Northwest Atlantic DPS	*Caretta caretta*	Threatened	May affect, likely to adversely affect	The species is known to nest on North Chandeleur Island. Nests present would be marked and avoided, or relocated prior to construction, but any nest not discovered and relocated could be lost. Impacts would also occur from the temporary disruption/reduction of nesting habitat. Long-term benefits due to increased nesting habitat would occur following implementation of the Project.
Fish				
Gulf sturgeon	*Acipenser oxyrinchus*	Threatened	No effect	The species range overlaps within only the Vessel Transit ZOI. No modification of riverine or estuarine habitat is proposed along vessel access routes.
Gulf sturgeon critical habitat	--	CHU8	No effect	Critical habitat is only present within the Vessel Transit ZOI; no dredging or other habitat modification is proposed within this ZOI.
Pallid sturgeon	*Scaphirhynchus albus*	Endangered	No effect	The species range overlaps within only the Vessel Transit ZOI. No modification of riverine or estuarine habitat is proposed along vessel access routes.
Insects				
Monarch butterfly	*Danaus plexippus*	Proposed Threatened	No effect	While pollinator plant species may be present in terrestrial habitat in the Action Area, milkweed was not documented in vegetation assessments conducted in 2023, and suitable monarch butterfly or caterpillar habitat would not be directly affected by beach, dune, or marsh fill for the Project.
Ferns and Allies				
Louisiana Quillwort	*Isoetes louisianensis*	Endangered	No effect	The species range overlaps within only the Vessel Transit ZOI. No terrestrial work or modification of terrestrial habitat is proposed along vessel access routes.

Common Name	**Scientific Name**	**Federal Status (or critical habitat unit, if applicable)**	**Effect Determination**	**Justification**
Species under NOAA NMFS Jurisdiction				
Reptiles—marine environment				
Green sea turtle, North Atlantic DPS	*Chelonia mydas*	Threatened	May affect, likely to adversely affect	Take of individuals could occur due to entrainment or impingement during use of hopper dredges. Construction activities may temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (2021).
Green sea turtle critical habitat	--	Proposed, North Atlantic DPS	No effect	The Project itself would not be within the proposed critical habitat and overlap with the Action Area would be restricted to the outer extent of the Restoration ZOI and a portion of the Vessel Transit ZOI. The only effects of the action within those overlapping areas would be limited to vessel transit, which would be similar to the existing uses.
Hawksbill sea turtle	*Eretmochelys imbricate*	Endangered	May affect, not likely to adversely affect	The species is not anticipated to be in the Action Area with any regularity, particularly in proximity to restoration activities. Agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (2021).
Kemp's ridley sea turtle	*Lepidochelys kempii*	Endangered	May affect, likely to adversely affect	Take of individuals could occur due to entrainment or impingement during use of hopper dredges. Construction activities may temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (2021).

Common Name	**Scientific Name**	**Federal Status (or critical habitat unit, if applicable)**	**Effect Determination**	**Justification**
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	May affect, not likely to adversely affect	The species is not anticipated to be in the Action Area with any regularity, particularly in proximity to restoration activities. Agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (2021).
Loggerhead sea turtle, Northwest Atlantic DPS	*Caretta caretta*	Threatened	May affect, likely to adversely affect	Take of individuals could occur due to entrainment or impingement during use of hopper dredges. Construction activities may temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (2021).
Loggerhead sea turtle critical habitat	--	Northwest Atlantic DPS	No effect	The Project itself would not be within the critical habitat and overlap with the Action Area would be restricted to Vessel Transit ZOI. The only effects of the action within those overlapping areas would be limited to vessel transit, which would be similar to the existing uses.
Fish				
Giant manta ray	*Mobula birostris*	Threatened	May affect, not likely to adversely affect	Construction activities may temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or other construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (2021).
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	Threatened	May affect, likely to adversely affect	Take of individuals could occur due to entrainment or impingement during use of hopper dredges, although the more susceptible juveniles are not anticipated in the dredging locations. Other construction activities may temporarily disturb or displace individuals, if present, but agency-recommended BMPs would be implemented to minimize the potential for impact due to vessel strikes or other construction activities. To minimize potential noise related impacts, CPRA would implement mitigation measures per NMFS Protected Species Construction Conditions (2021).

Common Name	**Scientific Name**	**Federal Status (or critical habitat unit, if applicable)**	**Effect Determination**	**Justification**
Gulf sturgeon critical habitat	---	CHU 8	No effect	Critical habitat is only present within the Vessel Transit ZOI; no dredging or other habitat modification is proposed within this ZOI.
Oceanic whitetip shark	*Carcharhinus longimanus*	Threatened	No effect	The species range overlaps within only the Vessel Transit ZOI. It is not subject to potential impacts from vessel strikes, and no modification of marine habitat is proposed along vessel access routes.
Marine Mammals				
Rice's whale	*Balaenoptera ricei*	Endangered	May affect, not likely to adversely affect	Potential occurrence is limited to the Vessel Transit ZOI, where potential impacts would be limited to vessel impact. Typical BMPs would be implemented to minimize the potential for impact due to vessel strikes.
Rice's whale critical habitat	---	Proposed	No effect	Critical habitat is only present within the Vessel Transit ZOI; no dredging or other habitat modification is proposed within this ZOI.

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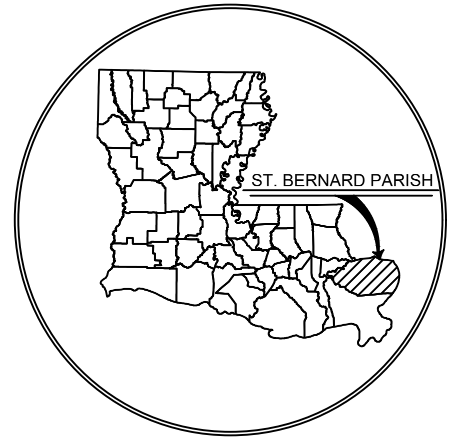
Attachment A
Engineering Drawings

Attachment B
Engineering Drawings

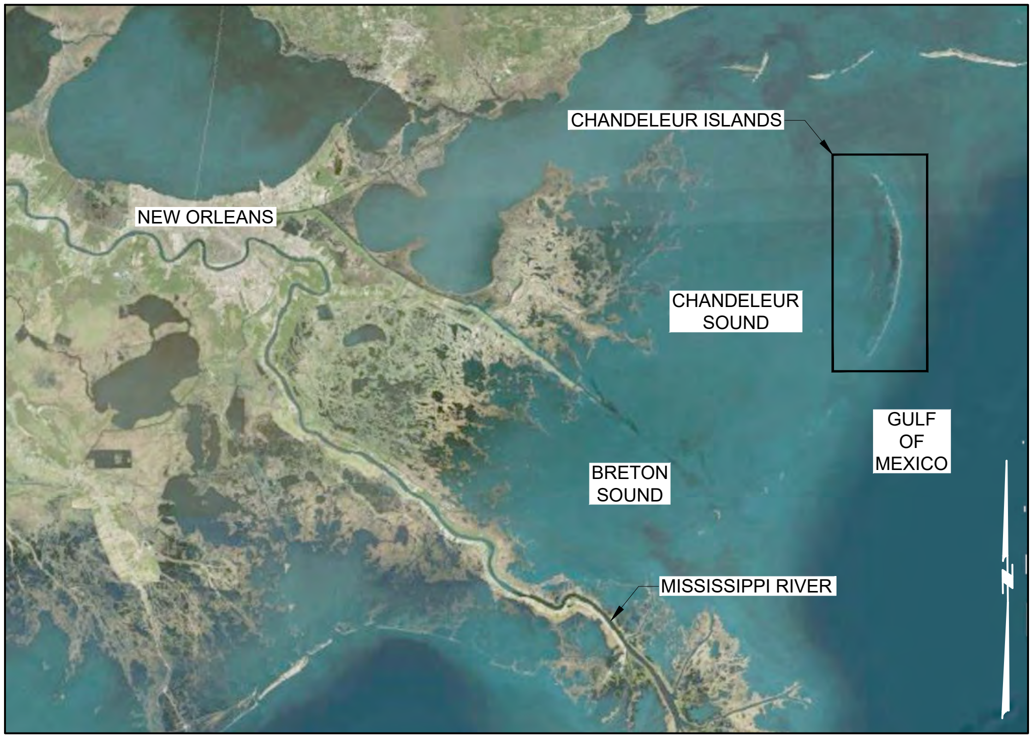
STATE OF LOUISIANA
COASTAL PROTECTION AND RESTORATION AUTHORITY

CHANDELEUR ISLAND RESTORATION PROJECT
STATE PROJECT NO. PO-0199

ST. BERNARD PARISH, LOUISIANA



INDEX TO SHEETS



15 MI 7.5 MI 0 MI 15 MI 30 MI

NOTES:

1. FOR PERMITTING PURPOSES ONLY. NOT TO BE USED FOR CONSTRUCTION.
2. RETAIN ENTIRE SET AS ONE, INDIVIDUAL SHEETS SHOULD NOT BE REMOVED.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

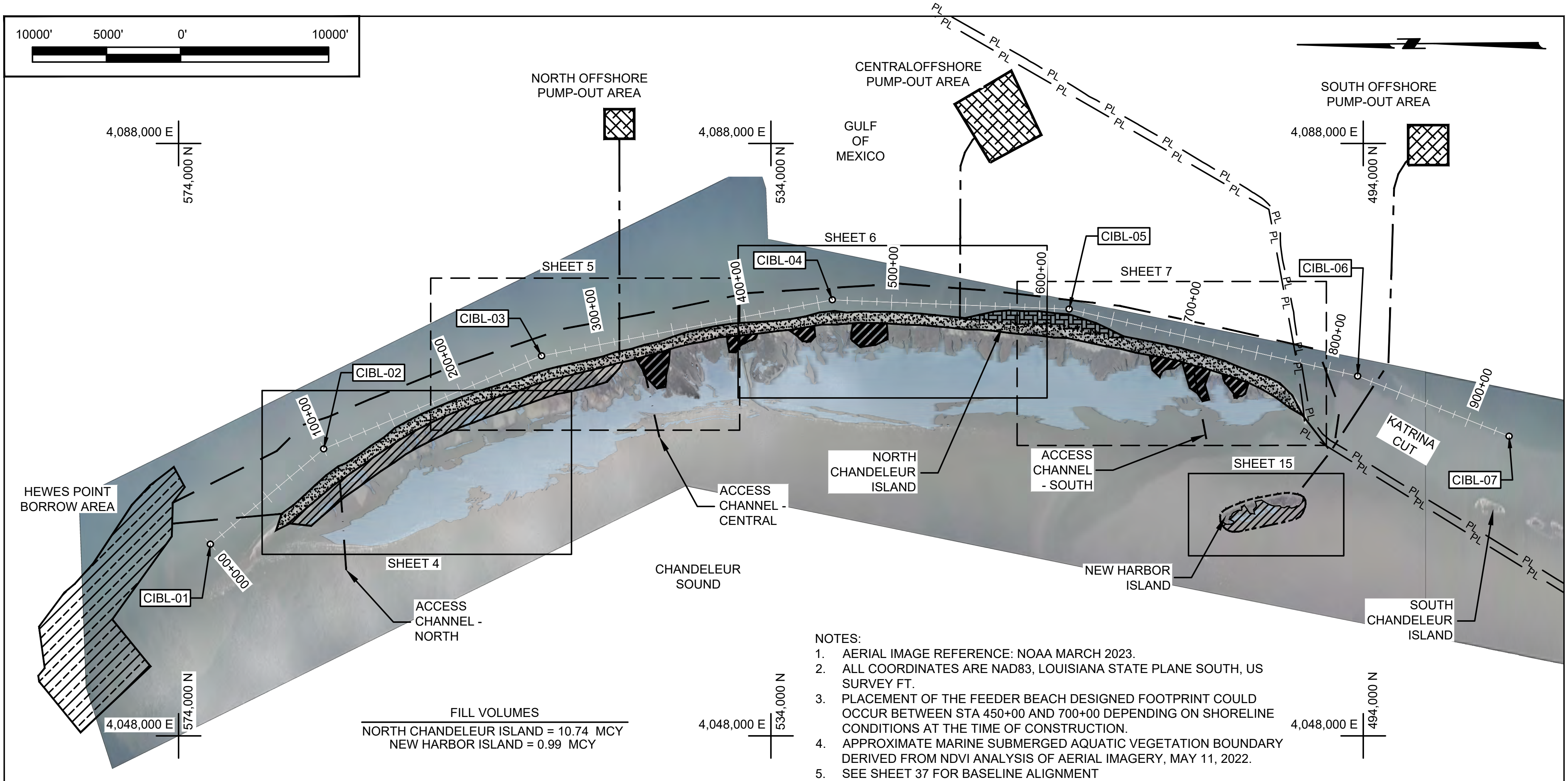
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

TITLE SHEET

DATE: NOVEMBER 2024

SHEET 1 OF 40



FILL VOLUMES

NORTH CHANDELEUR ISLAND = 10.74 MCY
NEW HARBOR ISLAND = 0.99 MCY

NOTES:
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3. PLACEMENT OF THE FEEDER BEACH DESIGNED FOOTPRINT COULD OCCUR BETWEEN STA 450+00 AND 700+00 DEPENDING ON SHORELINE CONDITIONS AT THE TIME OF CONSTRUCTION.
4. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
5. SEE SHEET 37 FOR BASELINE ALIGNMENT

LEGEND

- BEACH/DUNE FILL AREA
- FEEDER BEACH FILL AREA
- MARSH FILL AREA
- BORROW AREA LIMITS
- SHORELINE BREAKWATER
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- SAND RESERVOIR FILL AREA
- PUMP-OUT AREA LIMITS
- DETACHED BREAKWATER
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- 100+00 FILL AREA BASELINE
- ACCESS CHANNEL ALIGNMENT
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- PL PIPELINE
- CIBL-01 BASELINE ALIGNMENT COORDINATE

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CHANDELEUR ISLAND RESTORATION PROJECT

PROJECT OVERVIEW

STATE PROJECT NUMBER: PO-0199

DATE: NOVEMBER 2024

FEDERAL PROJECT NUMBER:

GENERAL NOTES:

1. ANY EXCAVATED MATERIAL WILL BE, TO THE BEST OF KNOWLEDGE, FREE OF CONTAMINANTS AND/OR WILL BE DISPOSED OF IN AN APPROVED LANDFILL.
2. THE CONTRACTOR SHALL BECOME FAMILIAR WITH THE SITE, CONSTRUCTION PLANS, AND CONTRACT DOCUMENTS AND SHALL CONDUCT WORK IN STRICT ACCORDANCE WITH ALL PERMITS AND APPROVALS OBTAINED FOR THIS PROJECT. THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY ERRORS OR DISCREPANCIES IN THE PLANS PRIOR TO BIDDING.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING LOUISIANA ONE CALL SYSTEM (1-800-272-3020) A MINIMUM OF 48 HOURS PRIOR TO THE COMMENCEMENT OF ANY EXCAVATION (DIGGING, DREDGING, JETTING, ETC.) OR DEMOLITION ACTIVITY. THE CONTRACTOR SHALL ALSO NOTIFY PIPELINE AND UTILITY OPERATORS 72 HOURS PRIOR TO ANY EXCAVATION. ALL PIPELINES AND UNDERGROUND UTILITIES SHALL BE FIELD LOCATED AND MARKED.
4. THE CONTRACTOR SHALL WORK COOPERATIVELY WITH THE OWNER TO ADDRESS THE NOTIFICATION AND COORDINATION REQUIREMENTS WITH THE LANDOWNERS, UTILITY OPERATORS, AND PIPELINE COMPANIES.
5. THE WATER BOTTOM SHALL NOT BE DISTURBED DURING ACCESS TO THE PROPOSED WORK LOCATION, OR BY THE AUTHORIZED ACTIVITIES WHETHER IT BE BY DREDGING, WHEEL WASHING , PROPWASHING, JETTING, MUCKING, PLOWING, BULL DOZING OR ANY MEANS OF MOVING BOTTOM MATERIAL, EXCEPT AS DEPICTED ON THE PERMIT SHEETS. POWERED VESSELS SHALL BE OPERATED SO AS NOT TO DISTURB THE WATER BOTTOM OR SEAGRASS BEDS BY PROPELLER OR JET ACTION.
6. ALL LOGS, STUMPS, AND OTHER DEBRIS UNEARTHED DURING DREDGING SHALL BE REMOVED TO AN APPROVED OFFSITE DISPOSAL AREA.
7. THE CONTRACTOR MUST INSTALL AND MAINTAIN ANY SAFETY LIGHTS, SIGNS, AND SIGNALS PRESCRIBED BY THE U.S. COAST GUARD, THROUGH REGULATIONS OR OTHERWISE ON THE AUTHORIZED FACILITIES.
8. ANY DAMAGE TO EXISTING U.S. COAST GUARD (USCG) NAVIGATION AIDS OR PRIVATE NAVIGATION AIDS SHALL BE REPAIRED BY THE CONTRACTOR TO U.S. COAST GUARD STANDARDS AT THE EXPENSE OF THE CONTRACTOR.
9. SEDIMENT PIPELINES IN OPEN WATER AND/OR NAVIGABLE WATERS SHALL BE MARKED WITH BUOYS BY THE CONTRACTOR IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS AND USCG REGULATIONS. THE CONTRACTOR SHALL MAINTAIN BUOYS DURING CONSTRUCTION OR HAVE ADEQUATE NAVIGATIONAL EQUIPMENT ON THE DREDGE TO AVOID DREDGING IN RESTRICTED AREAS.
10. THE PROPOSED PROJECT AND ANY FUTURE MAINTENANCE WORK INVOLVING THE USE OF FLOATING CONSTRUCTION EQUIPMENT (BARGE MOUNTED CRANES, BARGE MOUNTED PILE DRIVING EQUIPMENT, FLOATING DREDGE EQUIPMENT, DREDGE DISCHARGE PIPELINES, ETC.) IN FEDERAL WATERS, SHALL NOTIFY THE USCG SO THAT A NOTICE TO MARINERS, IF REQUIRED, MAY BE PREPARED. NOTIFICATION, WITH A COPY OF THE PERMIT APPROVAL AND DRAWINGS, SHALL BE MAILED TO THE USCG, SECTOR NEW ORLEANS COMMAND CENTER, 201 HAMMOND HIGHWAY, METAIRIE, LOUISIANA 70005, 30 DAYS BEFORE COMMENCEMENT OF WORK.
11. THE OFFSHORE WORK AREAS SHALL CONSIST OF THE BORROW AREA, PUMP-OUT AREAS, AND CONVEYANCE CORRIDORS. THE INSHORE WORK AREA IS DEFINED BY A 50-FOOT OFFSET FROM THE OUTER LIMITS OF THE ACCESS CHANNELS AND TEMPORARY SIDECAST DISPOSAL AREAS, 200-FOOT OFFSET FROM THE TOE OF THE HYDRAULIC FILL TEMPLATE, AND 100-FOOT OFFSET FROM THE TOE OF ROCK STRUCTURES. THE CONTRACTOR SHALL BE REQUIRED TO CONFINE HIS/HER PLANT, EQUIPMENT, AND OPERATIONS OF PERSONNEL WITHIN THE LIMITS OF THE WORK AREA, AREAS PERMITTED BY LAW, ORDINANCES, PERMITS, AND THE REQUIREMENTS OF THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL NOT UNREASONABLY ENCUMBER THE PREMISES WITH PLANT OR EQUIPMENT.
12. THE CONTRACTOR SHALL FOLLOW CONVEYANCE CORRIDORS, ACCESS CHANNELS, AND / OR FILL TEMPLATES, AND SHALL NOT, AT ANY TIME, TRAVEL ON EXISTING MARSH, VEGETATED WETLANDS, OR SEAGRASS BEDS UNLESS SPECIFIED IN THE PERMIT OR THROUGH WRITTEN DIRECTION FROM ENGINEER.
13. THE CONTRACTOR SHALL ABIDE BY ALL ECOLOGICAL AND ENVIRONMENTAL BEST MANAGEMENT PRACTICES DEFINED IN THE PERMITS, FEDERAL AND STATE REGULATIONS, AND THE CONSTRUCTION DOCUMENTS.
14. AS-BUILT DRAWINGS AND/OR PLATS SHALL HAVE WRITTEN ON THEM THE DATE OF COMPLETION OF SAID ACTIVITIES AND SHALL BE SUBMITTED TO THE LOUISIANA DEPARTMENT OF NATURAL RESOURCES, OFFICE OF COASTAL MANAGEMENT, P.O. BOX 44487, BATON ROUGE, LA 70804-4487.
15. THIS DRAWING SET IS FOR PERMITTING PURPOSES ONLY AND IS NOT TO BE USED FOR CONSTRUCTION.

SURVEY NOTES:

1. ALL COORDINATES ARE NORTH AMERICAN DATUM OF 1983 (NAD 83 - GEOID18), LOUISIANA STATE PLANE, SOUTHERN ZONE, U.S. SURVEY FEET. ALL PROJECT COORDINATES AND ELEVATIONS ARE BASED ON NATIONAL GEODETIC SURVEY AND LOUISIANA DEPARTMENT OF NATURAL RESOURCES MONUMENTS.

MONUMENTS	ELEVATION	NORTHING	EASTING
CI-0178B	3.872'	505,754.39	4,072,974.00
CI-BM2	3.109'	536,344.97	4,074,755.33

2. ALL ELEVATIONS ARE IN NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88 - 2004.65), U.S. SURVEY FEET UNLESS OTHERWISE SPECIFIED.
3. HEWES POINT BORROW AREA, NORTH OFFSHORE PUMP-OUT AREA AND CONVEYANCE CORRIDOR, AND NEW HARBOR ISLAND EXTENSION OF THE NEARSHORE CONVEYANCE CORRIDOR SURVEYS PERFORMED BY OCEAN SURVEYS, INC. (OSI) FROM JUNE 5 - 24, 2023. NEARSHORE CONVEYANCE CORRIDOR AND THE CENTRAL AND SOUTH OFFSHORE PUMP-OUT AREAS AND CONVEYANCE CORRIDORS SURVEYS PERFORMED BY TIDEWATER ATLANTIC RESEARCH, INC. (TAR) FROM MAY 31 - SEPTEMBER 14, 2010.
4. HEWES POINT BORROW AREA AVOIDANCE AREAS RECOMMENDED BY GOODWIN AND ASSOCIATES (GOODWIN), 2023. NEARSHORE CONVEYANCE CORRIDOR AVOIDANCE AREAS RECOMMENDED BY TAR 2011. HEWES POINT BORROW AREA GEOTECHNICAL INVESTIGATIONS PERFORMED BY ATHENA TECHNOLOGIES, INC. (ATHENA) ON OCTOBER 6, 2023.
5. CHANDELEUR AND NEW HARBOR ISLAND TOPOGRAPHIC AND BATHYMETRIC SURVEYS PERFORMED BY EMC, INC. FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
6. OIL/GAS PIPELINE INFORMATION OBTAINED FROM THE BUREAU OF OCEAN ENERGY MANAGEMENT (HTTPS://WWW.DATA.BOEM.GOV).
7. INFORMATION SHOWN HERE IN REFLECTS CONDITIONS AS THEY EXISTED ON THE SURVEY DATE SHOWN AND CAN ONLY BE CONSIDERED INDICATIVE OF CONDITIONS AT THAT TIME.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

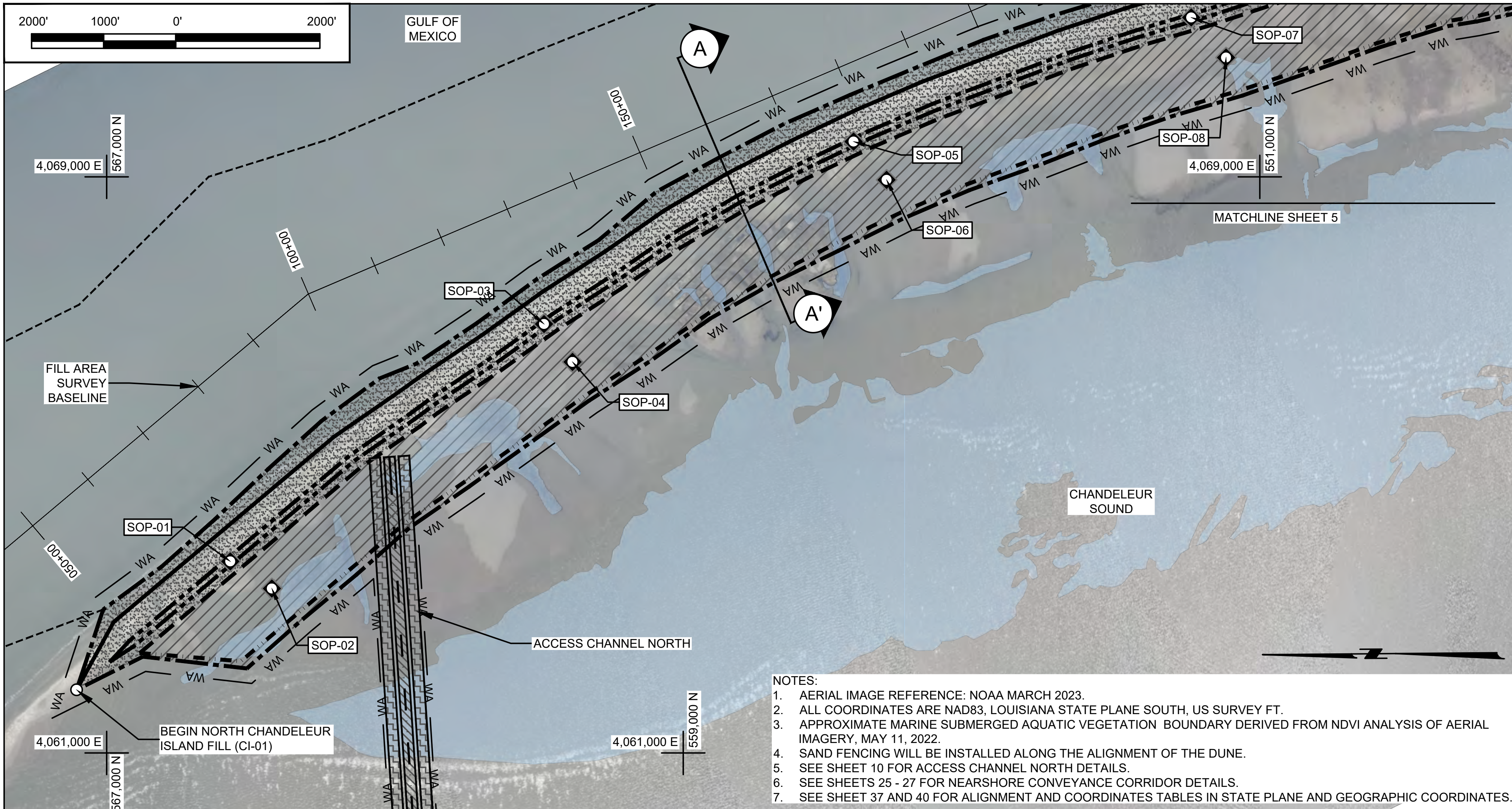
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

GENERAL AND SURVEY NOTES

DATE: NOVEMBER 2024

SHEET 3 OF 40



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4. SAND FENCING WILL BE INSTALLED ALONG THE ALIGNMENT OF THE DUNE.
5. SEE SHEET 10 FOR ACCESS CHANNEL NORTH DETAILS.
6. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 37 AND 40 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- BEACH FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/MARSH INTERFACE
- BEACH/DUNE FILL
- MARSH FILL
- WA — WORK AREA
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- SETTLEMENT AND OVERWASH MONITORING SYSTEM
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- 100+00 FILL AREA BASELINE

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CHANDELEUR ISLAND RESTORATION PROJECT

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NORTH CHANDELEUR ISLAND RESTORATION AREA PLAN VIEW

DATE: NOVEMBER 2024

SHEET 4 OF 40

NOTES:
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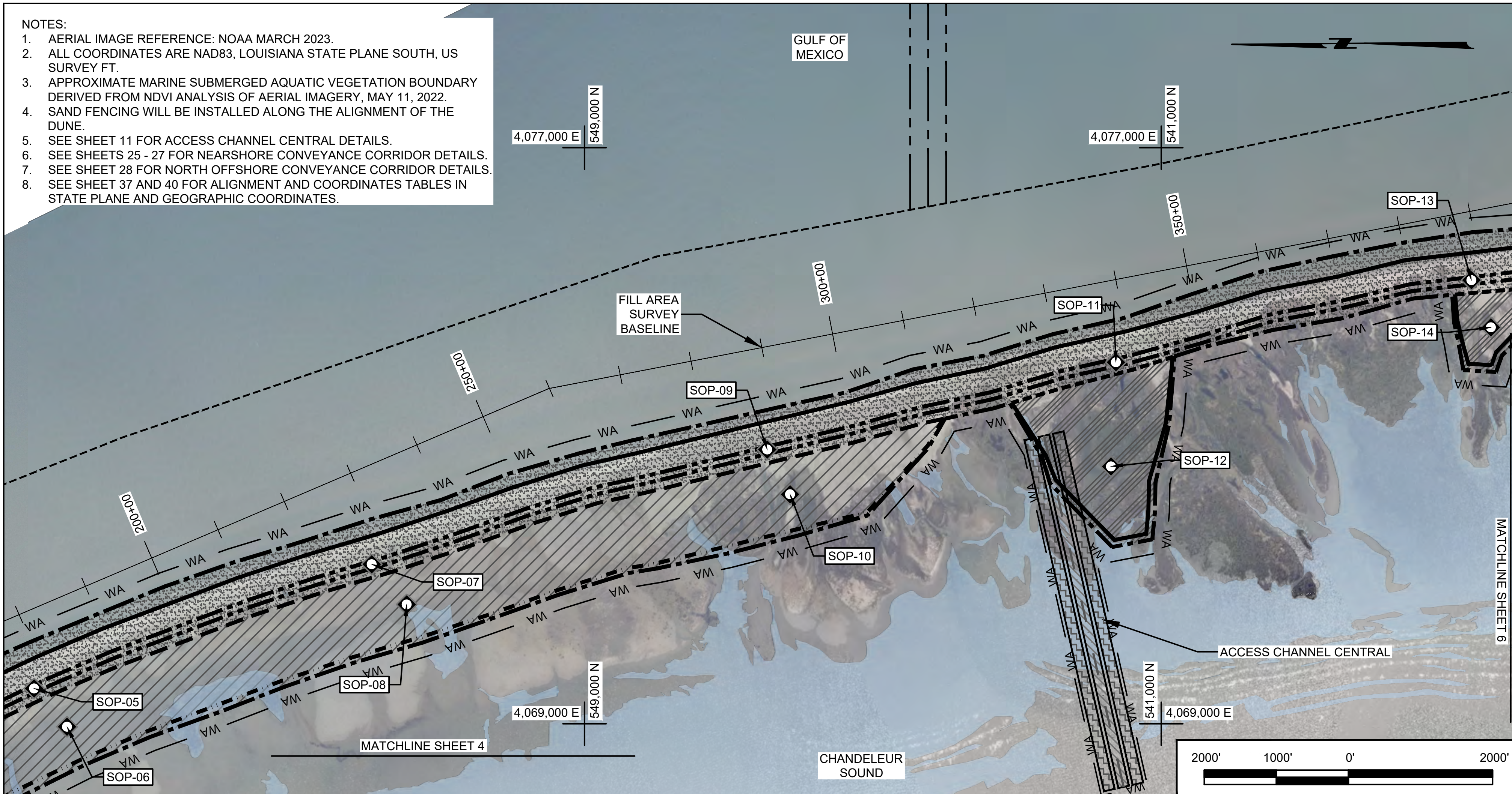
5. SEE SHEET 11 FOR ACCESS CHANNEL CENTRAL DETAILS.
6. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 28 FOR NORTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 37 AND 40 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.



LEGEND

FILL EXTENTS	BEACH/DUNE FILL
BEACH/SAND RESERVOIR FILL CREST	MARSH FILL
DUNE FILL CREST	SAND RESERVOIR FILL
MARSH FILL CREST	ACCESS CHANNEL
DUNE/MARSH INTERFACE	TEMPORARY SIDECAST DISPOSAL
DUNE/SAND RESERVOIR INTERFACE	NEARSHORE CONVEYANCE CORRIDOR LIMITS
WA — WORK AREA	OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
SETTLEMENT AND OVERWASH MONITORING SYSTEM	APPROX. MARINE SUBMERGED AQUATIC VEGETATION
100+00 FILL AREA BASELINE	

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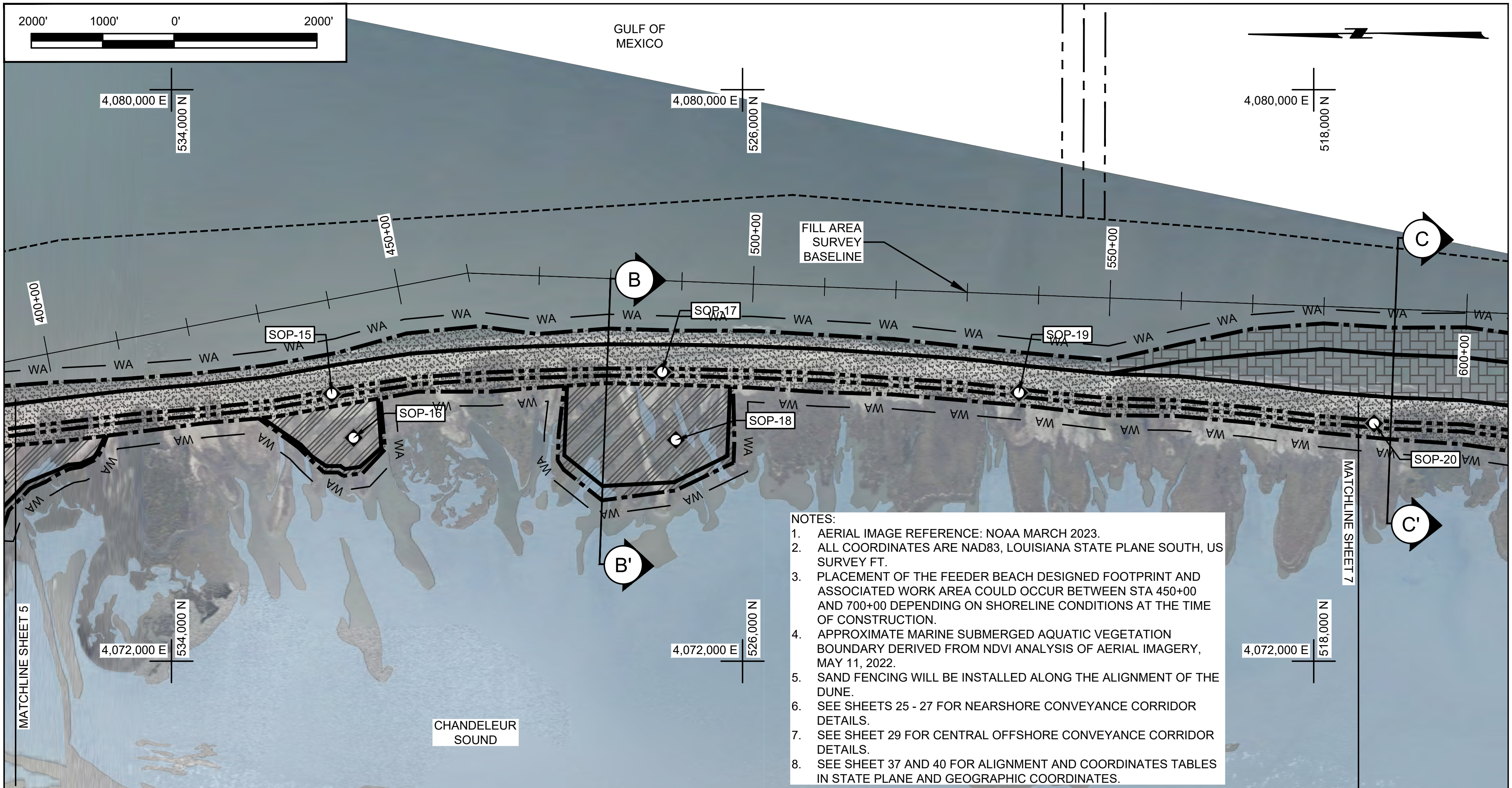
DATE: NOVEMBER 2024



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7. SEE SHEET 29 FOR CENTRAL OFFSHORE CONVEYANCE CORRIDOR DETAILS.
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LEGEND

- FILL EXTENTS
- BEACH/SAND RESERVOIR FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/SAND RESERVOIR INTERFACE
- BEACH/DUNE FILL
- SAND RESERVOIR FILL
- FEEDER BEACH FILL
- WA — WORK AREA
- NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
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CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

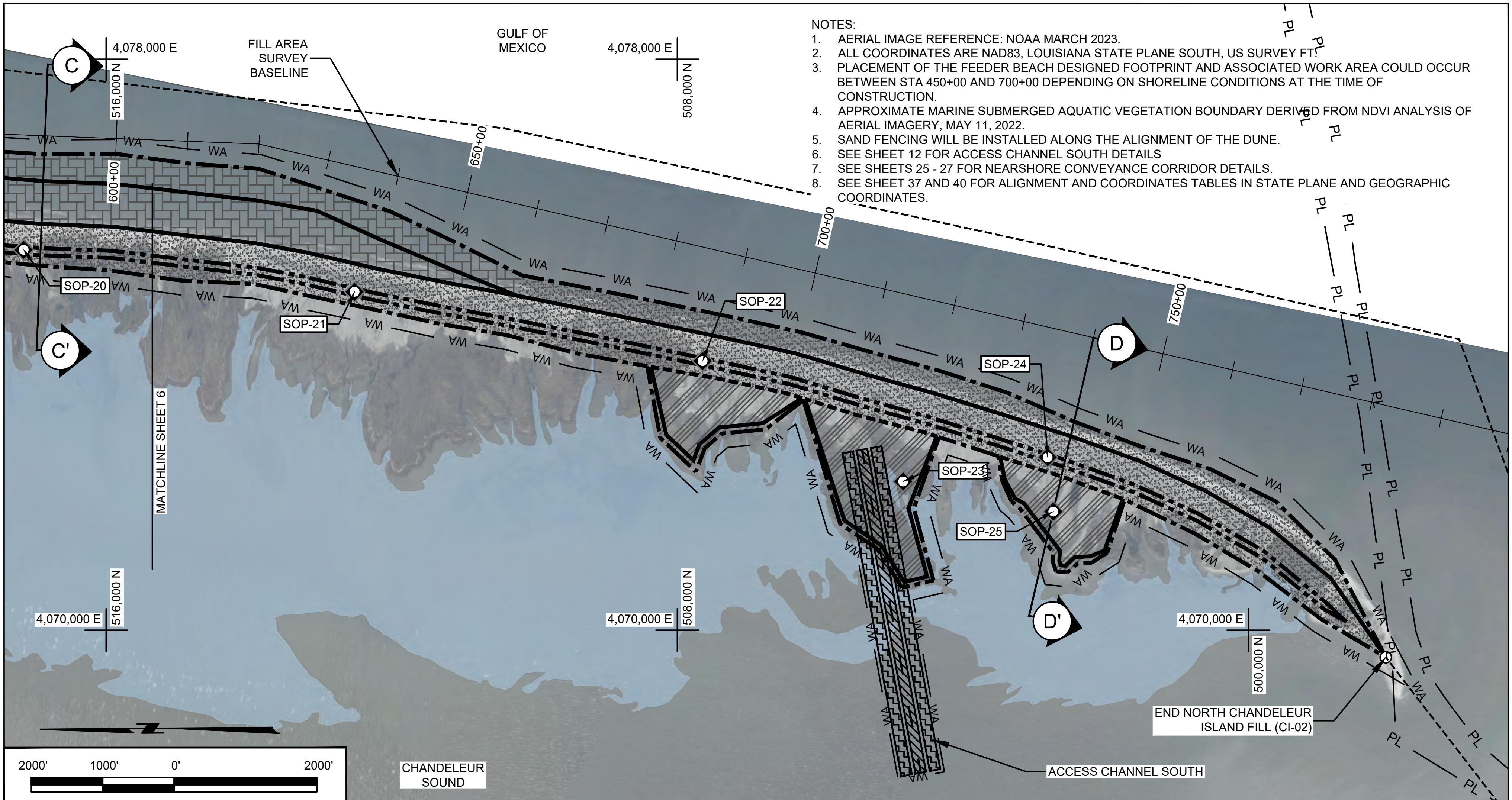
FEDERAL PROJECT NUMBER:

NORTH CHANDELEUR ISLAND RESTORATION AREA PLAN VIEW

DATE: NOVEMBER 2024

SHEET 6 OF 40

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. PLACEMENT OF THE FEEDER BEACH DESIGNED FOOTPRINT AND ASSOCIATED WORK AREA COULD OCCUR BETWEEN STA 450+00 AND 700+00 DEPENDING ON SHORELINE CONDITIONS AT THE TIME OF CONSTRUCTION.
4. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
5. SAND FENCING WILL BE INSTALLED ALONG THE ALIGNMENT OF THE DUNE.
6. SEE SHEET 12 FOR ACCESS CHANNEL SOUTH DETAILS
7. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 37 AND 40 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.



LEGEND

- FILL EXTENTS
- BEACH/SAND RESERVOIR FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/SAND RESERVOIR INTERFACE
- BEACH/DUNE FILL
- SAND RESERVOIR FILL
- FEEDER BEACH FILL
- WA — WORK AREA
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- PL — PIPELINE
- SETTLEMENT AND OVERWASH MONITORING SYSTEM
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- 100+00 FILL AREA BASELINE

BY	DESCRIPTION	DATE

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

CHANDELEUR ISLAND RESTORATION PROJECT

NORTH CHANDELEUR ISLAND RESTORATION AREA PLAN VIEW

STATE PROJECT NUMBER: PO-0199

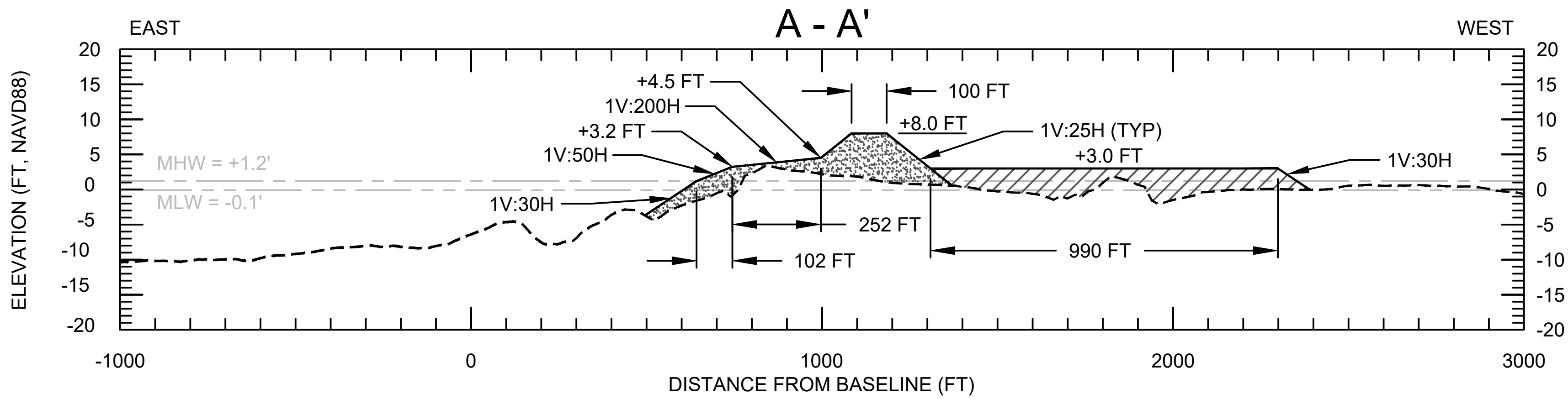
DATE: NOVEMBER 2024

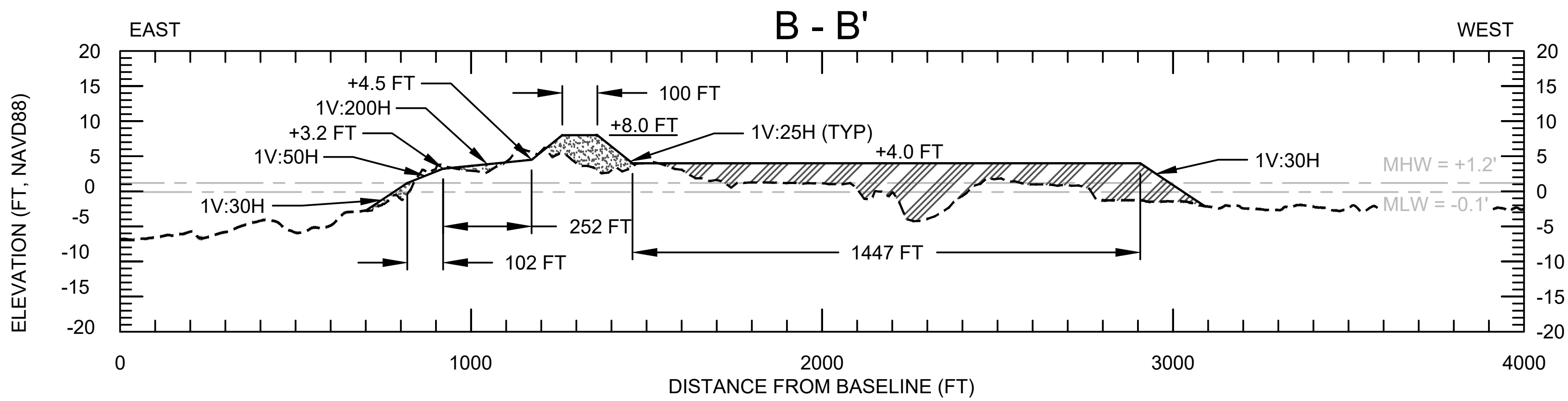
DRAWN BY: STEVE DARTEZ

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

APPROVED BY: MICHAEL T. POFF, P.E.

FEDERAL PROJECT NUMBER:





NOTES:
1. SURVEY CONDUCTED BY EMC, INC. FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEET 37 FOR ALIGNMENTS.

SCALE:
H: 1" = 500'
V: 1" = 25'

DESIGN ELEMENTS:
1. DESIGN DIMENSIONS ARE MEASURED FROM THE CREST LINES OF THE RESPECTIVE FEATURES.
2. DUNE DESIGN ELEVATION = +8.0 FT NAVD88.
3. DUNE DESIGN SLOPE = 1V:25H.
4. BEACH DESIGN ELEVATION = +4.5 FT NAVD88 TO +3.2 FT NAVD88.
5. BEACH DESIGN SLOPES = 1V:200H TRANSITIONING TO 1V:50H AT +3.2 FT NAVD88 AND T0 1V:30H AT MHW.
6. MARSH DESIGN ELEVATION = +3.0 FT NAVD88.
7. MARSH DESIGN SLOPE = 1V:30H.
8. SAND RESERVOIR DESIGN ELEVATION = +4.0 FT NAVD88.
9. SAND RESERVOIR DESIGN SLOPE = 1V:30H.
10. A +1.0 FT VERTICAL CONSTRUCTION TOLERANCE IS INCLUDED TO ACCOUNT FOR CONSTRUCTION METHODS AND CONSOLIDATION / SETTLEMENT OF THE FILL.

LEGEND:
- EXISTING GRADE
- DESIGN
- BEACH/DUNE FILL
- MARSH FILL
- SAND RESERVOIR FILL

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

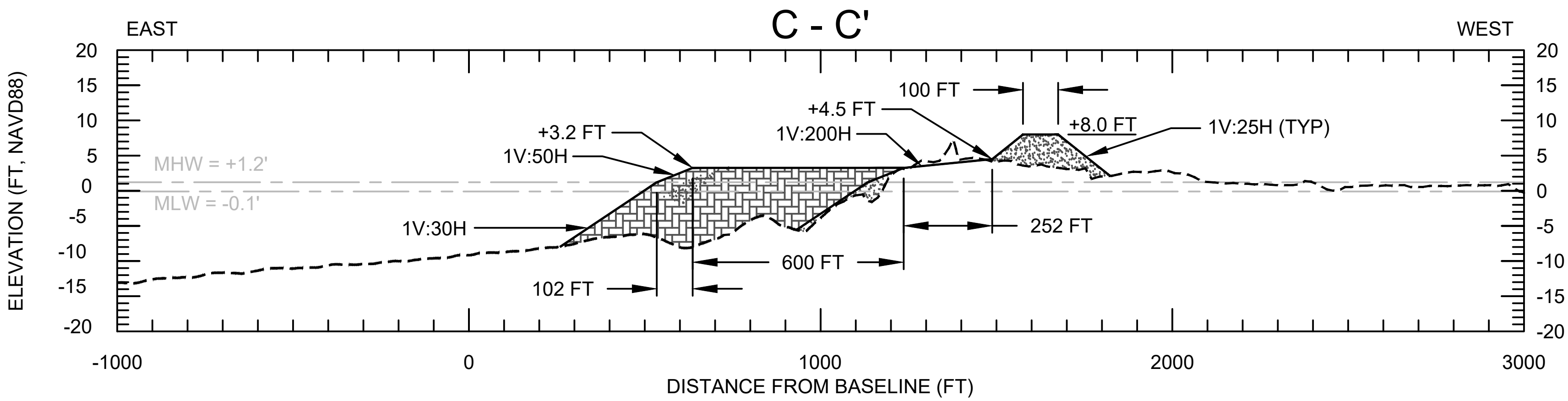
STATE PROJECT NUMBER: PO-0199

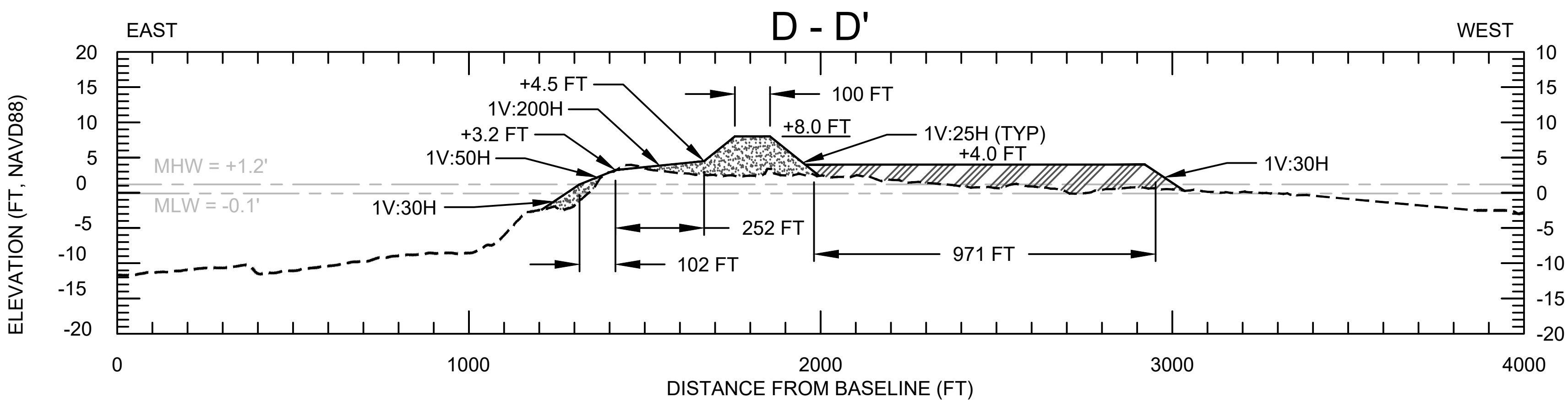
FEDERAL PROJECT NUMBER:

NORTH CHANDELEUR ISLAND RESTORATION AREA TYPICAL SECTIONS

DATE: NOVEMBER 2024

SHEET 8 OF 40





NOTES:

1. SURVEY CONDUCTED BY EMC, INC. FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEET 37 FOR ALIGNMENTS.

SCALE:
H: 1" = 500'
V: 1" = 25'

DESIGN ELEMENTS:

1. DESIGN DIMENSIONS ARE MEASURED FROM THE CREST LINES OF THE RESPECTIVE FEATURES.
2. DUNE DESIGN ELEVATION = +8.0 FT NAVD88.
3. DUNE DESIGN SLOPE = 1V:25H.
4. BEACH DESIGN ELEVATION = +4.5 FT NAVD88 TO +3.2 FT NAVD88.
5. BEACH DESIGN SLOPES = 1V:200H TRANSITIONING TO 1V:50H AT +3.2 FT NAVD88 AND T0 1V:30H AT MHW (EXCEPT AT FEEDER BEACH).
6. FEEDER BEACH DESIGN ELEVATION = +3.24 FT NAVD88.
7. FEEDER BEACH SLOPES = 1V:50H TRANSITIONING TO 1V:30H AT MHW.
8. SAND RESERVOIR DESIGN ELEVATION = +4.0 FT NAVD88.
9. SAND RESERVOIR DESIGN SLOPE = 1V:30H.
10. A +1.0 FT VERTICAL CONSTRUCTION TOLERANCE IS INCLUDED TO ACCOUNT FOR CONSTRUCTION METHODS AND CONSOLIDATION / SETTLEMENT OF THE FILL.

LEGEND:

- EXISTING GRADE
- DESIGN
- BEACH/DUNE FILL
- SAND RESERVOIR FILL
- FEEDER BEACH FILL

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

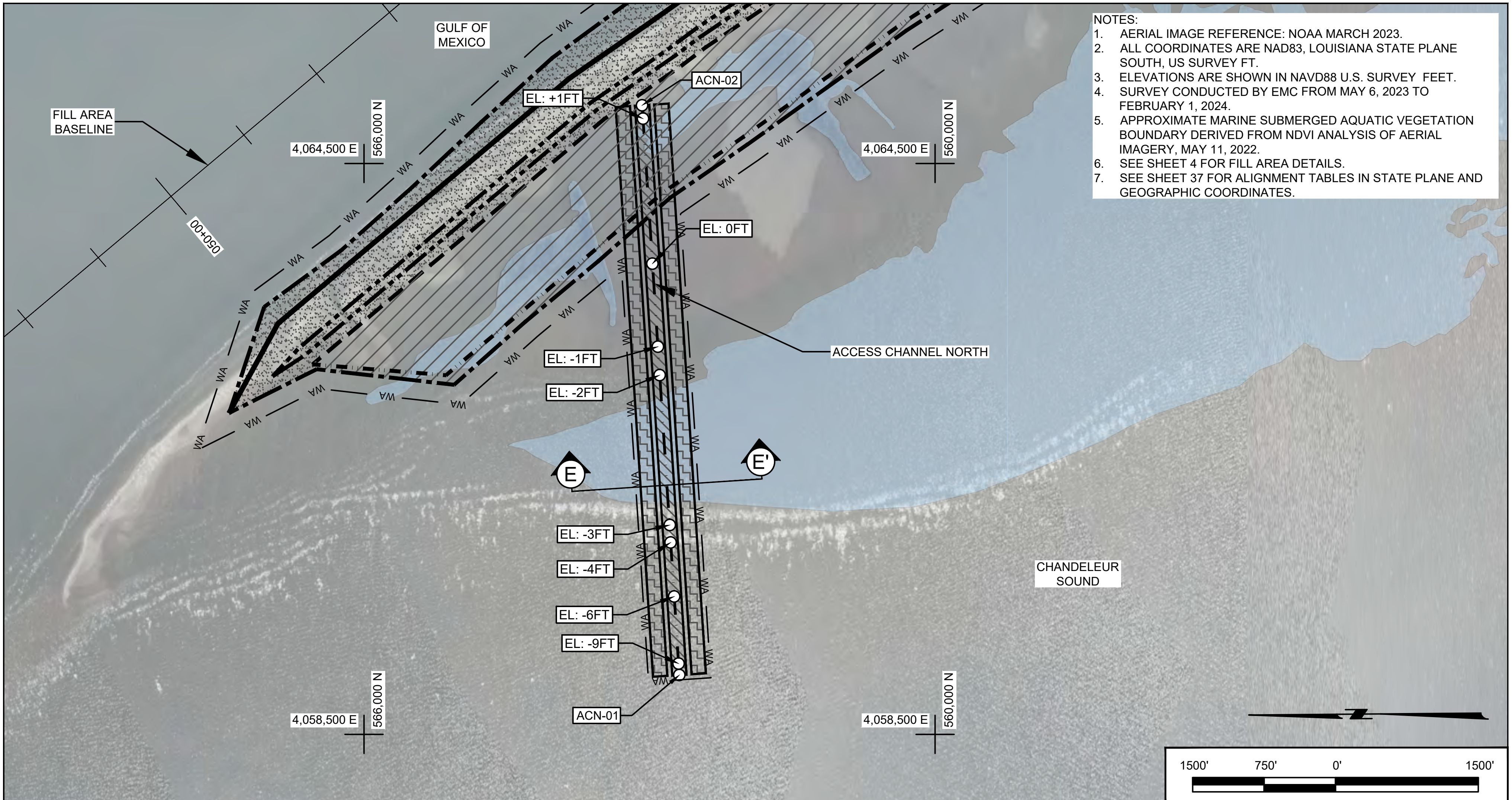
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NORTH CHANDELEUR ISLAND RESTORATION AREA TYPICAL SECTIONS

DATE: NOVEMBER 2024

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
4. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
5. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
6. SEE SHEET 4 FOR FILL AREA DETAILS.
7. SEE SHEET 37 FOR ALIGNMENT TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.



LEGEND

FILL EXTENTS	
BEACH FILL CREST	
DUNE FILL CREST	
MARSH FILL CREST	
DUNE/MARSH INTERFACE	
BEACH/DUNE FILL	
MARSH FILL	
ACCESS CHANNEL	
TEMPORARY SIDECAST DISPOSAL	
WA	WORK AREA
ACN-01	ACCESS CHANNEL - NORTH ALIGNMENT COORDINATE
EL: -6FT	EXISTING GRADE ELEVATION
	APPROX. MARINE SUBMERGED AQUATIC VEGETATION
100+00	FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

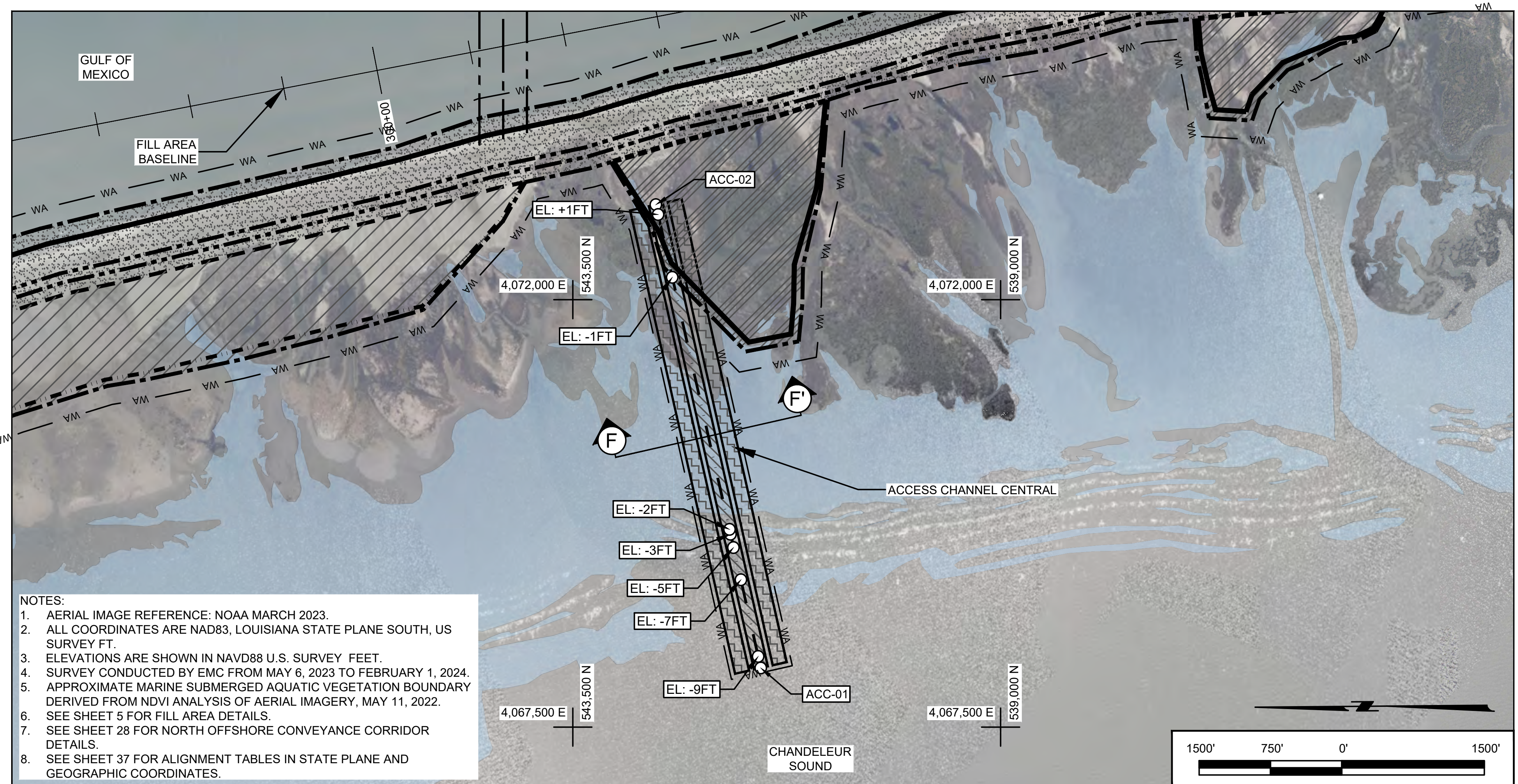
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL - NORTH PLAN VIEW

DATE: NOVEMBER 2024

SHEET 10 OF 40



NOTES:
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3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
4. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
5. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
6. SEE SHEET 5 FOR FILL AREA DETAILS.
7. SEE SHEET 28 FOR NORTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 37 FOR ALIGNMENT TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- BEACH FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/SAND RESERVOIR INTERFACE
- WA — WORK AREA
- BEACH/DUNE FILL
- MARSH FILL
- SAND RESERVOIR FILL
- FEEDER BEACH FILL
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL
- ACC-01 — ACCESS CHANNEL - CENTRAL ALIGNMENT COORDINATE
- EL: -6FT — EXISTING GRADE ELEVATION
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- 100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

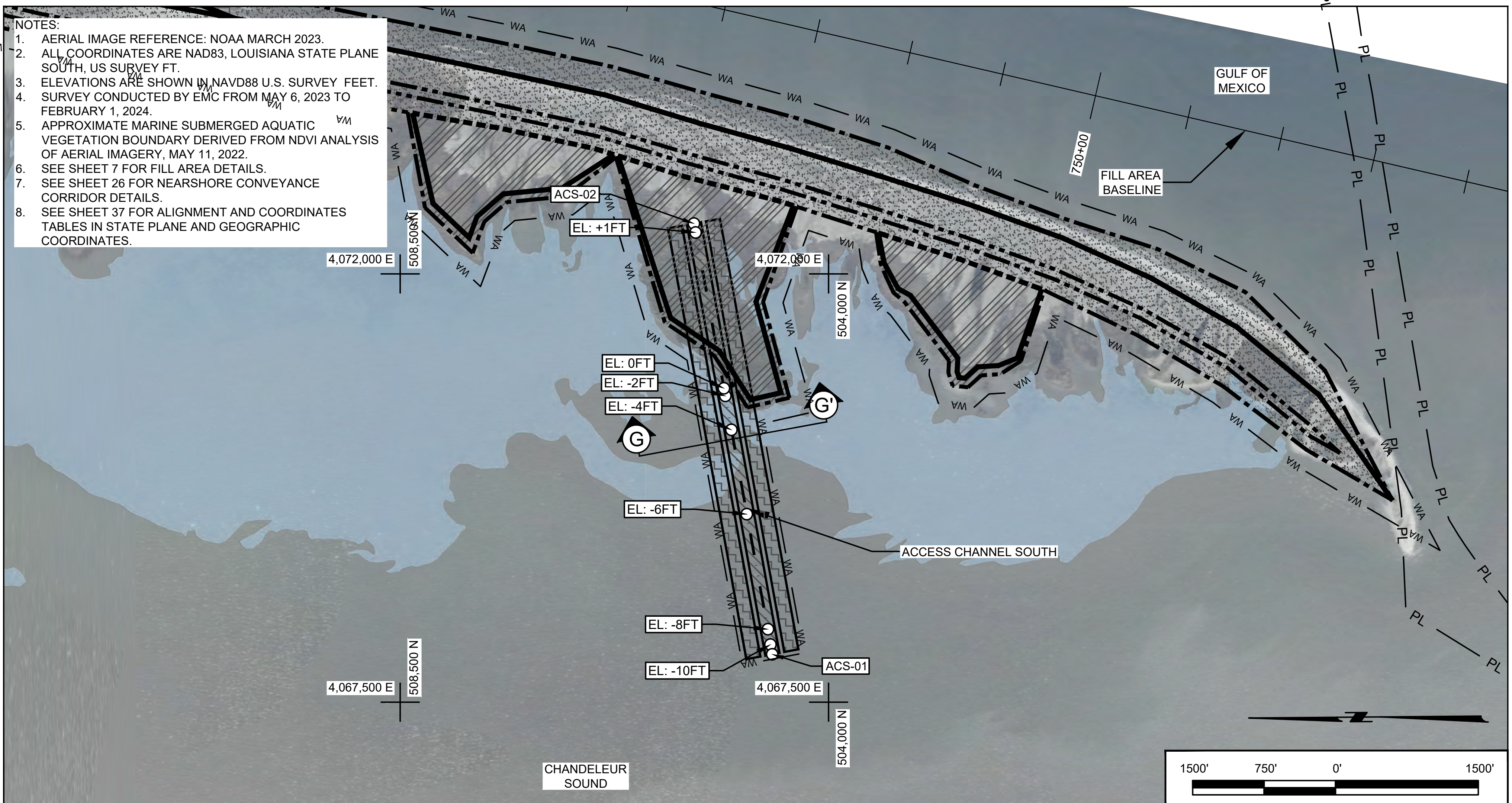
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL - CENTRAL PLAN VIEW

DATE: NOVEMBER 2024

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
4. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
5. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
6. SEE SHEET 7 FOR FILL AREA DETAILS.
7. SEE SHEET 26 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 37 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.



LEGEND

- FILL EXTENTS
- BEACH FILL CREST
- DUNE FILL CREST
- MARSH FILL CREST
- DUNE/SAND RESERVOIR INTERFACE
- WORK AREA (WA)
- BEACH/DUNE FILL
- SAND RESERVOIR FILL
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL
- NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT
- ACS-01: ACCESS CHANNEL - SOUTH ALIGNMENT COORDINATE
- EL: -6FT: EXISTING GRADE ELEVATION
- PL: PIPELINE
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- 100+00: FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

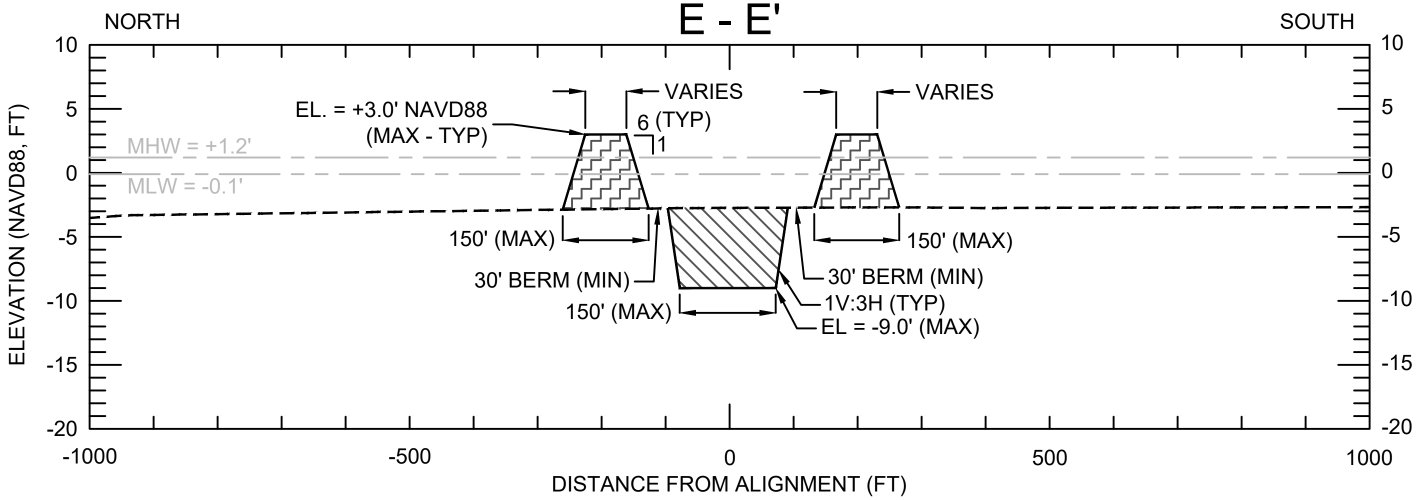
FEDERAL PROJECT NUMBER:

ACCESS CHANNEL - SOUTH PLAN VIEW

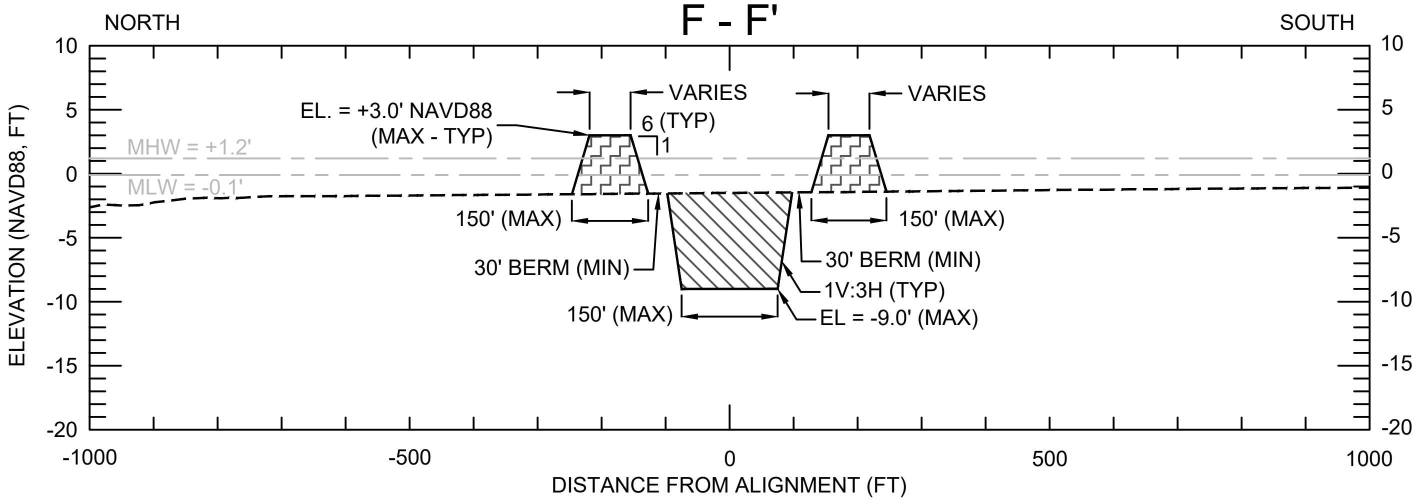
DATE: NOVEMBER 2024

SHEET 12 OF 40

E - E'



F - F'



LEGEND:

- EXISTING GRADE
- DESIGN
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL

SCALE:
H: 1" = 300'
V: 1" = 15'

NOTES:
1. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

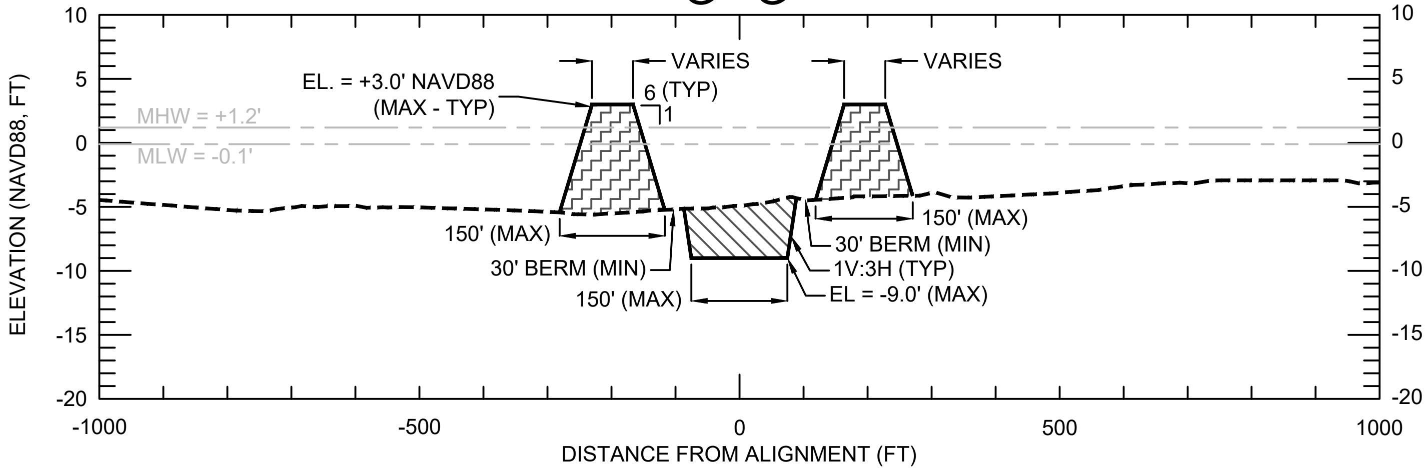
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL TYPICAL SECTIONS

DATE: NOVEMBER 2024

G - G'



LEGEND:

- EXISTING GRADE
- DESIGN
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL

SCALE:
H: 1" = 300'
V: 1" = 15'

NOTES:
1. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

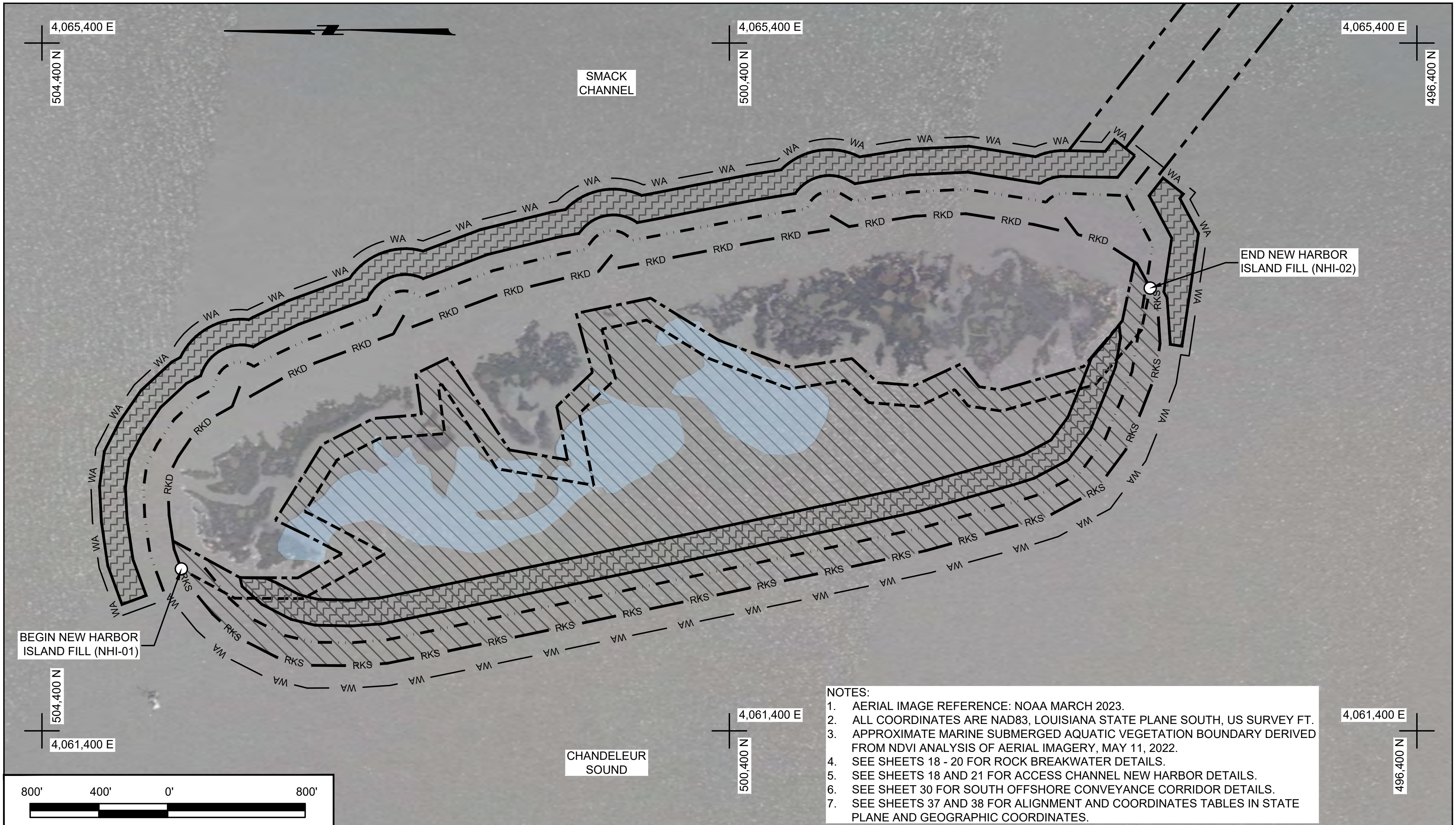
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL TYPICAL SECTION

DATE: NOVEMBER 2024



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
4. SEE SHEETS 18 - 20 FOR ROCK BREAKWATER DETAILS.
5. SEE SHEETS 18 AND 21 FOR ACCESS CHANNEL NEW HARBOR DETAILS.
6. SEE SHEET 30 FOR SOUTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEETS 37 AND 38 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- MARSH FILL EXTENTS
- ACCESS CHANNEL ALIGNMENT
- RKD — DETACHED ROCK BREAKWATER ALIGNMENT
- RKS — SHORELINE ROCK BREAKWATER ALIGNMENT
- WA — WORK AREA
- TEMPORARY SIDECAST DISPOSAL AREA
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- SOUTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

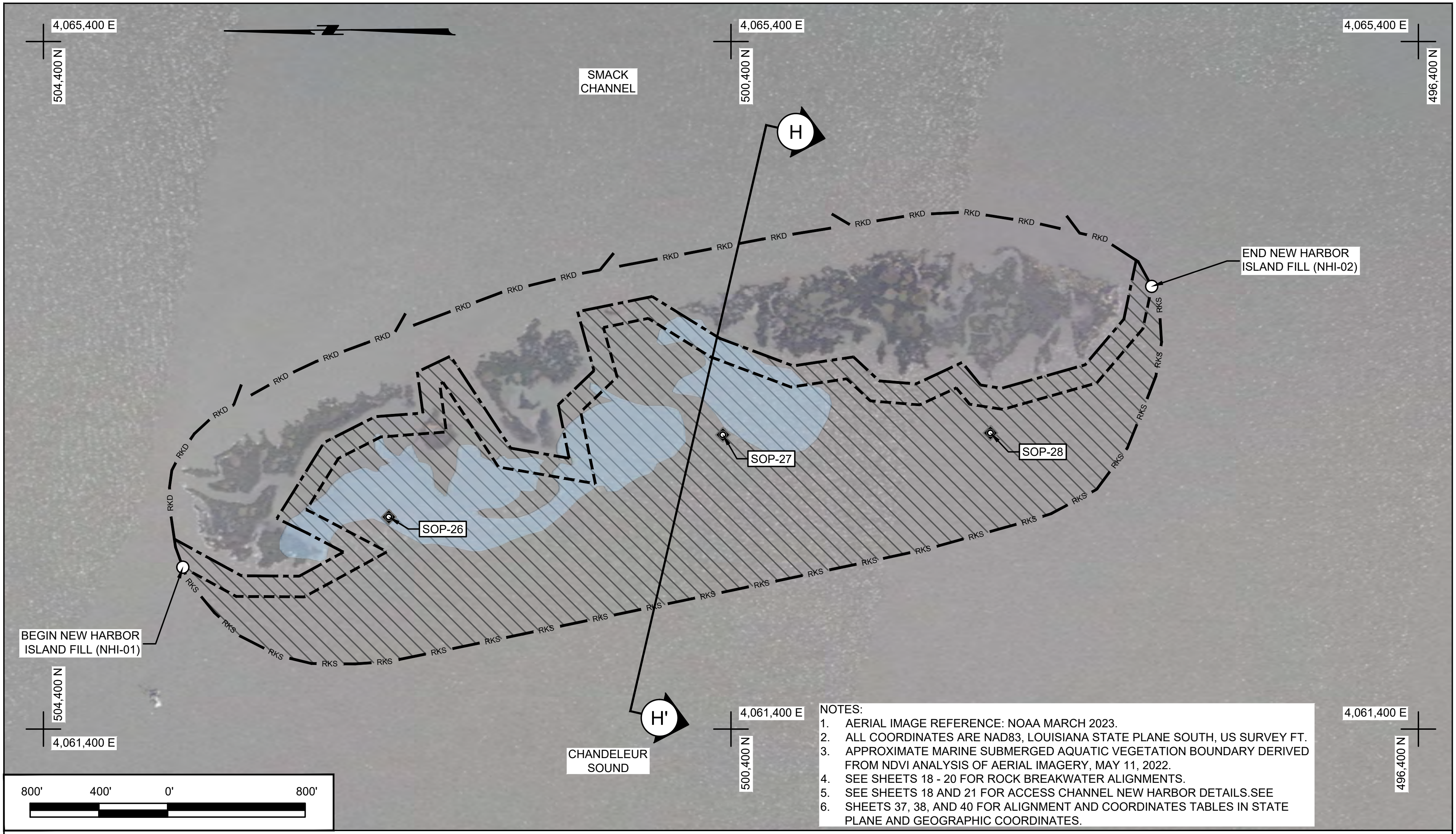
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NEW HARBOR ISLAND RESTORATION AREA OVERVIEW

DATE: NOVEMBER 2024

SHEET 15 OF 40



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
4. SEE SHEETS 18 - 20 FOR ROCK BREAKWATER ALIGNMENTS.
5. SEE SHEETS 18 AND 21 FOR ACCESS CHANNEL NEW HARBOR DETAILS.SEE
6. SHEETS 37, 38, AND 40 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- MARSH FILL CREST ALIGNMENT
- MARSH FILL
- RKD — DETACHED ROCK BREAKWATER ALIGNMENT
- RKS — SHORELINE ROCK BREAKWATER ALIGNMENT
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- SETTLEMENT AND OVERWASH MONITORING SYSTEM

BY	DESCRIPTION	DATE

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

CHANDELEUR ISLAND RESTORATION PROJECT

NEW HARBOR ISLAND FILL AREA PLAN VIEW

STATE PROJECT NUMBER: PO-0199

DATE: NOVEMBER 2024

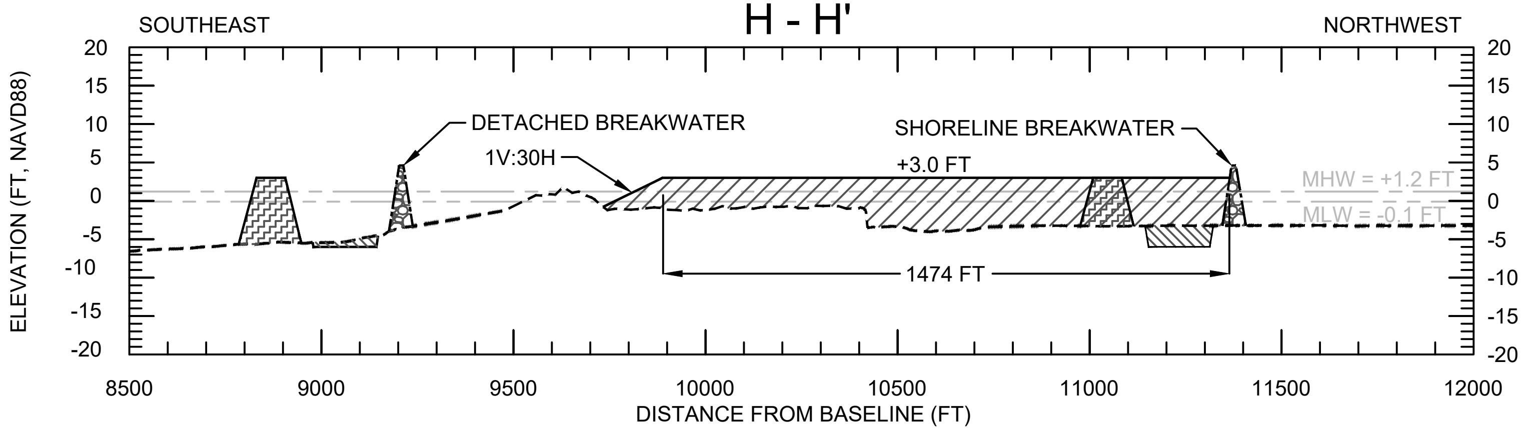
DRAWN BY: STEVE DARTEZ

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

APPROVED BY: MICHAEL T. POFF, P.E.

FEDERAL PROJECT NUMBER:

H - H'



NOTES:
1. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEE SHEETS 18 - 20 FOR ROCK BREAKWATER DETAILS
3. SEE SHEET 21 FOR ACCESS CHANNEL NEW HARBOR TYPICAL SECTION.
4. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

DESIGN ELEMENTS:
1. DESIGN DIMENSIONS ARE MEASURED FROM THE CREST LINES OF THE RESPECTIVE FEATURES.
2. MARSH DESIGN ELEVATION = +3.0 FT NAVD88.
3. MARSH DESIGN SLOPE = 1V:30H.
4. A +1.0 FT VERTICAL CONSTRUCTION TOLERANCE IS INCLUDED TO ACCOUNT FOR CONSTRUCTION METHODS AND CONSOLIDATION / SETTLEMENT OF THE FILL.

LEGEND:
- EXISTING GRADE
- DESIGN
- MARSH FILL
- ROCK BREAKWATER
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL

SCALE:
H: 1" = 500'
V: 1" = 25'

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726
DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

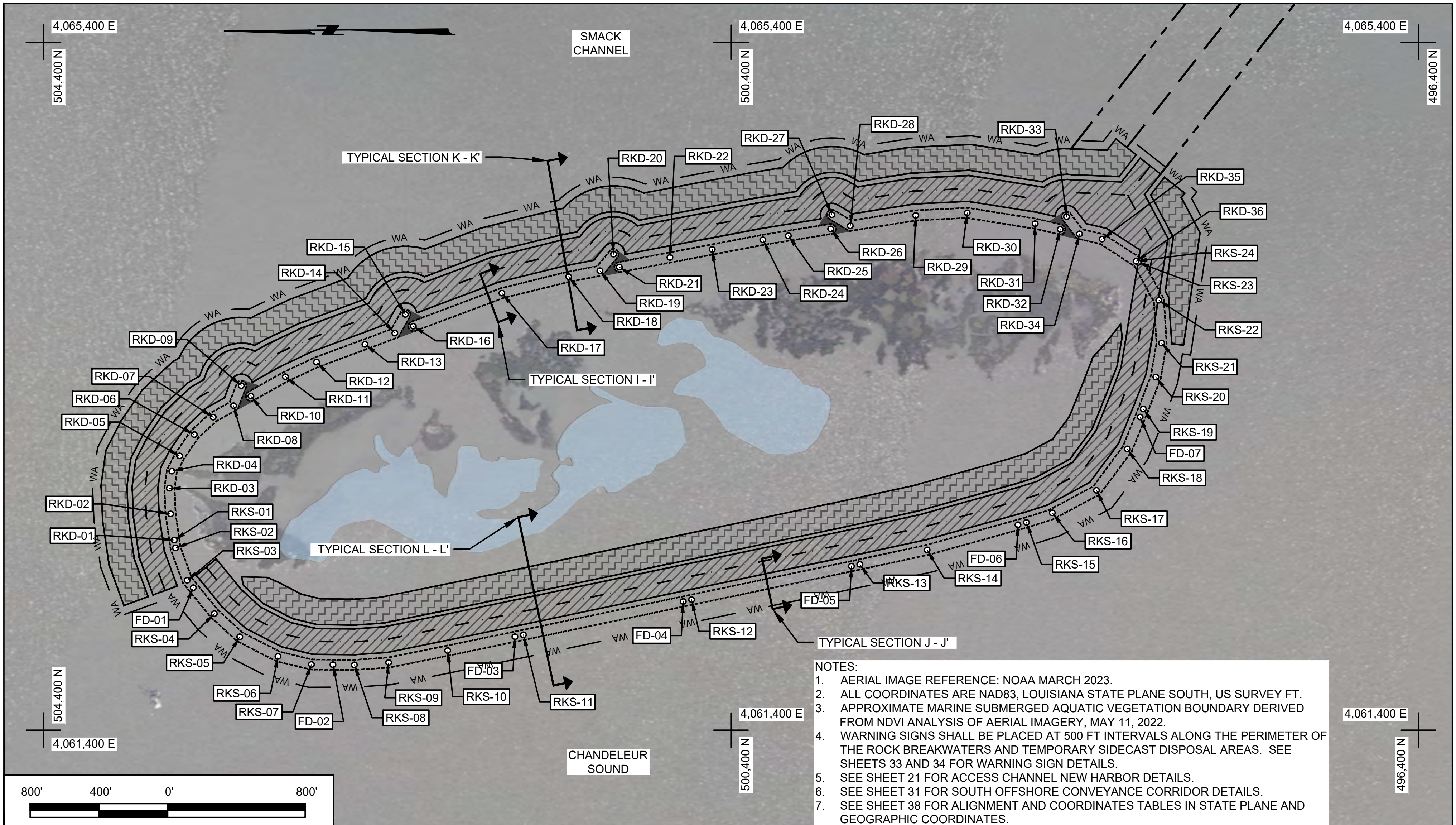
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NEW HARBOR ISLAND FILL AREA TYPICAL SECTION

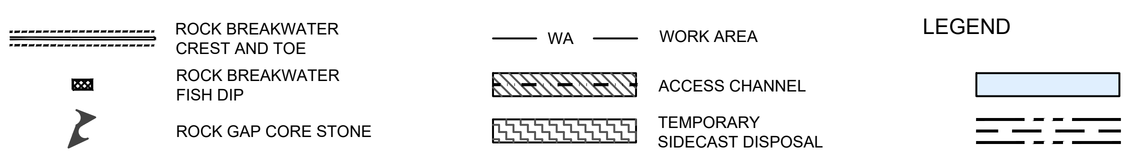
DATE: NOVEMBER 2024



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.
4. WARNING SIGNS SHALL BE PLACED AT 500 FT INTERVALS ALONG THE PERIMETER OF THE ROCK BREAKWATERS AND TEMPORARY SIDECAST DISPOSAL AREAS. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.
5. SEE SHEET 21 FOR ACCESS CHANNEL NEW HARBOR DETAILS.
6. SEE SHEET 31 FOR SOUTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 38 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND



BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

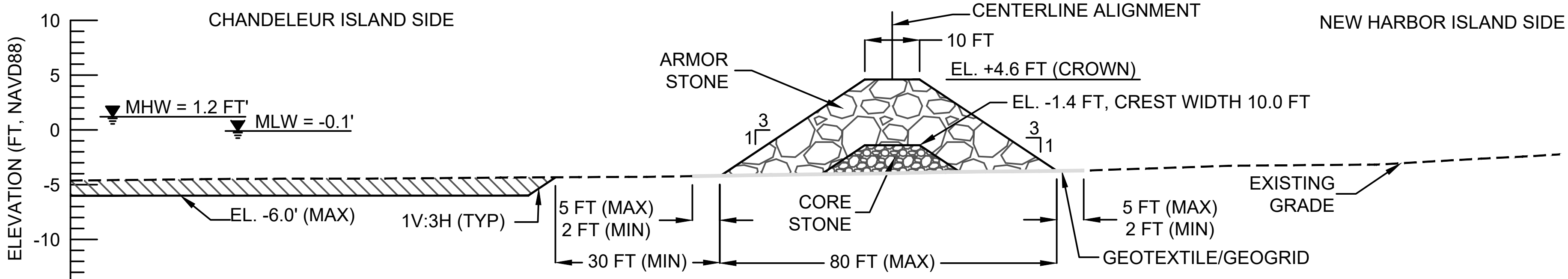
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NEW HARBOR ISLAND ROCK BREAKWATER AND ACCESS CHANNEL PLAN VIEW

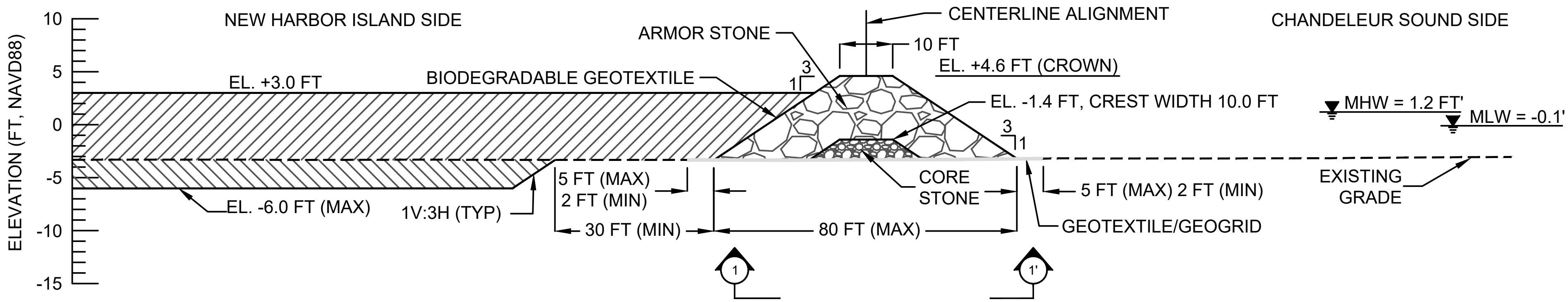
DATE: NOVEMBER 2024

I -I'



DETACHED ROCK BREAKWATER TYPICAL SECTION

J -J'



SHORELINE ROCK BREAKWATER TYPICAL SECTION

LEGEND:

- EXISTING GRADE
- DESIGN
- ARMOR STONE
- CORE STONE
- MARSH FILL
- ACCESS CHANNEL

NOTES:
1. SECTIONS ARE VIEWED AS LOOKING SOUTH.
2. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
3. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

DESIGN ELEMENTS:
1. DESIGN DIMENSIONS ARE MEASURED FROM THE CREST LINES OF THE RESPECTIVE FEATURES.
2. BREAKWATER DESIGN ELEVATION = +4.6 FT NAVD88.
4. BREAKWATER DESIGN SLOPES = 1V:3H.
5. A +1.0 FT VERTICAL CONSTRUCTION TOLERANCE IS INCLUDED TO ACCOUNT FOR CONSTRUCTION METHODS AND CONSOLIDATION / SETTLEMENT OF THE FILL.

SCALE:
H: 1" = 30'
V: 1" = 15'

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

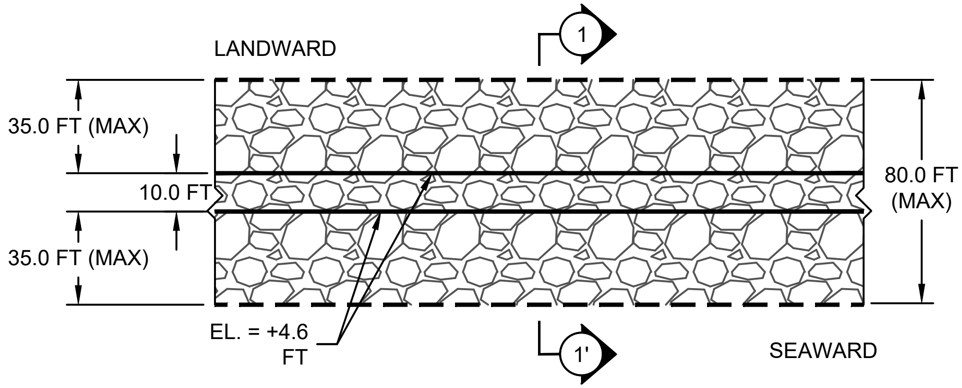
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NEW HARBOR ISLAND ROCK BREAKWATER TYPICAL SECTIONS

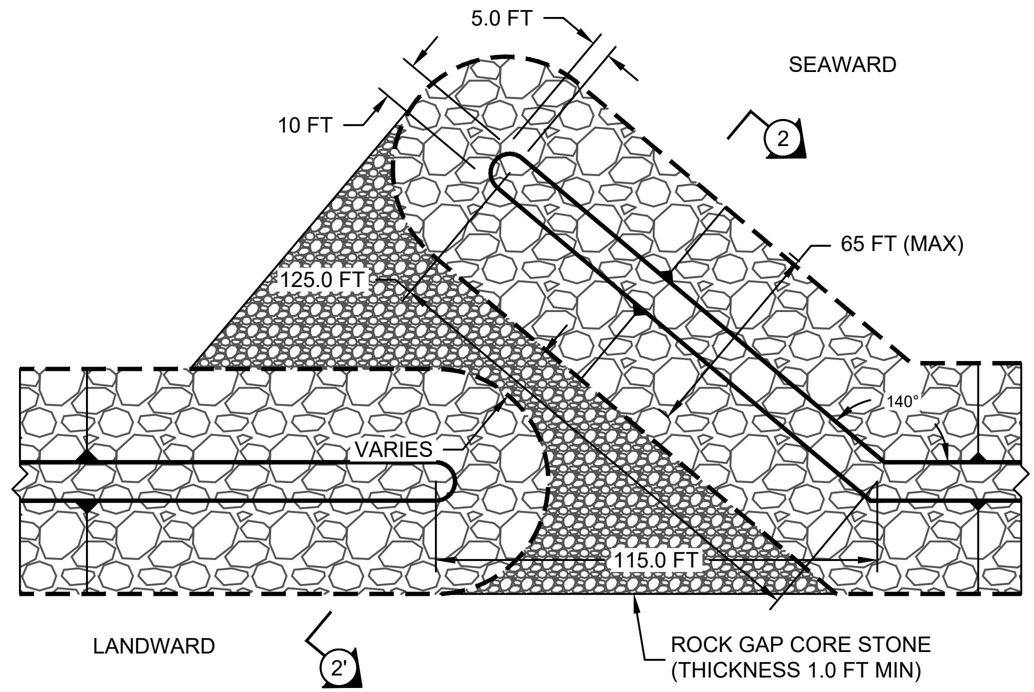
DATE: NOVEMBER 2024



CROWN CREST — TOE OF BREAKWATER AT EXISTING GRADE

SHORELINE ROCK BREAKWATER TYPICAL SECTION PLAN VIEW

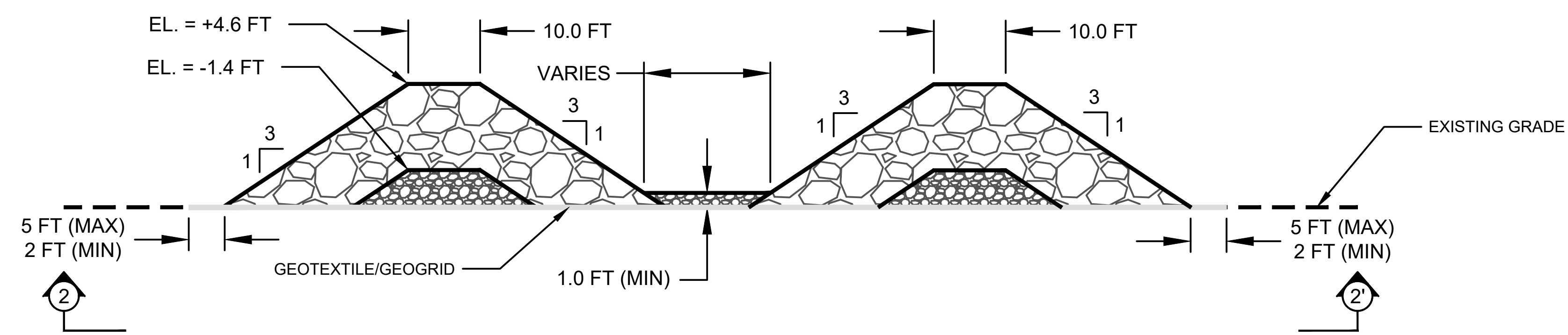
SCALE: AS SHOWN



CROWN CREST — TOE OF BREAKWATER AT EXISTING GRADE

DETACHED ROCK BREAKWATER TYPICAL PLAN VIEW

SCALE: AS SHOWN



DETACHED ROCK BREAKWATER GAP TYPICAL SECTION

SCALE: AS SHOWN

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

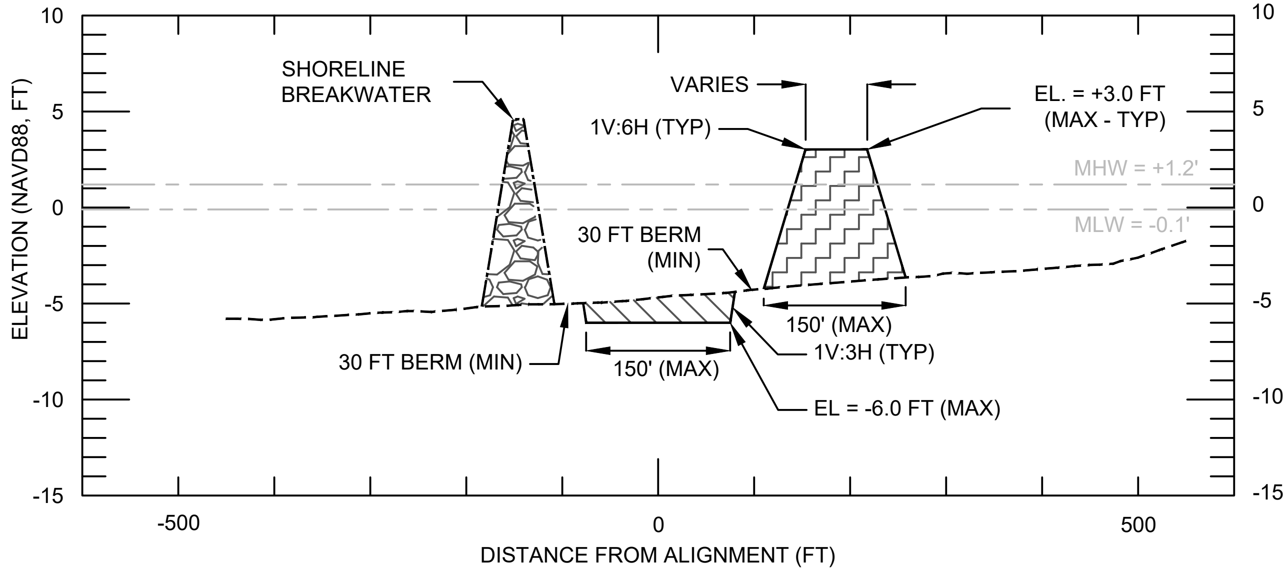
FEDERAL PROJECT NUMBER:

NEW HARBOR ISLAND ROCK BREAKWATER DETAILS

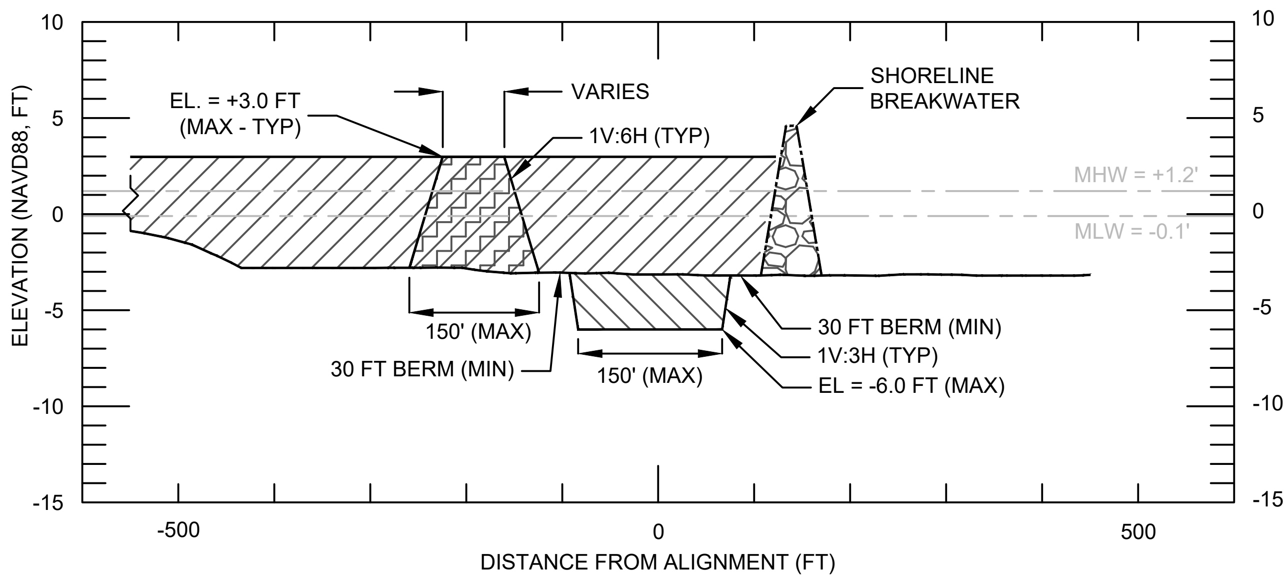
DATE: NOVEMBER 2024

SHEET 20 OF 40

K - K'



L - L'



NOTES:

1. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. TEMPORARY SIDECAST DISPOSAL AREAS TO BE DEGRADE BACK TO EXISTING CONDITIONS AND SPOIL PLACED IN THE ACCESS CHANNEL PRIOR TO MARSH FILL PLACEMENT.
3. SEE SHEETS 33 AND 34 FOR WARNING SIGN DETAILS.

SCALE:
H: 1" = 200'
V: 1" = 10'

LEGEND:

- EXISTING GRADE
- DESIGN
- MARSH FILL
- ROCK BREAKWATER
- ACCESS CHANNEL
- TEMPORARY SIDECAST DISPOSAL

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

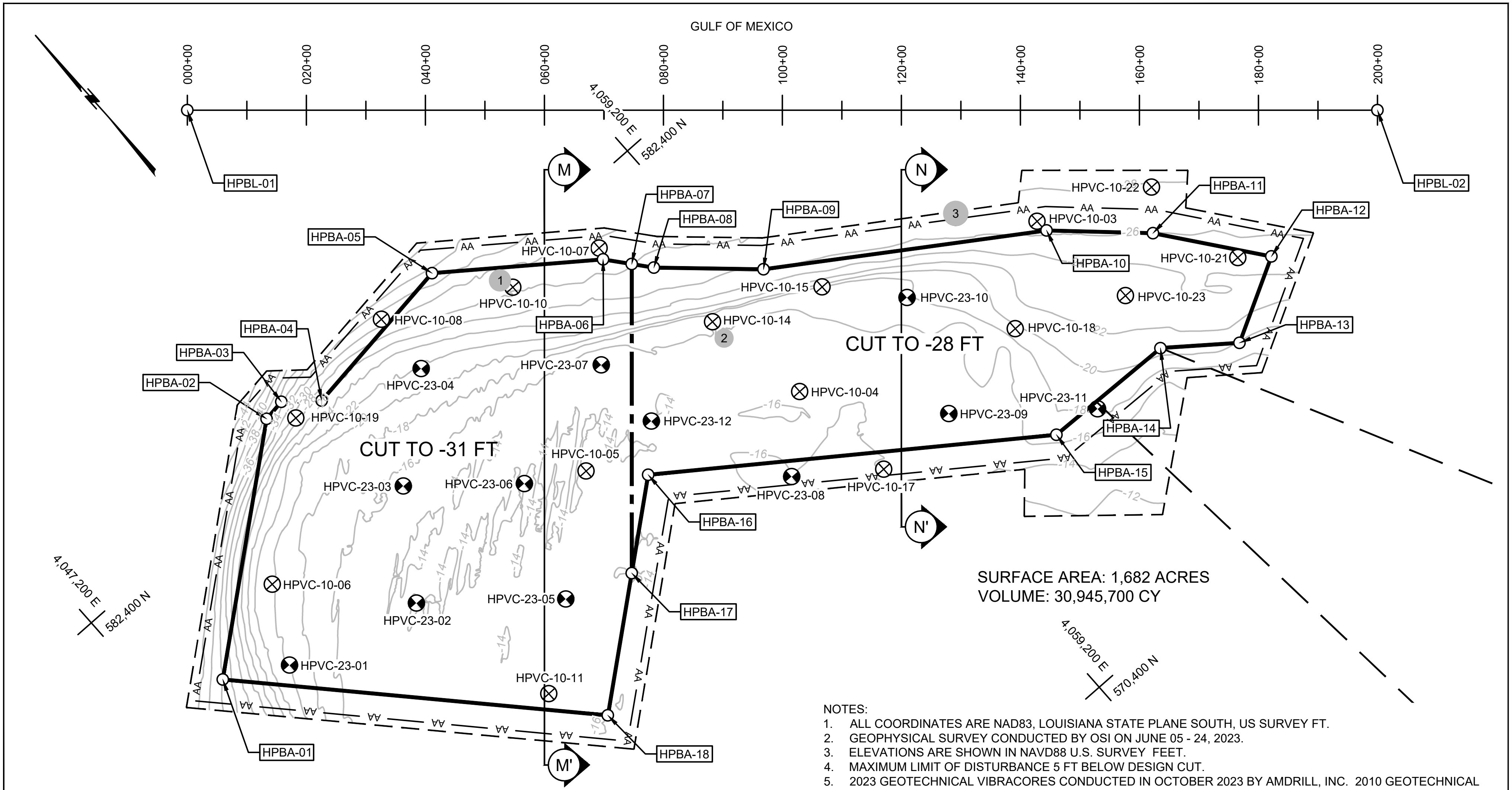
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ACCESS CHANNEL - NEW HARBOR
TYPICAL SECTION

DATE: NOVEMBER 2024

SHEET 21 OF 40



NOTES:
1. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
2. GEOPHYSICAL SURVEY CONDUCTED BY OSI ON JUNE 05 - 24, 2023.
3. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
4. MAXIMUM LIMIT OF DISTURBANCE 5 FT BELOW DESIGN CUT.
5. 2023 GEOTECHNICAL VIBRACORES CONDUCTED IN OCTOBER 2023 BY AMDRILL, INC. 2010 GEOTECHNICAL VIBRACORES CONDUCTED IN JUNE 2010 BY COASTAL PLANNING AND ENGINEERING, INC.
6. SEE SHEET 25 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 37 FOR COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.
8. SEE SHEET 40 FOR AVOIDANCE AREA DETAILS.

LEGEND

(solid heavy line)	DESIGN CUT TOE
(dash-dot heavy line)	DESIGN CUT STEP
(dashed line)	GEOPHYSICAL SURVEY LIMITS
-14	BATHYMETRIC CONTOUR (OSI, 2023)
AA	ALLOWABLE ANCHOR AREA (400 FT OFFSET FROM DESIGN CUT)
1	AVOIDANCE AREA (GOODWIN, 2023)
HPVC-23-04	2023 GEOTECHNICAL VIBRACORE (AMDRILL, 2023)
HPVC-10-08	2010 GEOTECHNICAL VIBRACORE (CPE, 2010)
(long dashed line)	NEARSHORE CONVEYANCE CORRIDOR LIMITS
HPBA-01	BORROW AREA ALIGNMENT COORDINATE
(line with tick)	BORROW AREA BASELINE

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

CHANDELEUR ISLAND RESTORATION PROJECT

HEWES POINT BORROW AREA PLAN VIEW

STATE PROJECT NUMBER: PO-0199

DATE: NOVEMBER 2024

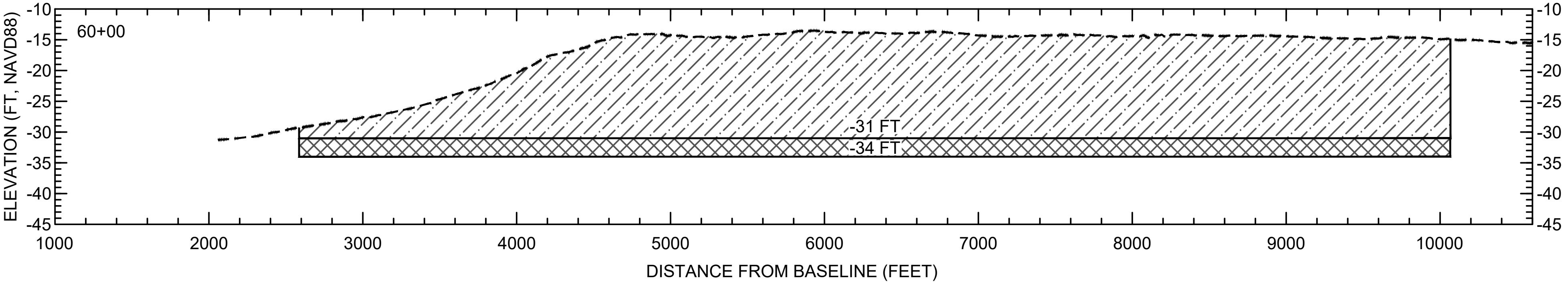
DRAWN BY: STEVE DARTEZ

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

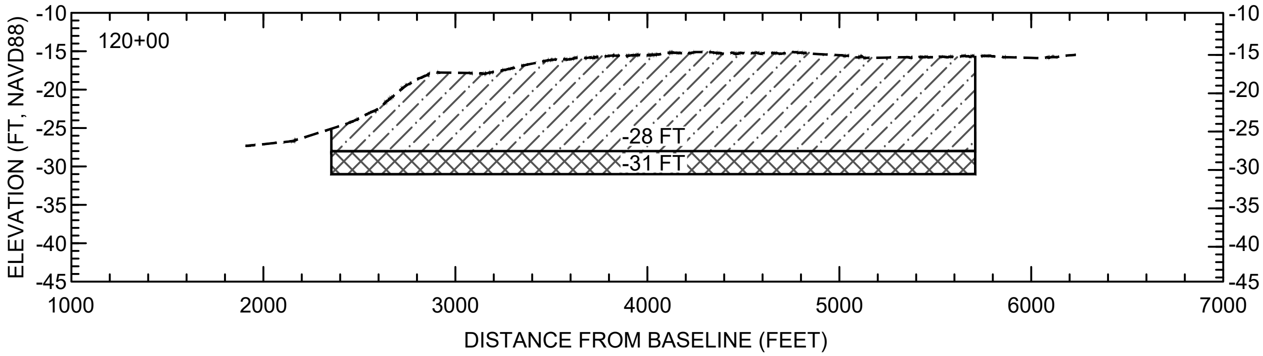
APPROVED BY: MICHAEL T. POFF, P.E.

FEDERAL PROJECT NUMBER:

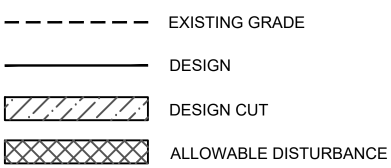
M - M'



N - N'



LEGEND:



SCALE:
H: 1" = 500'
V: 1" = 25'

NOTES:
1. GEOPHYSICAL SURVEY CONDUCTED BY OSI ON JUNE 05 - 24, 2023.
2. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
3. MEAN HIGH WATER = +1.2 FT NAVD88, MEAN LOW WATER = -0.1 FT NAVD88.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

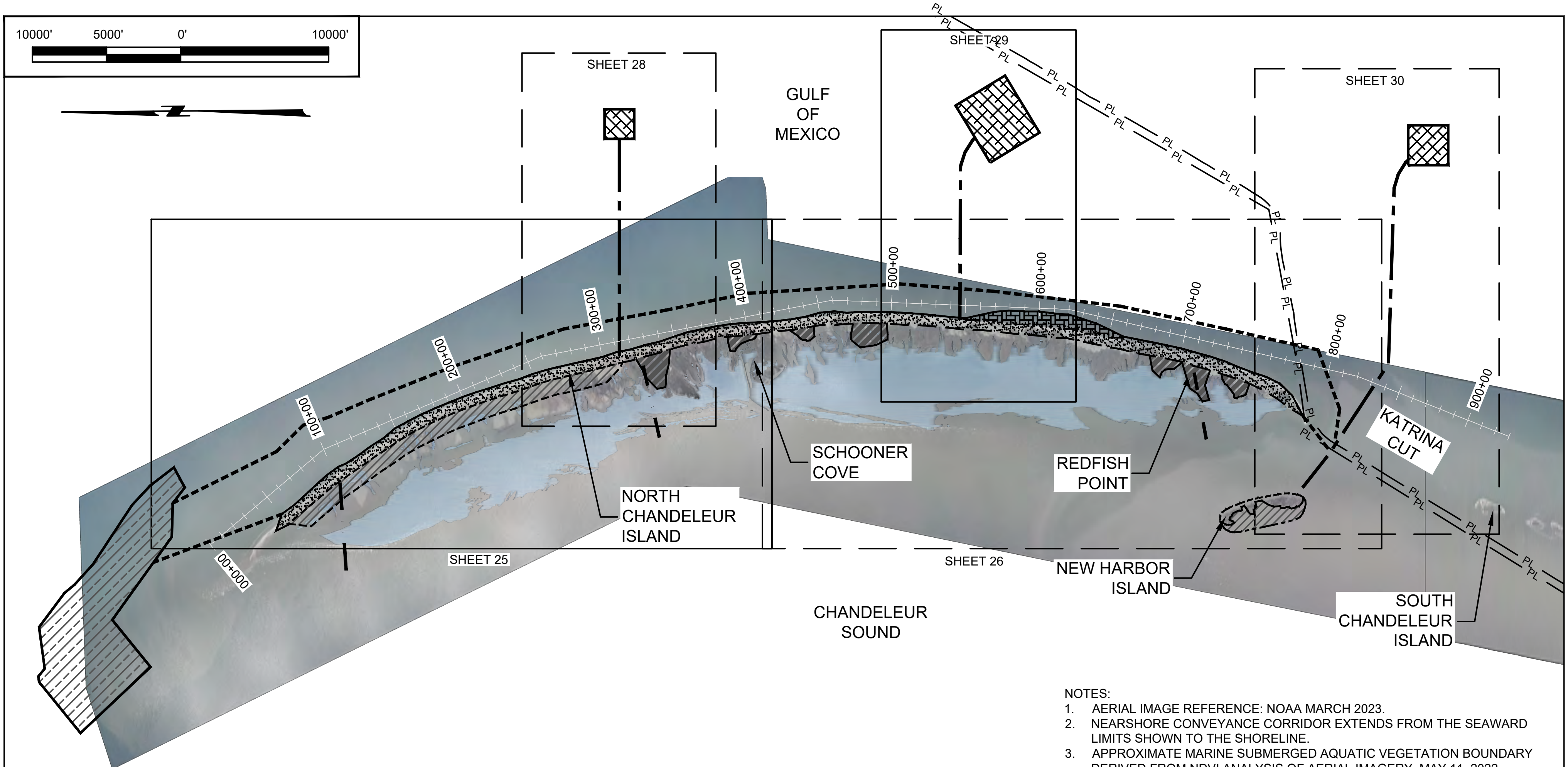
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

HEWES POINT BORROW AREA TYPICAL SECTIONS

DATE: NOVEMBER 2024



NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
3. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.

LEGEND

- BEACH/DUNE FILL AREA
- MARSH FILL AREA
- SAND RESERVOIR FILL AREA
- FEEDER BEACH FILL AREA
- BORROW AREA LIMITS
- PUMP-OUT AREA LIMITS
- ACCESS CHANNEL ALIGNMENT
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- APPROX. MARINE SUBMERGED AQUATIC VEGETATION
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- PL — PIPELINE
- 100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: BEVIN BARRINGER, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

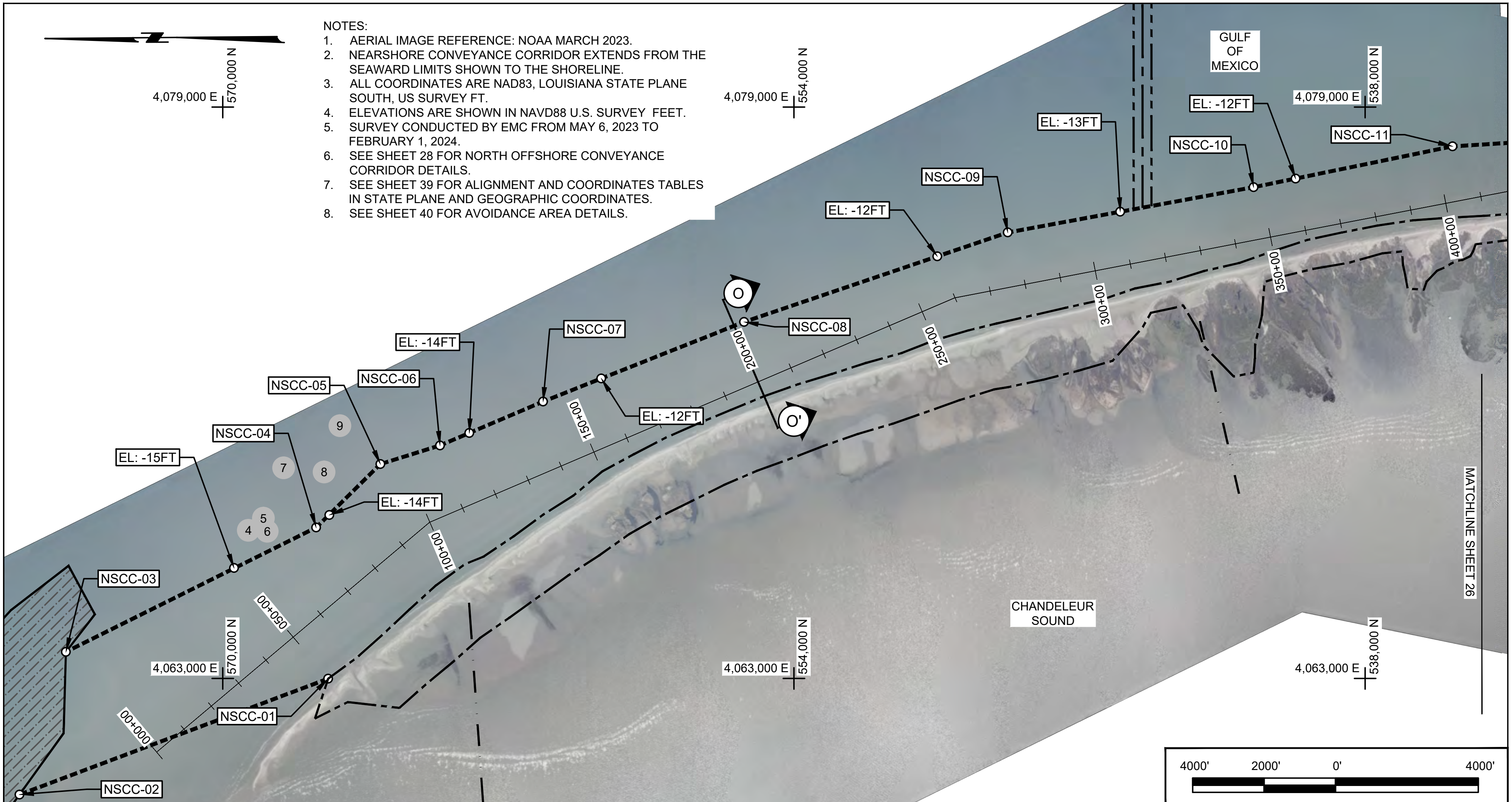
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

PUMP-OUT AREA AND CONVEYANCE CORRIDOR OVERVIEW

DATE: OCTOBER 2024

NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
3. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
4. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
5. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
6. SEE SHEET 28 FOR NORTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.
8. SEE SHEET 40 FOR AVOIDANCE AREA DETAILS.



LEGEND

NEARSHORE CONVEYANCE CORRIDOR LIMITS

OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT/LIMITS

NSCC-01 — NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE

EL: -16FT — EXISTING GRADE ELEVATION (FT, NAVD88)

FILL EXTENTS

ACCESS CHANNEL

BORROW AREA

4 — AVOIDANCE AREA (TAR 2011)

100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

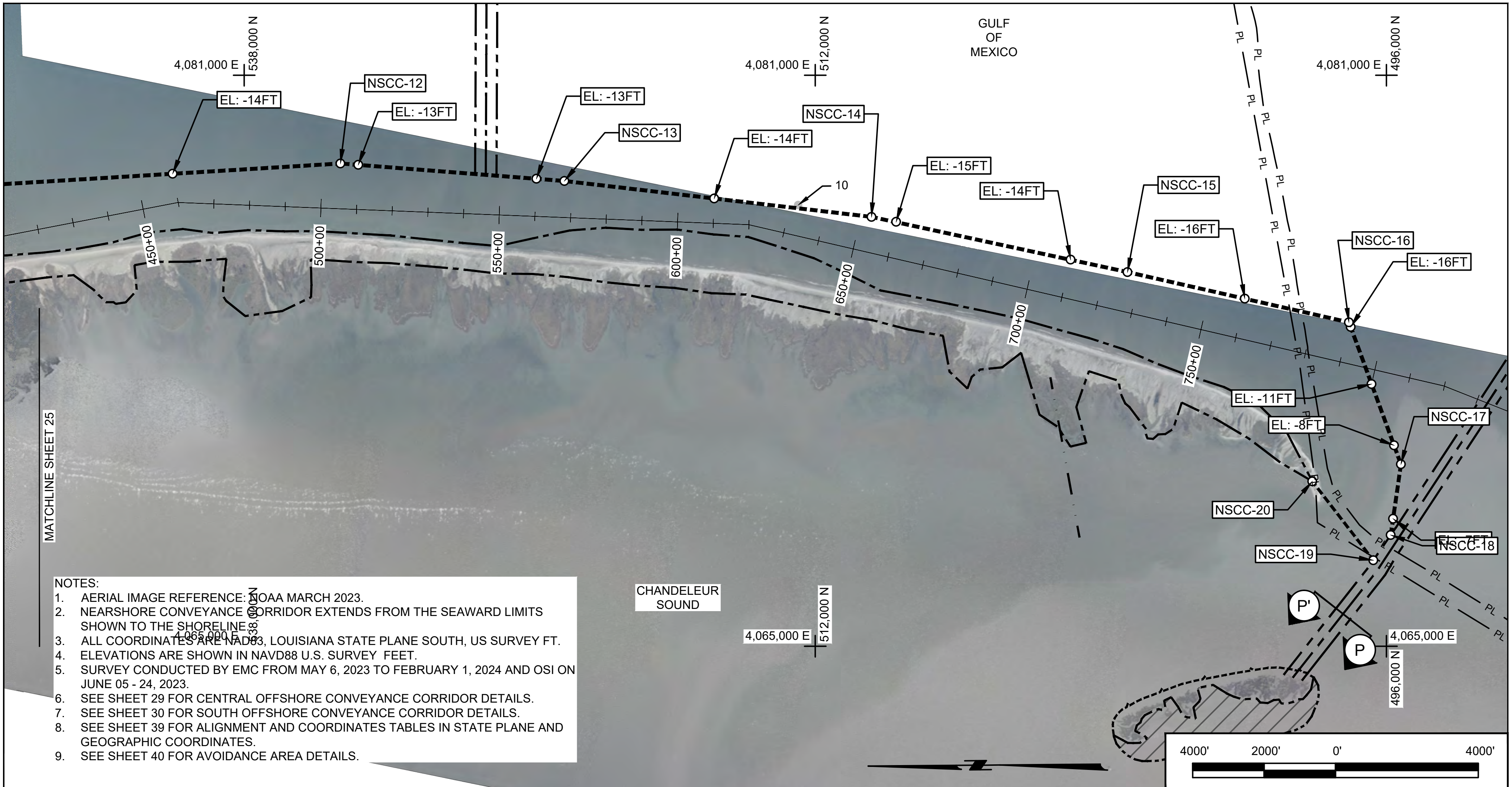
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NEARSHORE CONVEYANCE CORRIDOR PLAN VIEW

DATE: NOVEMBER 2024



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
3. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
4. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
5. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024 AND OSI ON JUNE 05 - 24, 2023.
6. SEE SHEET 29 FOR CENTRAL OFFSHORE CONVEYANCE CORRIDOR DETAILS.
7. SEE SHEET 30 FOR SOUTH OFFSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.
9. SEE SHEET 40 FOR AVOIDANCE AREA DETAILS.

LEGEND

- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT/LIMITS
- NSCC-01 — NEARSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE
- EL: -16FT — EXISTING GRADE ELEVATION (FT, NAVD88)
- FILL EXTENTS
- ACCESS CHANNEL
- SHORELINE BREAKWATER
- DETACHED BREAKWATER
- 10 — AVOIDANCE AREA (TAR 2011)
- PL — PIPELINE
- 100+00 — FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

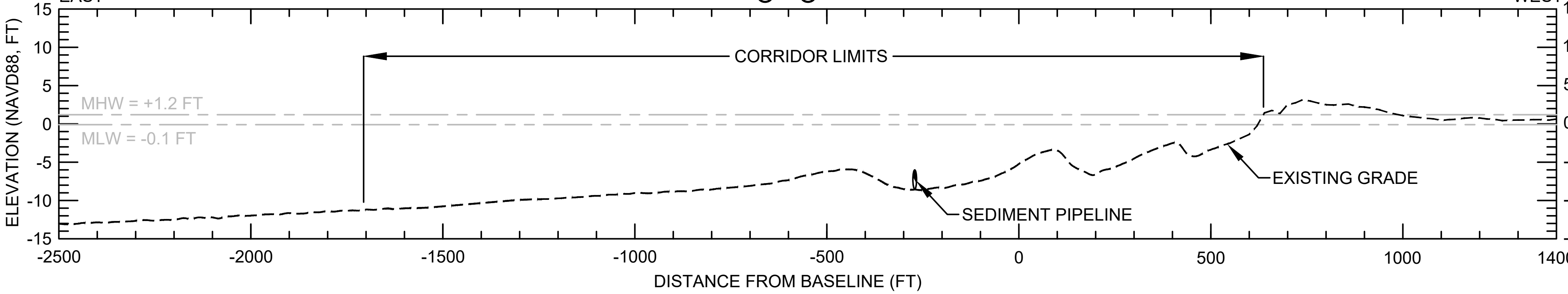
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

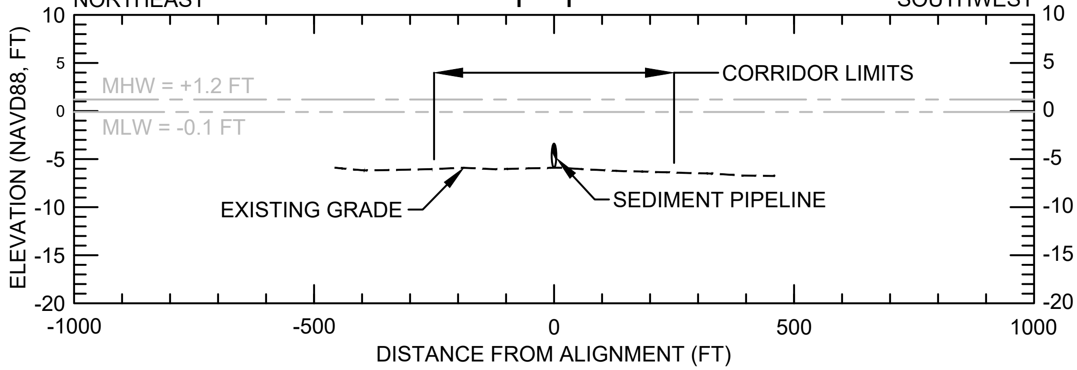
NEARSHORE CONVEYANCE CORRIDOR PLAN VIEW

DATE: NOVEMBER 2024

O - O'



P - P'



SCALE:
H: 1" = 400'
V: 1" = 20'

NOTES:
1. SURVEY CONDUCTED BY EMC, INC. FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
2. SEDIMENT PIPELINE INSTALLATION DETAILS ARE THE SAME FOR THE OFFSHORE CONVEYANCE CORRIDORS SHOWN ON SHEETS 28 - 30.
3. SEE SHEET 39 FOR ALIGNMENTS.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

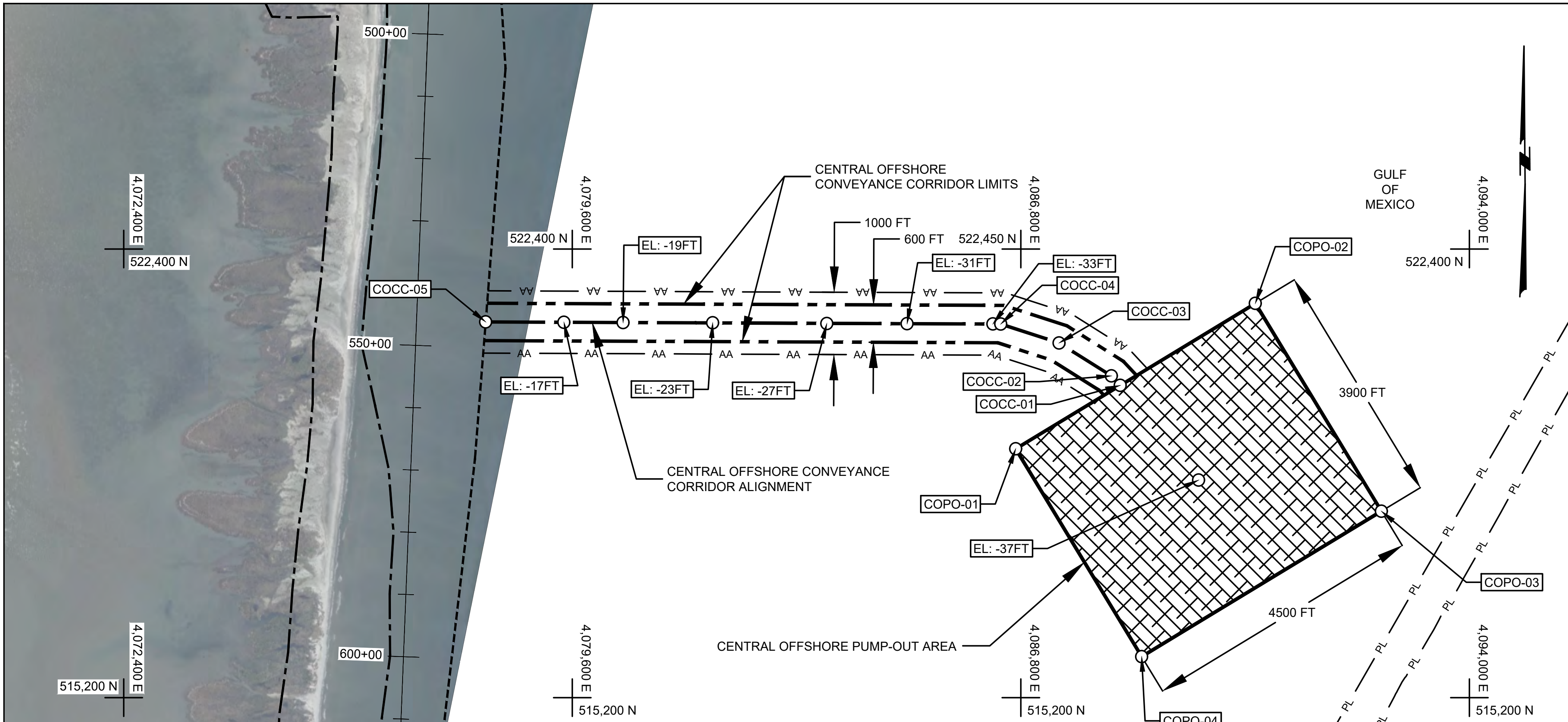
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NEARSHORE CONVEYANCE CORRIDOR TYPICAL SECTIONS

DATE: NOVEMBER 2024



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL ANCHORING WITHIN THE PUMP-OUT AREA SHALL BE CONDUCTED WITHIN THE PUMP-OUT AREA LIMITS.
3. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
4. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
5. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
6. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024.
7. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

FILL EXTENTS

CENTRAL OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

CENTRAL OFFSHORE PUMP-OUT AREA

NEARSHORE CONVEYANCE CORRIDOR LIMITS

COPO-01 — CENTRAL OFFSHORE PUMP-OUT AREA COORDINATE

COCC-01 — CENTRAL OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE

EL: -16FT — EXISTING GRADE ELEVATION(FT, NAVD88)

AA — ANCHORAGE AREA

FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

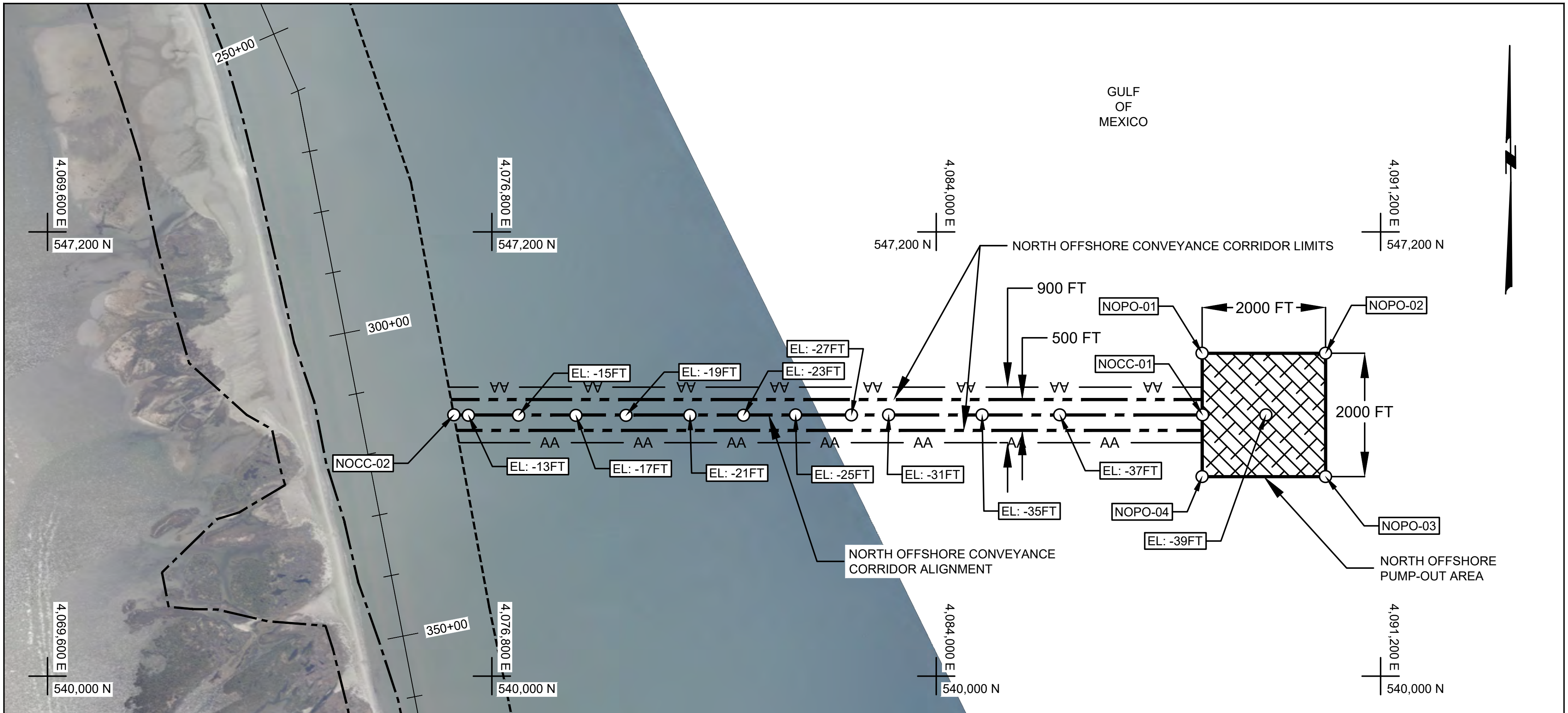
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

CENTRAL OFFSHORE PUMP-OUT AREA AND CONVEYANCE CORRIDOR PLAN VIEW

DATE: NOVEMBER 2024

SHEET 29 OF 40



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL ANCHORING WITHIN THE PUMP-OUT AREA SHALL BE CONDUCTED WITHIN THE PUMP-OUT AREA LIMITS.
3. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
4. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
5. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
6. SURVEY CONDUCTED BY OSI ON JUNE 05 - 24, 2023.
7. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.

LEGEND

- FILL EXTENTS
- NORTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT
- NORTH OFFSHORE PUMP-OUT AREA
- NEARSHORE CONVEYANCE CORRIDOR LIMITS
- NOPO-01 — NORTH OFFSHORE PUMP-OUT AREA COORDINATE
- NOCC-01 — NORTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE
- EL: -16FT — EXISTING GRADE ELEVATION(FT, NAVD88)
- AA — ANCHORAGE AREA
- FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
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LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

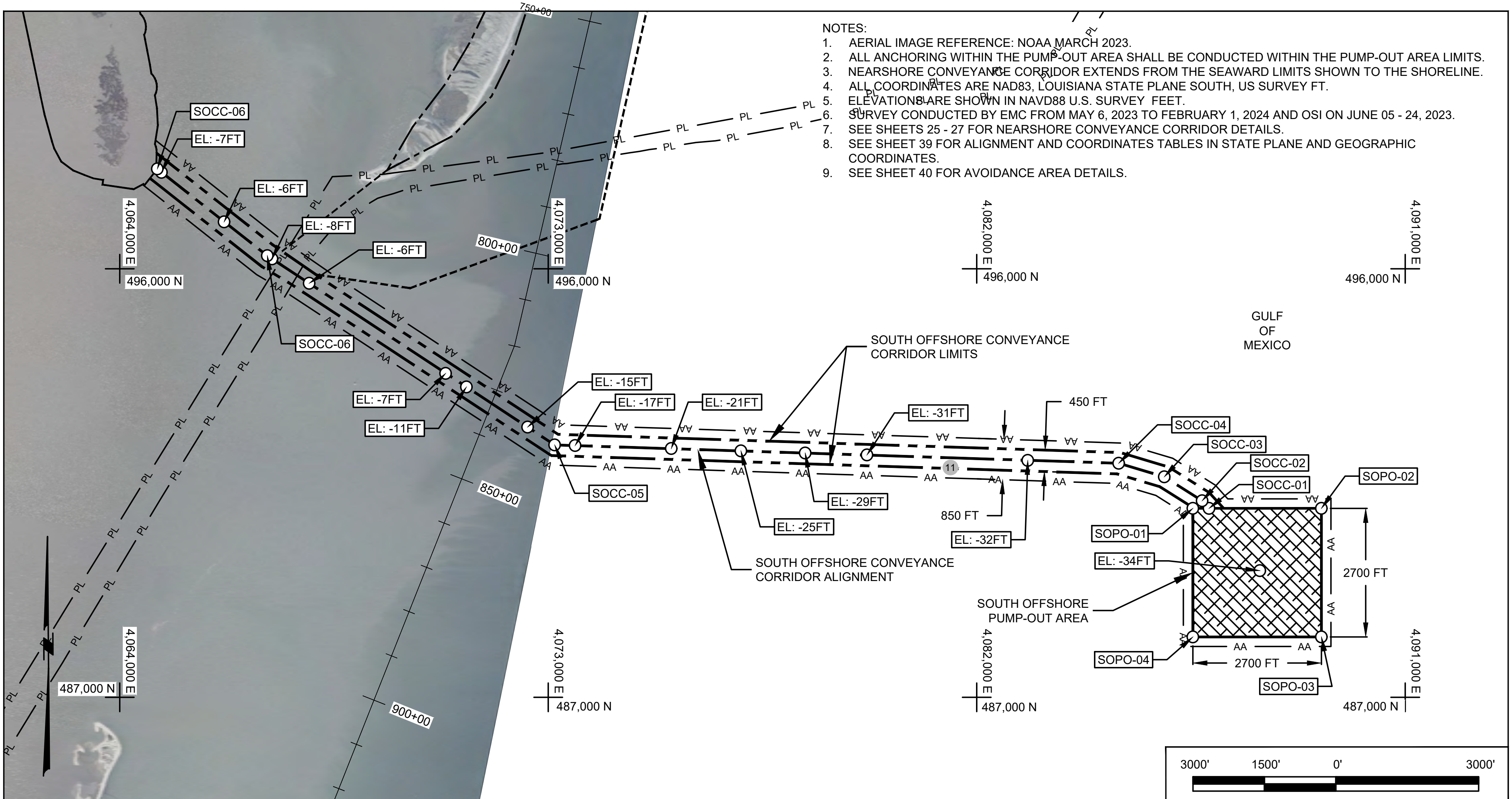
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

NORTH OFFSHORE PUMP-OUT AREA AND CONVEYANCE CORRIDOR PLAN VIEW

DATE: NOVEMBER 2024

SHEET 28 OF 40



NOTES:

1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. ALL ANCHORING WITHIN THE PUMP-OUT AREA SHALL BE CONDUCTED WITHIN THE PUMP-OUT AREA LIMITS.
3. NEARSHORE CONVEYANCE CORRIDOR EXTENDS FROM THE SEAWARD LIMITS SHOWN TO THE SHORELINE.
4. ALL COORDINATES ARE NAD83, LOUISIANA STATE PLANE SOUTH, US SURVEY FT.
5. ELEVATIONS ARE SHOWN IN NAVD88 U.S. SURVEY FEET.
6. SURVEY CONDUCTED BY EMC FROM MAY 6, 2023 TO FEBRUARY 1, 2024 AND OSI ON JUNE 05 - 24, 2023.
7. SEE SHEETS 25 - 27 FOR NEARSHORE CONVEYANCE CORRIDOR DETAILS.
8. SEE SHEET 39 FOR ALIGNMENT AND COORDINATES TABLES IN STATE PLANE AND GEOGRAPHIC COORDINATES.
9. SEE SHEET 40 FOR AVOIDANCE AREA DETAILS.

LEGEND

FILL EXTENTS	
NEW HARBOR ISLAND WORK AREA	
SOUTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT	
SOUTH OFFSHORE PUMP-OUT AREA	
NEARSHORE CONVEYANCE CORRIDOR LIMITS	
SOPO-01	SOUTH OFFSHORE PUMP-OUT AREA COORDINATE
SOCC-01	SOUTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT COORDINATE
EL: -16FT	EXISTING GRADE ELEVATION(FT, NAVD88)
AA	ANCHORAGE AREA
PL	PIPELINE
11	AVOIDANCE AREA (TAR 2011)
	FILL AREA BASELINE

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

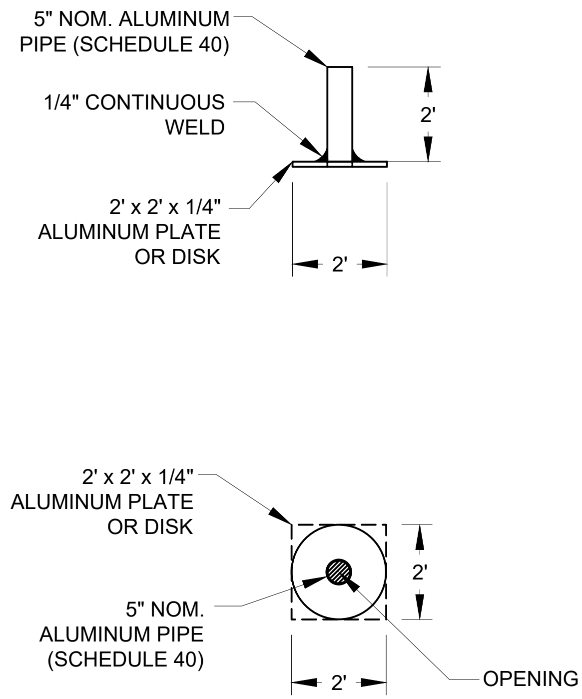
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

SOUTH OFFSHORE PUMP-OUT AREA AND CONVEYANCE CORRIDOR PLAN VIEW

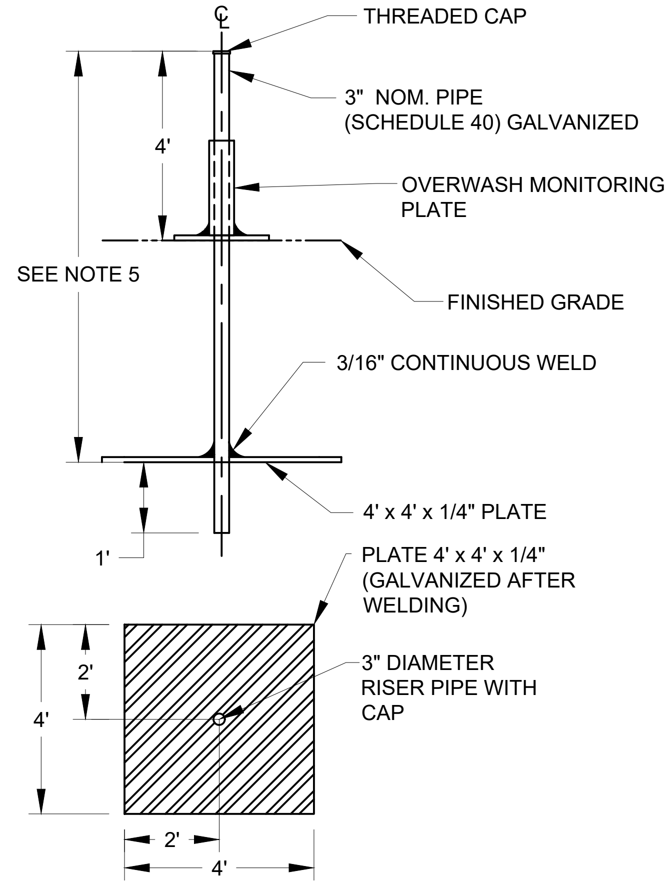
DATE: NOVEMBER 2024

SHEET 30 OF 40



OVERWASH MONITORING PLATE

(NOT TO SCALE)



SETTLEMENT PLATE

(NOT TO SCALE)

SETTLEMENT AND OVERWASH MONITORING SYSTEM NOTES:

1. SETTLEMENT PLATES SHALL BE CONSTRUCTED USING ASTM A36 STEEL AND HOT- DIPPED GALVANIZED AFTER FABRICATION.
2. ALL SETTLEMENT PLATES SHALL BE SURVEYED WITHIN A DAY OF INSTALLATION AND WEEKLY THROUGHOUT THE DURATION OF THE PROJECT.
3. ALL SETTLEMENT PLATES MUST BE INSTALLED AND MAINTAINED WITHIN 10.5 DEGREES OF VERTICAL.
4. ALL SETTLEMENT PLATES SHALL BE MARKED WITH SURVEY FLAGGING.
5. LENGTH OF THE SETTLEMENT PLATE RISER PIPE SHALL BE SUCH THAT THE ELEVATION OF THE TOP CAP BE NO LESS THAN 4 FEET ABOVE MAXIMUM FINAL DESIGN GRADE FOR ITS LOCATION.
6. OVERWASH MONITORING PLATES SHALL BE FABRICATED USING 6061-TS GRADE ALUMINUM PER SPECIFICATION TS-16.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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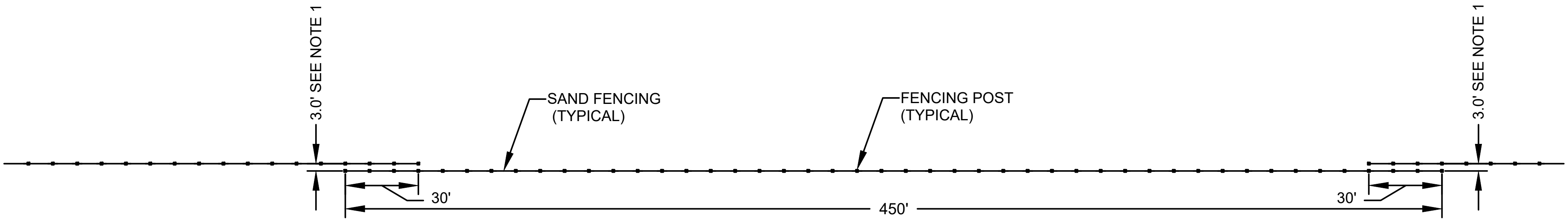
CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

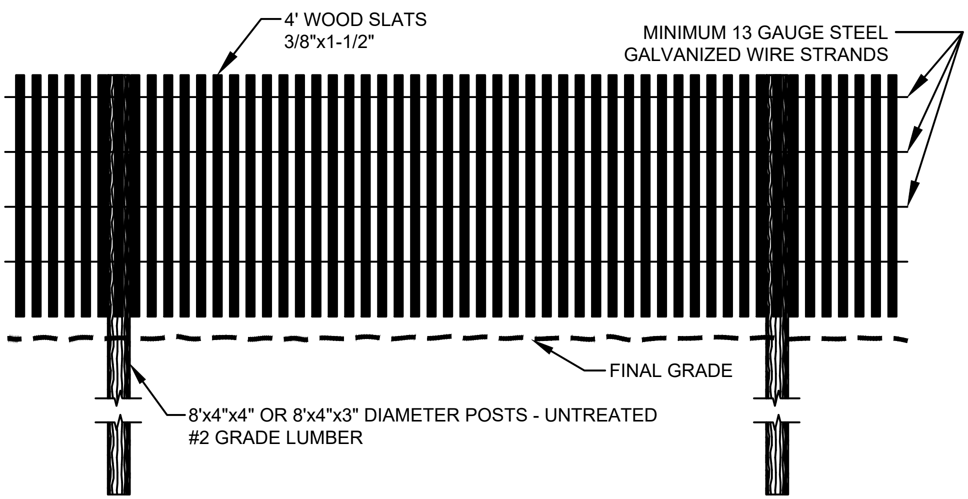
SETTLEMENT AND OVERWASH MONITORING DETAILS

DATE: NOVEMBER 2024

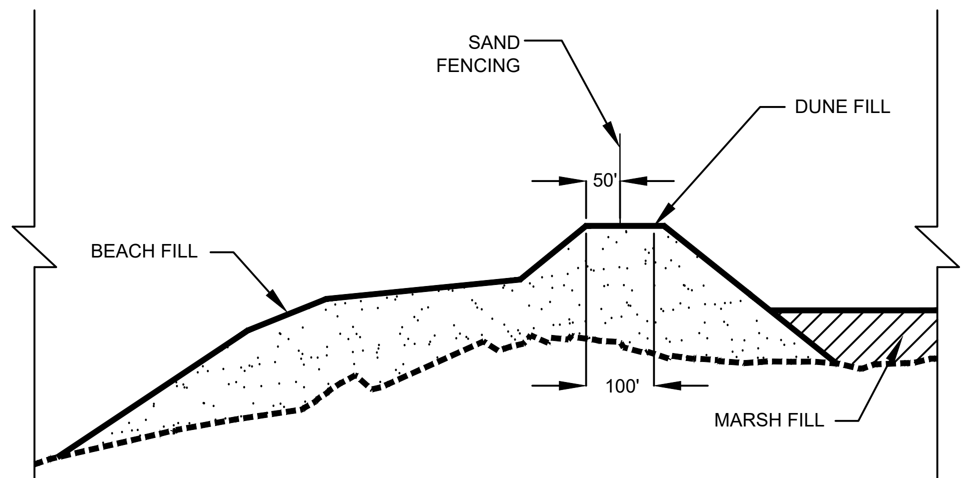


NOTES:
1. THE DISTANCE BETWEEN FENCES SHALL BE INCREASED FROM 3.0' TO 8.0' AT EVERY FIFTH GAP TO ALLOW ALL-TERRAIN VEHICLE ACCESS.

FENCING GAPPING DIMENSIONS
NOT TO SCALE



FENCING DETAIL
NOT TO SCALE



FENCING SECTION TYPICAL
NOT TO SCALE

BY	DESCRIPTION	DATE

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150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

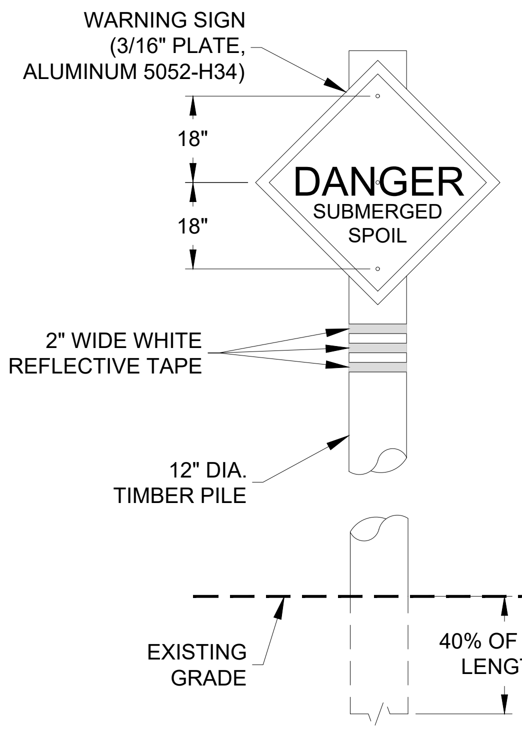
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

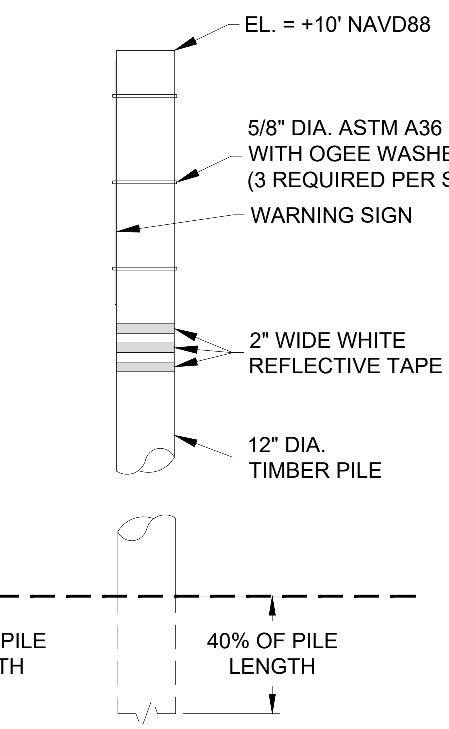
SAND FENCING DETAILS

DATE: NOVEMBER 2024

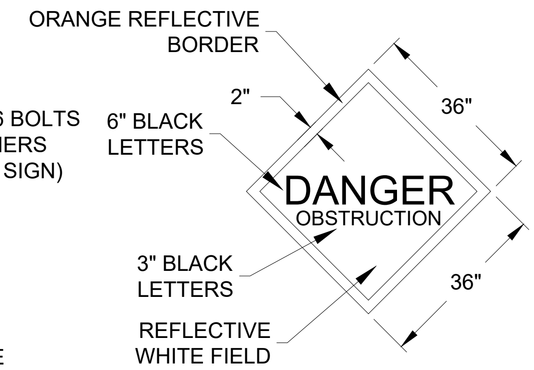
SHEET 32 OF 40



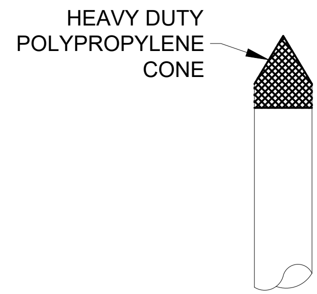
SIGN DETAIL



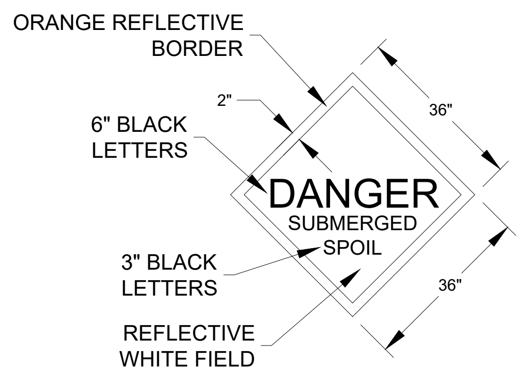
POST DETAIL



ROCK BREAKWATER SIGN DIMENSION
AND LETTERING DETAIL



TYPICAL TIMBER PILE
CAP



ROCK BREAKWATER SIGN DIMENSION
AND LETTERING DETAIL

NOTES:
1. WARNING SIGNS SHALL BE INSTALLED AS REQUIRED BY U.S. COAST GUARD.
2. WARNING SIGNS MUST MEET U.S. COAST GUARD STANDARDS.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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DESIGNED BY: BRETT BORNE, P.E.
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LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

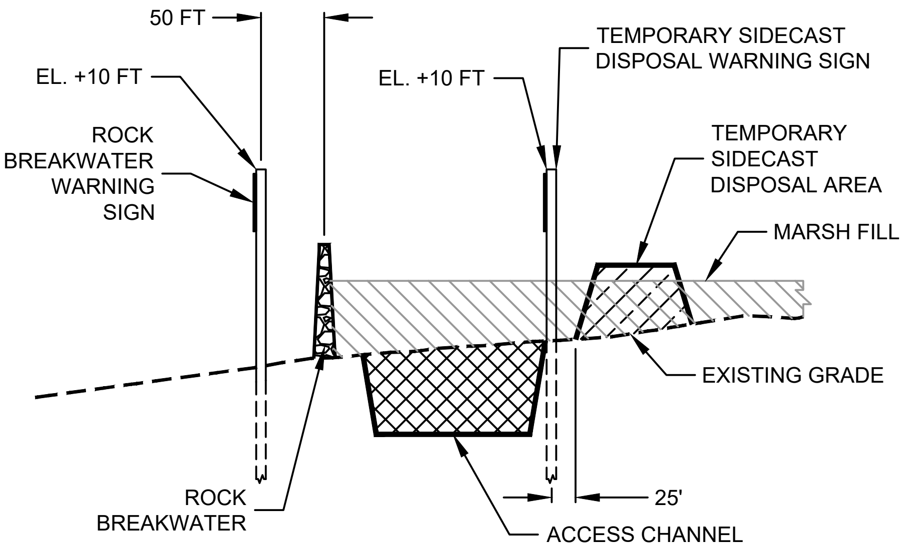
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

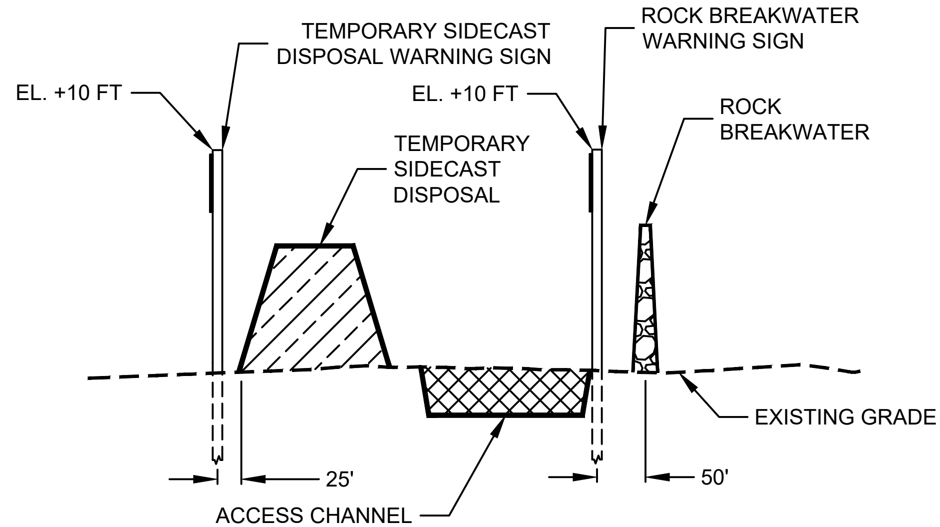
WARNING SIGN CONSTRUCTION DETAILS

DATE: NOVEMBER 2024

SHEET 33 OF 40



SHORELINE ROCK BREAKWATER
SIGN DETAIL
(NOT TO SCALE)



DETACHED ROCK BREAKWATER
SIGN DETAIL
(NOT TO SCALE)

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

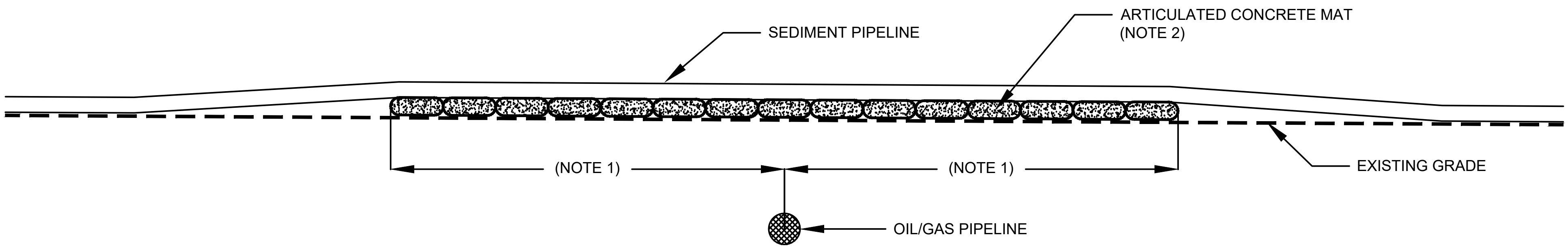
STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

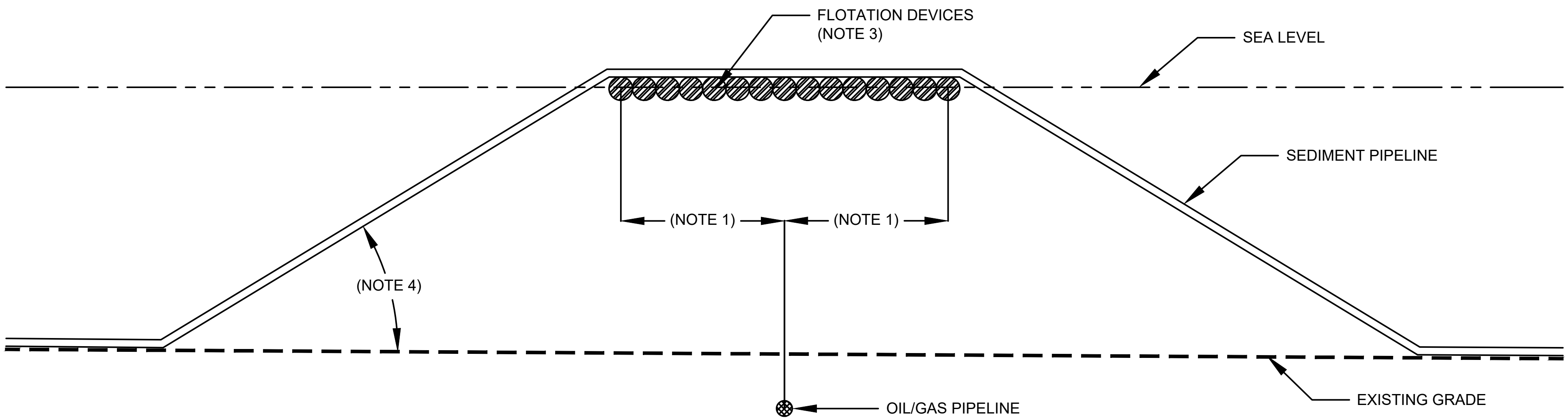
WARNING SIGN PLACEMENT DETAILS

DATE: NOVEMBER 2024

SHEET 34 OF 40



OPTIONAL ARTICULATED CONCRETE MAT PROTECTION CROSSING
(NOT TO SCALE)



OPTIONAL FLOTATION CROSSING
(NOT TO SCALE)

NOTES:
1. MEANS AND METHODS OF SEDIMENT PIPELINE CROSSING OF AN OIL/GAS PIPELINE SHALL BE COORDINATED BY THE CONSTRUCTION CONTRACTOR WITH THE OIL/GAS PIPELINE OPERATOR.
2. ARTICULATED CONCRETE MAT CONSTRUCTION AND COVERAGE AREA SHALL BE COORDINATED BY THE CONSTRUCTION CONTRACTOR WITH THE OIL/GAS PIPELINE OPERATOR.
3. FLOTATION DEVICE CONSTRUCTION AND PLACEMENT SHALL BE DETERMINED BY INDUSTRY STANDARDS FOR SEDIMENT PIPELINE SUPPORT AND CONSTRUCTION CONTRACTOR STANDARD EQUIPMENT.
4. ANGLE OF SEDIMENT PIPELINE DEPARTURE FROM EXISTING GRADE SHALL BE DETERMINED BY INDUSTRY STANDARDS FOR SEDIMENT PIPELINE SUPPORT AND CONSTRUCTION CONTRACTOR EQUIPMENT.

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

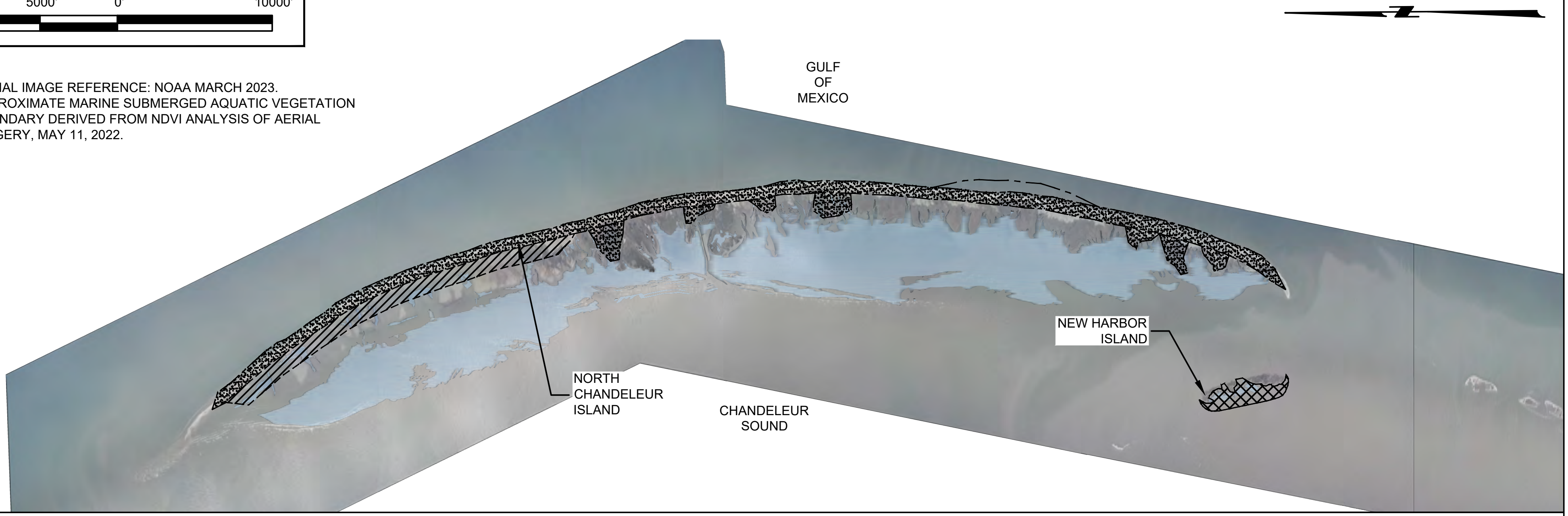
FEDERAL PROJECT NUMBER:

OPTIONAL SEDIMENT PIPELINE CROSSING TYPICAL DETAILS

DATE: NOVEMBER 2024

10000' 5000' 0' 10000'

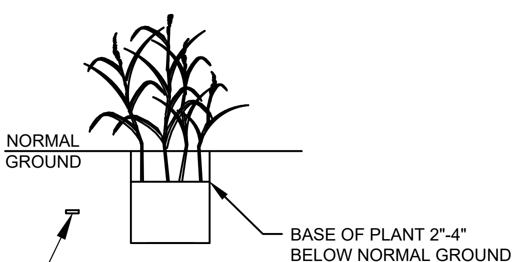
NOTES:
1. AERIAL IMAGE REFERENCE: NOAA MARCH 2023.
2. APPROXIMATE MARINE SUBMERGED AQUATIC VEGETATION BOUNDARY DERIVED FROM NDVI ANALYSIS OF AERIAL IMAGERY, MAY 11, 2022.



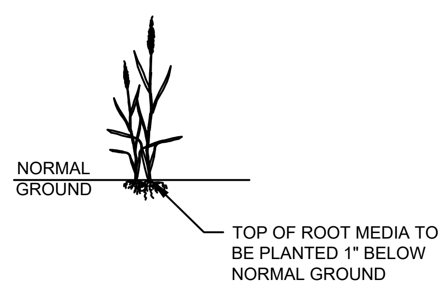
LEGEND

- BEACH/DUNE FILL PLANTING (PANICUM AMARUM)
- MARSH FILL PLANTING (SPARTINA ALTERNIFLORA)
- NEW HARBOR ISLAND PLANTING (AVICENNIA GERMINANS)
- MARINE SUBMERGED AQUATIC VEGETATION AREA (SEE NOTE 4)

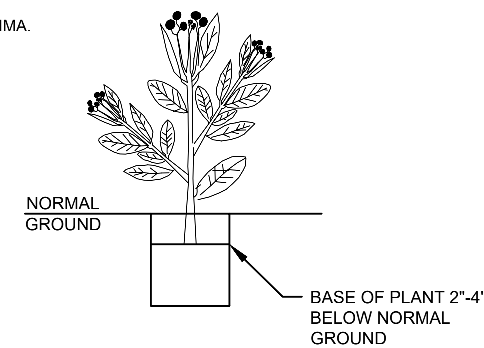
NOTES:
1. PANICUM AMARUM PLANTS SHALL BE PLANTED ON SEVEN (7) FOOT CENTERS WITH ROWS TEN (10) FOOT APART.
2. SPARTINA ALTERNIFLORA PLANTS SHALL BE PLANTED ON THREE (3) FOOT CENTERS WITH ROWS THREE (3) FOOT APART.
3. AVICENNIA GERMINANS SHALL BE PLANTED ON EIGHT (8) FOOT CENTERS WITH ROWS EIGHT (8) FOOT APART.
4. SPECIES OF SEAGRASS THAT COULD BE PLANTED ARE THALASSIA TESTUDINUM, SYRINGODIUM FILIFORME, HALOPHILA ENGELMANNII, HALODULE BEAUDETTEI, AND RUPPIA MARITIMA.
5. SPECIES OF PLANTS AND SPACING ARE SUBJECT TO CHANGE DUE TO SITE CONDITIONS AND / OR CONSTRUCTION VARIABLES.



TYPICAL DETAIL A
PANICUM AMARUM
4" CONTAINER



TYPICAL DETAIL B
SPARTINA ALTERNIFLORA
PLUG



TYPICAL DETAIL C
AVICENNIA GERMINANS
GALLON CONTAINER

BY	DESCRIPTION	DATE

DRAWN BY: STEVE DARTEZ

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LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

VEGETATIVE PLANTING DETAILS

STATE PROJECT NUMBER: PO-0199

DATE: NOVEMBER 2024

FEDERAL PROJECT NUMBER:

HEWES POINT BORROW AREA BOUNDARY				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
HPBA-01	580,626.71	4,048,229.40	30° 04' 27.37" N	88° 54' 25.05" W
HPBA-02	583,426.56	4,051,675.20	30° 04' 54.36" N	88° 53' 45.16" W
HPBA-03	583,477.79	4,052,050.62	30° 04' 54.79" N	88° 53' 40.87" W
HPBA-04	583,045.24	4,052,572.18	30° 04' 50.40" N	88° 53' 35.04" W
HPBA-05	583,427.92	4,055,377.81	30° 04' 53.59" N	88° 53' 03.02" W
HPBA-06	581,702.67	4,057,689.47	30° 04' 36.03" N	88° 52' 27.14" W
HPBA-07	581,325.90	4,057,999.26	30° 04' 32.23" N	88° 52' 33.70" W
HPBA-08	581,034.76	4,058,238.64	30° 04' 29.30" N	88° 52' 31.05" W
HPBA-09	579,796.65	4,059,604.51	30° 04' 16.76" N	88° 52' 15.81" W
HPBA-10	577,144.45	4,063,606.22	30° 03' 49.65" N	88° 51' 30.93" W
HPBA-11	575,927.81	4,064,917.53	30° 03' 37.33" N	88° 51' 16.31" W
HPBA-12	574,320.17	4,066,153.61	30° 03' 21.16" N	88° 51' 02.64" W
HPBA-13	573,585.20	4,064,792.56	30° 03' 14.17" N	88° 51' 18.31" W
HPBA-14	574,394.61	4,063,733.97	30° 03' 22.41" N	88° 51' 30.15" W
HPBA-15	574,458.27	4,061,462.08	30° 03' 23.53" N	88° 51' 55.98" W
HPBA-16	578,484.74	4,055,868.48	30° 04' 04.56" N	88° 52' 58.64" W
HPBA-17	577,427.19	4,054,568.51	30° 03' 54.37" N	88° 53' 13.69" W
HPBA-18	575,898.65	4,052,689.57	30° 03' 39.64" N	88° 53' 35.44" W

HEWES POINT BORROW AREA BASELINE ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
HPBL-01	588,200.00	4,054,100.00	30° 05' 41.09" N	88° 53' 16.41" W
HPBL-02	574,987.69	4,069,114.49	30° 03' 27.13" N	88° 50' 28.79" W

CHANDELEUR ISLAND RESTORATION AREA EXTENTS				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
CI-01	567,417.32	4,061,877.71	30° 02' 13.75" N	88° 51' 52.98" W
CI-02	498,075.82	4,069,620.16	29° 50' 45.82" N	88° 50' 42.04" W

NEW HARBOR ISLAND RESTORATION AREA EXTENTS				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
NHI-01	503,187.71	4,062,137.24	29° 51' 38.01" N	88° 52' 05.75" W
NHI-02	498,068.43	4,063,439.83	29° 50' 47.07" N	88° 51' 52.21" W

CHANDELEUR ISLAND RESTORATION AREA BASELINE ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
CIBL-01	571,852.61	4,060,935.79	30° 02' 57.85" N	88° 52' 02.61" W
CIBL-02	564,201.48	4,067,374.74	30° 01' 40.75" N	88° 50' 51.25" W
CIBL-03	549,487.10	4,073,658.62	29° 59' 13.77" N	88° 49' 43.43" W
CIBL-04	529,846.87	4,077,435.05	29° 55' 58.57" N	88° 49' 05.40" W
CIBL-05	513,859.05	4,076,810.86	29° 53' 20.47" N	88° 49' 16.48" W
CIBL-06	494,376.76	4,072,289.74	29° 50' 08.63" N	88° 50' 12.65" W
CIBL-07	484,152.16	4,068,232.97	29° 48' 28.31" N	88° 51' 01.22" W

ACCESS CHANNEL - NORTH ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
ACN-01	562,687.13	4,059,123.81	30° 01' 27.53" N	88° 52' 25.46" W
ACN-01	563,077.78	4,065,111.08	30° 01' 30.11" N	88° 51' 17.27" W

ACCESS CHANNEL - CENTRAL ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
ACC-01	541,522.11	4,068,123.51	29° 57' 56.13" N	88° 50' 48.33" W
ACC-01	542,625.61	4,073,000.22	29° 58' 06.00" N	88° 49' 52.62" W

ACCESS CHANNEL - SOUTH ALIGNMENT				
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
ACS-01	504,590.66	4,068,002.39	29° 51' 50.64" N	88° 50' 58.81" W
ACS-01	505,420.67	4,072,526.90	29° 51' 57.89" N	88° 50' 07.22" W

BY	DESCRIPTION	DATE
SD	WEST BELLE RECOVERY PROJECT "TE-176" MODIFICATION TO TE-118 EAST TIMBALIER ISLAND RESTORATION	02/ 2023

DRAWN BY: STEVE DARTEZ

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DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ALIGNMENT AND COORDINATE TABLES

DATE: NOVEMBER 2024

SHEET 37 OF 40

ROCK BREAKWATER - SHORELINE ALIGNMENT

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
RKS-01	503,638.37	4,062,505.15	29° 51' 42.39" N	88° 52' 01.46" W
RKS-02	503,631.64	4,062,458.75	29° 51' 42.34" N	88° 52' 01.99" W
RKS-03	503,563.05	4,062,270.88	29° 51' 41.70" N	88° 52' 04.14" W
RKS-04	503,405.25	4,062,077.13	29° 51' 40.18" N	88° 52' 06.38" W
RKS-05	503,257.61	4,061,942.22	29° 51' 38.75" N	88° 52' 07.95" W
RKS-06	503,035.03	4,061,828.38	29° 51' 36.57" N	88° 52' 09.29" W
RKS-07	502,840.59	4,061,781.52	29° 51' 34.65" N	88° 52' 09.87" W
RKS-08	502,590.61	4,061,779.12	29° 51' 32.18" N	88° 52' 09.96" W
RKS-09	502,391.08	4,061,792.94	29° 51' 30.20" N	88° 52' 09.85" W
RKS-10	502,047.99	4,061,862.13	29° 51' 26.79" N	88° 52' 09.15" W
RKS-11	501,607.40	4,061,953.70	29° 51' 22.41" N	88° 52' 08.22" W
RKS-12	500,628.52	4,062,158.11	29° 51' 12.68" N	88° 52' 06.14" W
RKS-13	499,649.82	4,062,363.41	29° 51' 02.95" N	88° 52' 04.04" W
RKS-14	499,258.76	4,062,447.51	29° 50' 59.06" N	88° 52' 03.18" W
RKS-15	498,680.52	4,062,607.63	29° 50' 53.30" N	88° 52' 01.51" W
RKS-16	498,529.52	4,062,662.92	29° 50' 51.80" N	88° 52' 00.92" W
RKS-17	498,272.81	4,062,794.11	29° 50' 49.23" N	88° 51' 59.49" W
RKS-18	498,094.01	4,063,035.00	29° 50' 47.41" N	88° 51' 56.80" W
RKS-19	498,000.17	4,063,266.72	29° 50' 46.43" N	88° 51' 54.19" W
RKS-20	497,927.78	4,063,453.16	29° 50' 45.67" N	88° 51' 52.09" W
RKS-21	497,894.50	4,063,650.38	29° 50' 45.30" N	88° 51' 49.86" W
RKS-22	497,910.40	4,063,899.87	29° 50' 45.41" N	88° 51' 47.03" W
RKS-23	498,030.45	4,064,119.16	29° 50' 46.55" N	88° 51' 44.51" W
RKS-24	498,042.35	4,064,126.88	29° 50' 46.66" N	88° 51' 44.42" W

ROCK BREAKWATER - FISH DIP LOCATION

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
FD-01	503,528.02	4,062,227.86	29° 51' 41.36" N	88° 52' 04.64" W
FD-02	502,715.11	4,061,780.32	29° 51' 33.41" N	88° 52' 09.92" W
FS-03	501,656.88	4,061,943.29	29° 51' 22.90" N	88° 52' 08.32" W
FS-04	500,677.48	4,062,147.88	29° 51' 13.17" N	88° 52' 06.24" W
FS-05	499,698.68	4,062,353.16	29° 51' 03.43" N	88° 52' 04.15" W
FS-06	498,729.87	4,062,593.96	29° 50' 53.79" N	88° 52' 01.65" W
FS-07	498,019.02	4,063,220.18	29° 50' 46.63" N	88° 51' 54.72" W

ROCK BREAKWATER - DETACHED ALIGNMENT

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
RKD-01	503,638.37	4,062,505.15	29° 51' 42.39" N	88° 52' 01.46" W
RKD-02	503,660.32	4,062,656.68	29° 51' 42.58" N	88° 51' 59.73" W
RKD-03	503,666.64	4,062,806.55	29° 51' 42.61" N	88° 51' 58.03" W
RKD-04	503,652.96	4,062,905.61	29° 51' 42.45" N	88° 51' 56.91" W
RKD-05	503,607.06	4,062,994.45	29° 51' 41.98" N	88° 51' 55.91" W
RKD-06	503,522.18	4,063,118.13	29° 51' 41.11" N	88° 51' 54.53" W
RKD-07	503,411.99	4,063,219.90	29° 51' 40.00" N	88° 51' 53.40" W
RKD-08	503,293.04	4,063,286.36	29° 51' 38.81" N	88° 51' 52.67" W
RKD-09	503,248.65	4,063,403.21	29° 51' 38.35" N	88° 51' 51.36" W
RKD-10	503,192.65	4,063,342.46	29° 51' 37.80" N	88° 51' 52.06" W
RKD-11	502,991.87	4,063,454.66	29° 51' 35.79" N	88° 51' 50.84" W
RKD-12	502,810.76	4,063,539.50	29° 51' 33.98" N	88° 51' 49.92" W
RKD-13	502,529.28	4,063,643.28	29° 51' 31.17" N	88° 51' 48.81" W
RKD-14	502,355.56	4,063,708.21	29° 51' 29.44" N	88° 51' 48.11" W
RKD-15	502,294.00	4,063,817.00	29° 51' 28.81" N	88° 51' 46.89" W
RKD-16	502,247.84	4,063,748.48	29° 51' 28.37" N	88° 51' 47.68" W
RKD-17	501,732.66	4,063,941.05	29° 51' 23.23" N	88° 51' 45.62" W
RKD-18	501,344.20	4,064,036.44	29° 51' 19.36" N	88° 51' 44.63" W
RKD-19	501,161.96	4,064,071.04	29° 51' 17.55" N	88° 51' 44.29" W
RKD-20	501,082.87	4,064,167.84	29° 51' 16.75" N	88° 51' 43.21" W
RKD-21	501,048.97	4,064,092.49	29° 51' 16.43" N	88° 51' 44.07" W
RKD-22	500,754.24	4,064,148.45	29° 51' 13.50" N	88° 51' 43.51" W
RKD-23	500,508.61	4,064,195.00	29° 51' 11.06" N	88° 51' 43.04" W
RKD-24	500,213.85	4,064,250.82	29° 51' 08.13" N	88° 51' 42.48" W
RKD-25	500,065.81	4,064,274.99	29° 51' 06.66" N	88° 51' 42.24" W
RKD-26	499,818.93	4,064,314.38	29° 51' 04.21" N	88° 51' 41.85" W
RKD-27	499,812.59	4,064,396.75	29° 51' 04.13" N	88° 51' 40.92" W
RKD-28	499,705.37	4,064,332.49	29° 51' 03.08" N	88° 51' 41.67" W
RKD-29	499,324.70	4,064,393.23	29° 50' 59.30" N	88° 51' 41.08" W
RKD-30	499,025.05	4,064,407.74	29° 50' 56.33" N	88° 51' 40.99" W
RKD-31	498,629.97	4,064,345.21	29° 50' 52.43" N	88° 51' 41.79" W
RKD-32	498,483.82	4,064,311.45	29° 50' 50.99" N	88° 51' 42.21" W
RKD-33	498,446.98	4,064,385.41	29° 50' 50.61" N	88° 51' 41.38" W
RKD-34	498,371.77	4,064,285.57	29° 50' 49.89" N	88° 51' 42.53" W
RKD-35	498,240.20	4,064,255.18	29° 50' 48.59" N	88° 51' 42.91" W
RKD-36	498,042.35	4,064,126.88	29° 50' 46.66" N	88° 51' 44.42" W

BY	DESCRIPTION	DATE
SD	WEST BELLE RECOVERY PROJECT "TE-176" MODIFICATION TO TE-118 EAST TIMBALIER ISLAND RESTORATION	02/ 2023

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
DENHAM SPRINGS, LA 70726

DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ALIGNMENT AND COORDINATE TABLES

DATE: NOVEMBER 2024

NEARSHORE CONVEYANCE CORRIDOR LIMITS

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
NSCC-01	567,048.15	4,062,992.09	30° 02' 09.86" N	88° 51' 40.40" W
NSCC-02	575,693.44	4,059,746.17	30° 03' 36.12" N	88° 52' 15.20" W
NSCC-03	574,394.40	4,063,741.35	30° 03' 22.41" N	88° 51' 30.07" W
NSCC-04	567,383.43	4,067,225.11	30° 02' 12.27" N	88° 50' 52.16" W
NSCC-05	565,583.53	4,069,002.80	30° 01' 54.08" N	88° 50' 32.39" W
NSCC-06	563,914.72	4,069,523.00	30° 01' 37.45" N	88° 50' 26.88" W
NSCC-07	561,027.15	4,070,752.20	30° 01' 08.61" N	88° 50' 13.62" W
NSCC-08	555,396.35	4,072,981.95	30° 00' 12.40" N	88° 49' 49.66" W
NSCC-09	548,008.60	4,075,487.55	29° 58' 58.74" N	88° 49' 23.01" W
NSCC-10	541,120.90	4,076,755.85	29° 57' 50.30" N	88° 49' 10.31" W
NSCC-11	535,550.20	4,077,899.25	29° 56' 54.92" N	88° 48' 58.70" W
NSCC-12	525,300.55	4,078,527.73	29° 55' 13.34" N	88° 48' 54.12" W
NSCC-13	519,027.30	4,078,037.05	29° 54' 11.36" N	88° 49' 01.26" W
NSCC-14	510,424.05	4,077,031.35	29° 52' 46.43" N	88° 49' 14.83" W
NSCC-15	503,253.38	4,075,484.28	29° 51' 35.80" N	88° 49' 34.18" W
NSCC-16	497,049.11	4,074,076.21	29° 50' 34.70" N	88° 49' 51.71" W
NSCC-17	495,592.98	4,070,098.22	29° 50' 21.14" N	88° 50' 37.23" W
NSCC-18	495,879.61	4,068,116.93	29° 50' 24.40" N	88° 50' 59.65" W
NSCC-19	496,367.75	4,067,409.06	29° 50' 29.39" N	88° 51' 07.56" W
NSCC-20	498,075.82	4,069,620.16	29° 50' 45.82" N	88° 50' 42.04" W

NORTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
NOCC-01	544,233.11	4,088,316.56	29° 58' 18.57" N	88° 46' 58.12" W
NOCC-02	544,233.06	4,076,182.78	29° 58' 21.22" N	88° 49' 16.05" W

NORTH OFFSHORE PUMP-OUT AREA BOUNDARY

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
NOPO-01	545,233.11	4,088,309.13	29° 58' 28.47" N	88° 46' 57.95" W
NOPO-02	545,233.11	4,090,309.13	29° 58' 28.03" N	88° 46' 35.21" W
NOPO-03	543,233.11	4,090,309.13	29° 58' 08.23" N	88° 46' 35.72" W
NOPO-04	543,233.11	4,088,309.13	29° 58' 08.67" N	88° 46' 58.46" W

CENTRAL OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
COCC-01	520,211.48	4,088,396.82	29° 54' 20.81" N	88° 47' 03.28" W
COCC-02	520,363.89	4,088,254.38	29° 54' 22.35" N	88° 47' 04.86" W
COCC-03	520,892.17	4,087,414.58	29° 54' 27.76" N	88° 47' 14.27" W
COCC-04	521,195.60	4,086,477.40	29° 54' 30.97" N	88° 47' 24.84" W
COCC-05	521,299.21	4,078,209.28	29° 54' 33.11" N	88° 48' 58.76" W

CENTRAL OFFSHORE PUMP-OUT AREA BOUNDARY

PI NUMBER	NORTHING	EASTING	LATITUDE	LONGITUDE
COPO-01	519,192.79	4,086,717.70	29° 54' 11.10" N	88° 47' 22.61" W
COPO-02	521,526.90	4,090,565.03	29° 54' 33.35" N	88° 46' 38.32" W
COPO-03	518,192.55	4,092,587.92	29° 53' 59.90" N	88° 46' 16.18" W
COPO-04	515,858.44	4,088,740.59	29° 53' 37.65" N	88° 47' 00.48" W

SOUTH OFFSHORE CONVEYANCE CORRIDOR ALIGNMENT

PI NUMBER	NORTHING	EASTING	LATITUDE	LONGITUDE
SOCC-01	490,968.33	4,086,881.41	29° 49' 31.72" N	88° 47' 27.87" W
SOCC-02	491,126.78	4,086,736.81	29° 49' 33.32" N	88° 47' 29.47" W
SOCC-03	491,629.56	4,085,939.79	29° 49' 38.47" N	88° 47' 38.39" W
SOCC-04	491,915.91	4,084,984.02	29° 49' 41.52" N	88° 47' 49.17" W
SOCC-05	492,300.25	4,073,134.99	29° 49' 47.90" N	88° 50' 03.57" W
SOCC-06	498,096.64	4,064,788.76	29° 50' 47.06" N	88° 51' 36.89" W

SOUTH OFFSHORE PUMP-OUT AREA BOUNDARY

PI NUMBER	NORTHING	EASTING	LATITUDE	LONGITUDE
SOPO-01	490,968.33	4,086,540.65	29° 49' 31.80" N	88° 47' 31.73" W
SOPO-02	490,968.33	4,089,240.65	29° 49' 21.20" N	88° 47' 01.09" W
SOPO-03	488,268.33	4,089,240.65	29° 49' 04.48" N	88° 47' 01.77" W
SOPO-04	488,268.33	4,086,540.65	29° 49' 05.08" N	88° 47' 32.41" W

BY	DESCRIPTION	DATE
SD	WEST BELLE RECOVERY PROJECT "TE-176" MODIFICATION TO TE-118 EAST TIMBALIER ISLAND RESTORATION	02/ 2023

DRAWN BY: STEVE DARTEZ

COASTAL ENGINEERING CONSULTANTS, INC.
PH: (225) 523-7403
1211 N. RANGE AVE, STE. E
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DESIGNED BY: BRETT BORNE, P.E.
LICENSE NUMBER: 42158

LOUISIANA COASTAL PROTECTION AND RESTORATION AUTHORITY
150 TERRACE AVENUE
BATON ROUGE, LA 70802

APPROVED BY: MICHAEL T. POFF, P.E.

CHANDELEUR ISLAND RESTORATION PROJECT

STATE PROJECT NUMBER: PO-0199

FEDERAL PROJECT NUMBER:

ALIGNMENT AND COORDINATE TABLES

DATE: NOVEMBER 2024

AVOIDANCE AREA DETAILS					
NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE	RADIUS (FT)
1	582,580.61	4,056,155.58	30° 04' 45.04" N	88° 52' 54.38" W	175
2	579,364.42	4,058,341.09	30° 04' 12.75" N	88° 52' 30.29" W	150
3	578,368.00	4,062,648.00	30° 04' 01.97" N	88° 51' 41.53" W	200
4	569,282.50	4,067,144.60	30° 02' 31.09" N	88° 50' 52.61" W	300
5	568,858.90	4,067,484.90	30° 02' 26.82" N	88° 50' 48.84" W	300
6	568,753.00	4,067,120.20	30° 02' 25.85" N	88° 50' 53.02" W	300
7	568,295.10	4,068,895.40	30° 02' 20.94" N	88° 50' 32.94" W	300
8	567,161.40	4,068,779.50	30° 02' 09.74" N	88° 50' 34.54" W	300
9	566,716.60	4,070,075.00	30° 02' 05.06" N	88° 50' 19.91" W	300
10	512,476.63	4,077,363.50	29° 53' 06.67" N	88° 49' 10.54" W	100
11	491,823.80	4,081,450.20	29° 49' 41.38" N	88° 48' 29.30" W	150

SETTLEMENT AND OVERWASH MONITORING SYSTEM LOCATION									
PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE	PI NUMBER	NORTHING	EASTING	LATTITUDE	LONGITUDE
SOP-01	565,284.69	4,063,659.89	30° 01' 52.27" N	88° 51' 33.23" W	SOP-15	531,753.82	4,075,744.55	29° 56' 17.81" N	88° 49' 24.14" W
SOP-02	564,707.76	4,063,283.33	30° 01' 46.64" N	88° 51' 37.66" W	SOP-16	531,448.28	4,075,127.73	29° 56' 14.92" N	88° 49' 31.22" W
SOP-03	560,931.16	4,066,956.64	30° 01' 08.47" N	88° 50' 56.81" W	SOP-17	527,126.32	4,076,049.40	29° 55' 31.95" N	88° 49' 21.82" W
SOP-04	560,535.77	4,066,430.60	30° 01' 04.67" N	88° 51' 02.89" W	SOP-18	526,933.44	4,075,097.99	29° 55' 30.24" N	88° 49' 32.68" W
SOP-05	556,635.83	4,069,490.04	30° 00' 25.42" N	88° 50' 29.06" W	SOP-19	522,128.04	4,075,759.20	29° 54' 42.54" N	88° 49' 26.36" W
SOP-06	556,178.62	4,068,958.86	30° 00' 21.01" N	88° 50' 35.21" W	SOP-20	517,154.50	4,075,329.07	29° 53' 53.41" N	88° 49' 32.49" W
SOP-07	551,951.78	4,071,214.80	29° 59' 38.69" N	88° 50' 10.61" W	SOP-21	512,519.97	4,074,741.18	29° 53' 07.67" N	88° 49' 40.32" W
SOP-08	551,467.08	4,070,657.28	29° 59' 34.01" N	88° 50' 17.07" W	SOP-22	507,644.03	4,073,771.43	29° 52' 19.62" N	88° 49' 52.54" W
SOP-09	546,465.35	4,072,808.20	29° 58' 44.05" N	88° 49' 53.85" W	SOP-23	504,835.66	4,072,082.96	29° 51' 52.19" N	88° 50' 12.41" W
SOP-10	546,148.75	4,072,186.57	29° 58' 41.05" N	88° 50' 01.00" W	SOP-24	502,812.94	4,072,422.46	29° 51' 32.10" N	88° 50' 09.06" W
SOP-11	541,627.62	4,074,021.39	29° 57' 55.90" N	88° 49' 41.26" W	SOP-25	502,732.69	4,071,661.32	29° 51' 31.47" N	88° 50' 17.72" W
SOP-12	541,695.51	4,072,574.26	29° 57' 56.89" N	88° 49' 57.70" W	SOP-26	502,390.40	4,062,633.98	29° 51' 30.02" N	88° 52' 00.30" W
SOP-13	536,695.40	4,075,159.81	29° 57' 06.84" N	88° 49' 29.55" W	SOP-27	500,446.95	4,063,112.27	29° 51' 10.68" N	88° 51' 55.35" W
SOP-14	536,425.66	4,074,505.32	29° 57' 04.32" N	88° 49' 37.06" W	SOP-28	498,890.32	4,063,122.72	29° 50' 55.27" N	88° 51' 55.61" W

Attachment B
Agency Coordination

OO/LA TIG Joint Restoration Plan #1- Chandeleur Islands
MEETING NOTES

Subject:	Section 7 ESA Consultation
Date/Time:	17 October 2024, 1:00pm CDT
Location:	Teams
Attendees:	Lee Walker (Fields Environmental Consulting; CPRA contractor) Jennifer McCoy (Edge Engineering and Science; CPRA contractor) Christy Fellas (NOAA Restoration Center, DWH NRDA Program – Compliance Coordinator) Michael Barron (USFWS, Wildlife Biologist – Compliance Coordinator) Amy Mathis (DOI, DWH Gulf Restoration Office – Restoration Planner)

Agency members and contractors to the CPRA met to discuss compliance activities for the Chandeleur Islands Restoration Project (Project) related to the Endangered Species Act. The group discussed the Biological Evaluation Form for the Deepwater Horizon Oil Spill Restoration (BE form), development of a Biological Assessment (BA) and Essential Fish Habitat Assessment (EFHA), and the process and timelines for completing these documents.

- Lee Walker indicated that the Project is in the early design phase and is at approximately 10% design, with a draft plan view and cross section available in the near future. Although construction procedures have not yet been determined, construction could include hopper and/or cutterhead dredging, impact pile-driving of timber piles, and potentially year-round construction both in-water and on nesting beaches.
- NMFS and USFWS confirmed that the BE form must be completed for this project, although the group expects that formal consultation will be appropriate based on Project discussions to date. Accordingly, the CPRA's contractor plans to provide a BE form and concurrently begin development of a draft BA and, at the suggestion of NMFS and USFWS, plans to follow the general format of the BA developed for the MBSD Project since it includes formal consultation for both agencies.
- After discussion on the best path forward, the group determined that CPRA's contractor could provide a draft BE form to NMFS and USFWS prior to official submission, recognizing that not all Project details will be available at that time. This draft form can include comments to the agencies if there are questions or if a species determination is unclear.
    - Christy will be out of town after November 4th; if the BE form is provided before that date, Christy can review before her leave.
    - Because of the anticipated need for formal consultation, the NMFS ESA PDC Checklist does not need to be included with the BE form, but applicable mitigation identified in the checklist should be identified in the BA.
    - Concurrently with BE form development, CPRA's contractor will begin drafting a BA. Because of pending changes in NMFS staff at the end of December and late-

    December leave for USFWS staff, it would be beneficial for the draft BA to be provided for review in late November/early December (by December 10th).
  - The draft RP/EA is anticipated to be provided to the TIG for internal review in January 2025, which is likely when the TIG would like to officially initiate consultation.
- CPRA's contractor indicated that it is currently considering a 6-mile Action Area, but that the vessel shore bases will be considered in the final Action Area. The USFWS confirmed that vessel paths should be included in the Action Area.
- The USFWS provided the following species comments:
  - The loss of wintering habitat for piping plover and red knot, though temporary, could result in a take.
  - Because the island includes wintering habitat for birds and nesting beaches for sea turtles, there would be impacts on species during any time of year.
  - CPRA's contractor should not officially submit a request for a species list through IPaC (now or in the future) but can develop the BE form and BA based on the unofficial pull. CPRA's contractor confirmed that it had pulled a species list from IPaC, but that it is marked as "not for consultation."
  - The BE form is also important to provide because of the data it includes on bald eagles and migratory birds.
- The USFWS generally expects to complete formal consultation within the 135-day period. NMFS consultations generally take longer and could take up to a year.
- The group discussed having a call in early to mid-January to discuss any concerns about species or construction methods to make sure that feedback has time to be incorporated consistently into the BA and EA/RP. CPRA's contractor indicated that the same team is developing the BA and EA/RP.
- DOI is the lead agency and CPRA's contractor will likely be responsible for developing any necessary documentation for CZMA consistency determination.
- A USACE permit app will be developed once permit drawings are available from CPRA but currently it is not known if a CPRA contractor will submit it as an agent or if DOI will submit it as the lead federal agency.
- Whoever submits the Corps permit application will communicate to the Corps that much of the compliance is being completed through the DWH process, with DOI/NOAA trustees as the lead Federal action agency. Christy/Michael can provide a letter to Corps if needed
- CPRA's contractor has looked into CBRA; the Chandeleur Islands is classified as an Otherwise Protected Area (LA-03P); therefore consultation is not required

From:	Barron, Michael G
To:	Lee Walker; Jenny McCoy; christina.fellas; Mathis, Amy L; Clardy, Sarah
Subject:	RE: [EXTERNAL] RE: Chandeleur Islands Restoration Plan Consultation
Date:	Tuesday, October 22, 2024 10:56:04 AM
Attachments:	Biological Assessment and Biological Opinions_Ship Island.pdf

Hi All,

My boss, Ben Frater, suggested that the Ship Island BA could also be helpful.

Please let me know if you have any questions.

Michael

Michael Glenn Barron, MS
(He, Him)
Wildlife Biologist – Compliance Coordinator
Department of the Interior
USFWS - Gulf Restoration Office
341 N. Greeno Road
Fairhope, AL 36532
251-421-7030 (Work - Preferred)
706-577-2645 (Cell)
michael_barron@fws.gov

From: Lee Walker <lee.walker@fieldsec.com>
Sent: Thursday, October 17, 2024 3:32 PM
To: Jenny McCoy <JMMcCoy@edge-es.com>; christina.fellas <christina.fellas@noaa.gov>; Barron, Michael G <michael_barron@fws.gov>; Mathis, Amy L <amy_mathis@fws.gov>; Clardy, Sarah <sarah_clardy@fws.gov>
Subject: [EXTERNAL] RE: Chandeleur Islands Restoration Plan Consultation

Christy, Michael, and Amy,

Thanks again for meeting with us today. Please let us know if there's anything we didn't capture correctly in the attached notes. Looking forward to getting consultation moving.

Thanks,
Lee

Lee Z. Walker
Principal
Fields Environmental Consulting
504-913-1857

-----Original Appointment-----
From: Lee Walker
Sent: Tuesday, October 8, 2024 9:31 AM
To: Jenny McCoy; christina.fellas; Barron, Michael G; Mathis, Amy L; Clardy, Sarah
Subject: Chandeleur Islands Restoration Plan Consultation
When: Thursday, October 17, 2024 1:00 PM-2:00 PM (UTC-06:00) Central Time (US & Canada).
Where: Teams

Lee Walker invited you to a Microsoft Teams Meeting:

Chandeleur Islands Restoration Plan Consultation
Thursday, October 17, 2024
1:00 PM - 2:00 PM (CST)
Meeting link: Chandeleur Islands Restoration Plan Consultation | Microsoft Teams | Meetup-Join

OO/LA TIG Joint Restoration Plan #1- Chandeleur Islands
CONSULTATION NOTES

Subject:	Section 7 ESA Consultation
Date/Time:	November 04 and 05, 2024
Location:	Not Applicable
Attendees:	Lee Walker (Fields Environmental Consulting; CPRA contractor) Jennifer McCoy (Edge Engineering and Science; CPRA contractor) Christy Fellas (NOAA Restoration Center, DWH NRDA Program – Compliance Coordinator) Michael Barron (USFWS, Wildlife Biologist – Compliance Coordinator)

Agency members provided preliminary feedback to the CPRA contractors regarding compliance considerations for the Chandeleur Islands Restoration Project (Project) related to the Endangered Species Act. The NOAA and USFWS liaisons provided preliminary feedback on the species lists and potential impacts on those species and their habitats.

Attachment C
Species Lists

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

St. Bernard County, Louisiana

Local office

Louisiana Ecological Services Field Office

(337) 291-3100
(337) 291-3139

200 Dulles Drive
Lafayette, LA 70506

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).

2. [NOAA Fisheries](), also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
West Indian Manatee Trichechus manatus Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/4469	Threatened Marine mammal

Birds

NAME	STATUS
Eastern Black Rail Laterallus jamaicensis ssp. jamaicensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/10477	Threatened
Piping Plover Charadrius melodus There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/6039	Threatened
Rufa Red Knot Calidris canutus rufa Wherever found There is **proposed** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/1864	Threatened

Reptiles

NAME	STATUS
Hawksbill Sea Turtle Eretmochelys imbricata Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3656	Endangered

Kemp's Ridley Sea Turtle Lepidochelys kempii Wherever found There is **proposed** critical habitat for this species. https://ecos.fws.gov/ecp/species/5523	Endangered
Leatherback Sea Turtle Dermochelys coriacea Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/1493	Endangered
Loggerhead Sea Turtle Caretta caretta There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/1110	Threatened

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9743	Candidate

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Piping Plover Charadrius melodus https://ecos.fws.gov/ecp/species/6039#crithab	Final
Rufa Red Knot Calidris canutus rufa https://ecos.fws.gov/ecp/species/1864#crithab	Proposed

Bald & Golden Eagles

Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act[1] and the Migratory Bird Treaty Act[2].

Any person or organization who plans or conducts activities that may result in impacts to bald or golden eagles, or their habitats[3], should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

There are likely bald eagles present in your project area. For additional information on bald eagles, refer to Bald Eagle Nesting and Sensitivity to Human Activity

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Sep 1 to Jul 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read

"Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

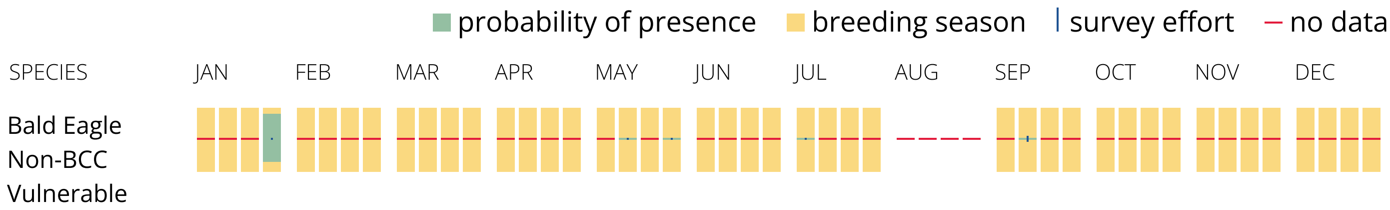
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply). To see a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs of bald and golden eagles in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur. Please contact your local Fish and Wildlife Service Field Office if you have questions.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats[3] should follow appropriate regulations and consider implementing appropriate conservation measures, as described in the links below. Specifically, please review the "Supplemental Information on Migratory Birds and Eagles".

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide conservation measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the PROBABILITY OF PRESENCE SUMMARY below to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON

American Oystercatcher Haematopus palliatus — Breeds Apr 15 to Aug 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8935

Bald Eagle Haliaeetus leucocephalus — Breeds Sep 1 to Jul 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1626

Black Skimmer Rynchops niger — Breeds May 20 to Sep 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5234

Brown Pelican Pelecanus occidentalis — Breeds Jan 15 to Sep 30

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/6034

Common Loon gavia immer — Breeds Apr 15 to Oct 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/4464

Double-crested Cormorant phalacrocorax auritus — Breeds Apr 20 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/3478

Forster's Tern Sterna forsteri — Breeds Mar 1 to Aug 15

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Gull-billed Tern Gelochelidon nilotica | Breeds May 1 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9501

Least Tern Sternula antillarum antillarum | Breeds Apr 25 to Sep 5
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Long-billed Curlew Numenius americanus | Breeds elsewhere
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/5511

Magnificent Frigatebird Fregata magnificens | Breeds elsewhere
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Marbled Godwit Limosa fedoa | Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Red Knot Calidris canutus roselaari | Breeds elsewhere
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8880

Red-breasted Merganser Mergus serrator | Breeds elsewhere
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Reddish Egret Egretta rufescens | Breeds Mar 1 to Sep 15
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/7617

Ring-billed Gull Larus delawarensis | Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Royal Tern Thalasseus maximus | Breeds Apr 15 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Ruddy Turnstone Arenaria interpres morinella | Breeds elsewhere

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Sandwich Tern Thalasseus sandvicensis | Breeds Apr 25 to Aug 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Short-billed Dowitcher Limnodromus griseus | Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9480

Sooty Tern Onychoprion fuscatus | Breeds Mar 10 to Jul 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Whimbrel Numenius phaeopus hudsonicus | Breeds elsewhere

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Willet Tringa semipalmata | Breeds Apr 20 to Aug 5

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Wilson's Plover Charadrius wilsonia | Breeds Apr 1 to Aug 20

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

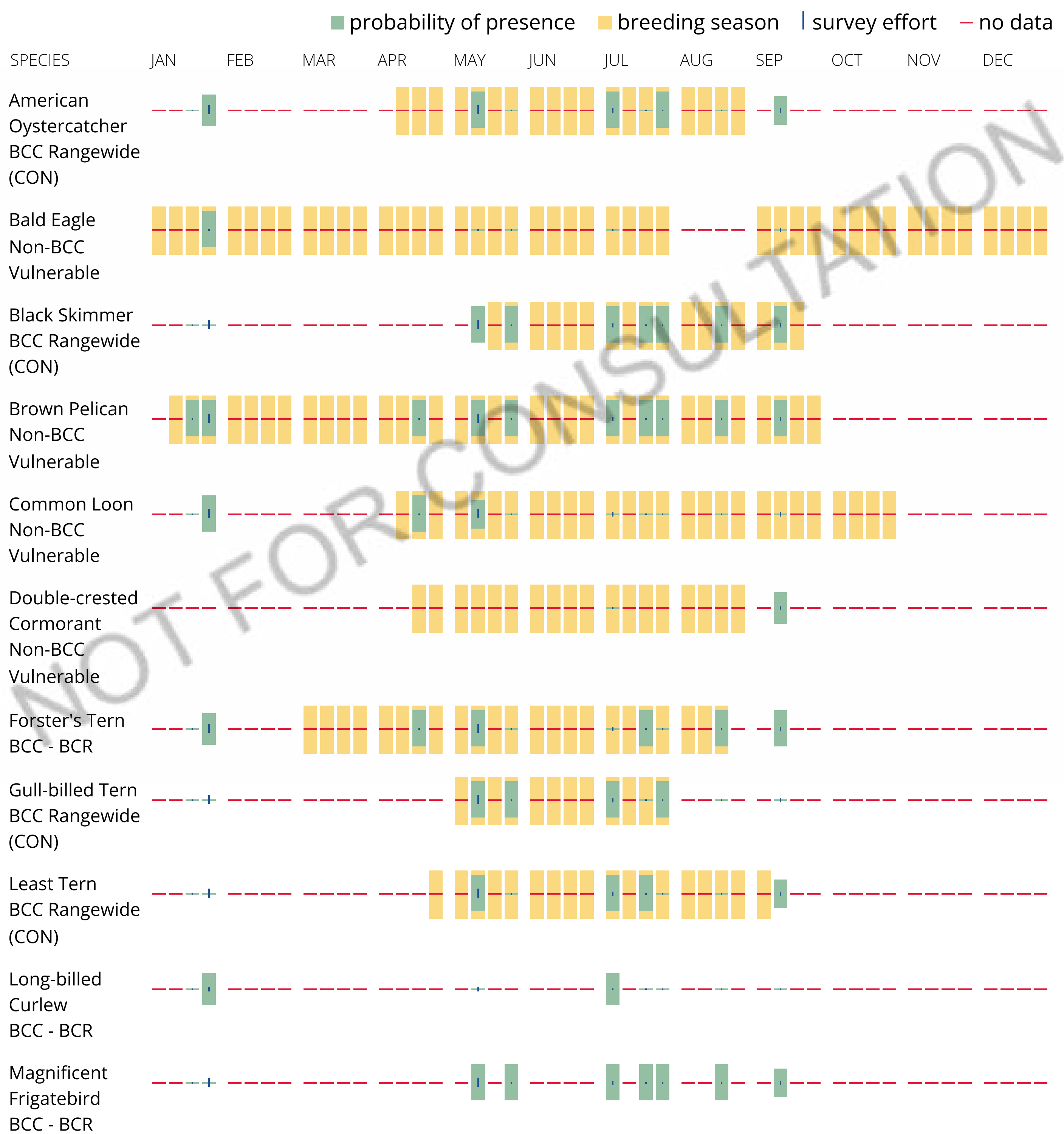
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

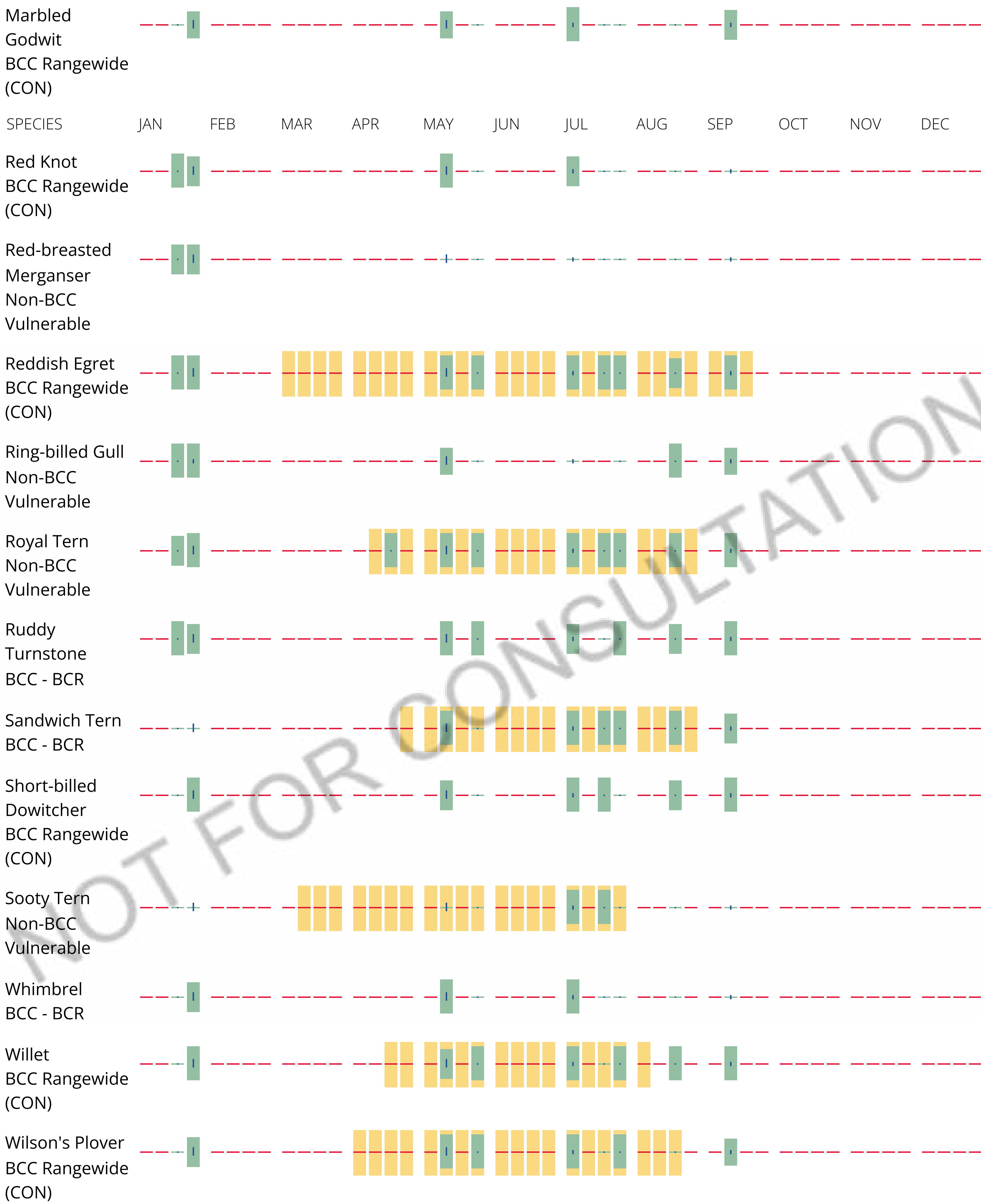
No Data (–)

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.





Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the Rapid Avian Information Locator (RAIL) Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may query your location using the RAIL Tool and look at the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);

2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Marine mammals

Marine mammals are protected under the Marine Mammal Protection Act. Some are also protected under the Endangered Species Act[1] and the Convention on International Trade in Endangered Species of Wild Fauna and Flora[2].

The responsibilities for the protection, conservation, and management of marine mammals are shared by the U.S. Fish and Wildlife Service [responsible for otters, walruses, polar bears, manatees, and dugongs] and NOAA Fisheries[3] [responsible for seals, sea lions, whales, dolphins, and porpoises]. Marine mammals under the responsibility of NOAA Fisheries are **not** shown on this list; for additional information on those species please visit the Marine Mammals page of the NOAA Fisheries website.

The Marine Mammal Protection Act prohibits the take of marine mammals and further coordination may be necessary for project evaluation. Please contact the U.S. Fish and Wildlife Service Field Office shown.

1. The Endangered Species Act (ESA) of 1973.
2. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a treaty to ensure that international trade in plants and animals does not threaten their survival in the wild.
3. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following marine mammals under the responsibility of the U.S. Fish and Wildlife Service are potentially affected by activities in this location:

NAME
West Indian Manatee *Trichechus manatus* https://ecos.fws.gov/ecp/species/4469

Coastal Barrier Resources System

Projects within the John H. Chafee Coastal Barrier Resources System (CBRS) may be subject to the restrictions on Federal expenditures and financial assistance and the consultation requirements of the Coastal Barrier Resources Act (CBRA) (16 U.S.C. 3501 et seq.). For more information, please contact the local Ecological Services Field Office or visit the CBRA

Consultations website. The CBRA website provides tools such as a flow chart to help determine whether consultation is required and a template to facilitate the consultation process.

This location overlaps the following CBRS unit(s):

Otherwise Protected Area (OPA)

OPAs are denoted with a "P" at the end of the unit number. The only prohibition within OPAs is on Federal flood insurance. ***CBRA consultation is not required for projects within OPAs.*** *However, agencies providing disaster assistance that is contingent upon a requirement to purchase flood insurance after the fact are advised to disclose the OPA designation and information on the restrictions on Federal flood insurance to the recipient prior to the commitments of funds.*

LA-03P - FI 11/16/1991

Data limitations

The CBRS boundaries used in IPaC are representations of the controlling boundaries, which are depicted on the official CBRS maps. The boundaries depicted in this layer are not to be considered authoritative for in/out determinations close to a CBRS boundary (i.e., within the "CBRS Buffer Zone" that appears as a hatched area on either side of the boundary). For projects that are very close to a CBRS boundary but do not clearly intersect a unit, you may contact the Service for an official determination by following the instructions here: https://www.fws.gov/service/coastal-barrier-resources-system-property-documentation

Data exclusions

CBRS units extend seaward out to either the 20- or 30-foot bathymetric contour (depending on the location of the unit). The true seaward extent of the units is not shown in the CBRS data, therefore projects in the offshore areas of units (e.g., dredging, breakwaters, offshore wind energy or oil and gas projects) may be subject to CBRA even if they do not intersect the CBRS data. For additional information, please contact CBRA@fws.gov.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
BRETON NATIONAL WILDLIFE REFUGE	12,141.26 acres

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Wetland information is not available at this time

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

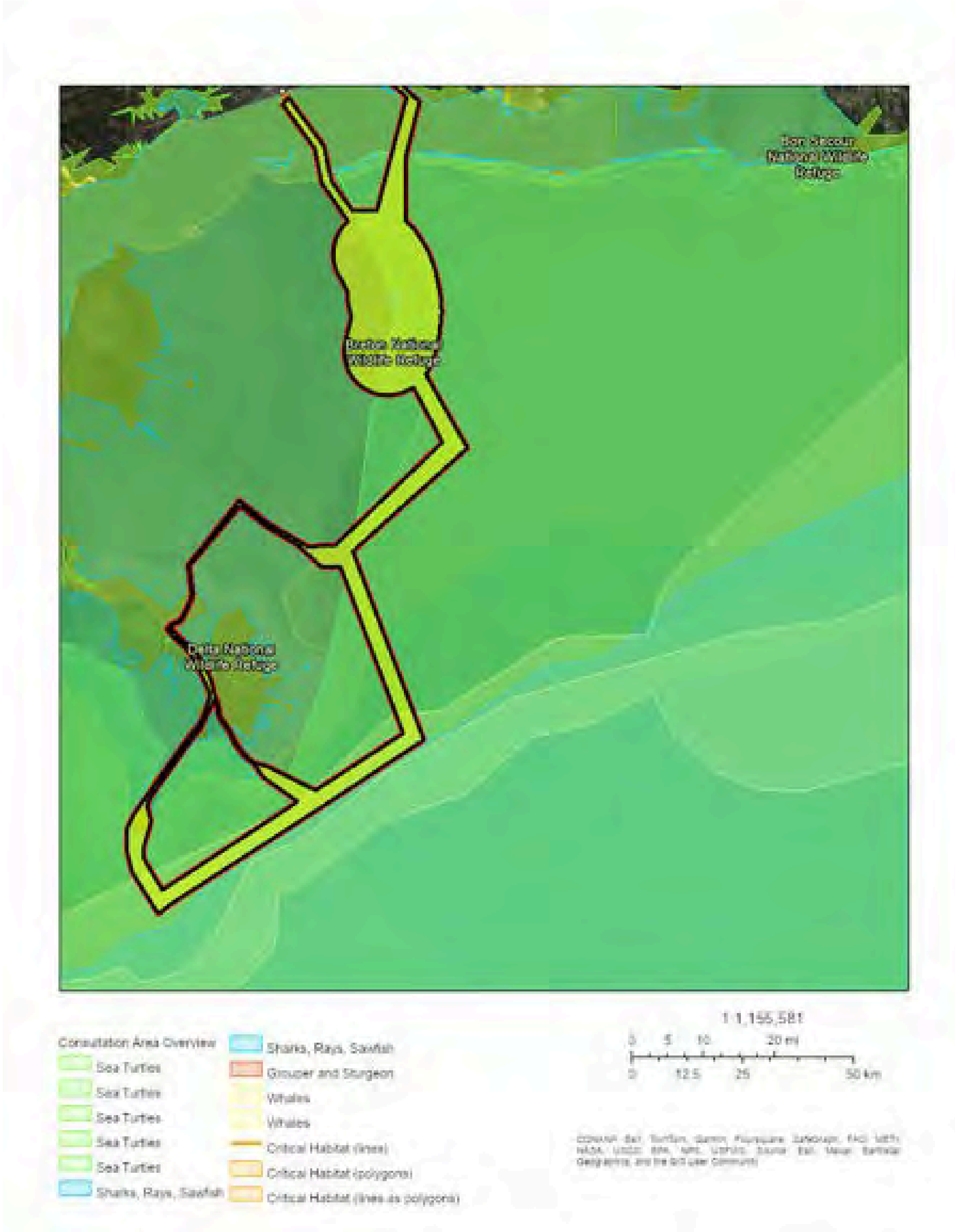
Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Drawn Action Area & Overlapping S7 Consultation Areas

Area of Interest (AOI) Information

Area : 23,296,832,195.08 ft²

Jan 6 2025 15:13:43 Central Standard Time



Summary

Name	Count	Area(ft²)	Length(ft)
Conchs	0	0	N/A
Corals	0	0	N/A
Sea Turtles	53	226,403,250,839.89	N/A
Sharks, Rays, Sawfish	65	91,437,144,956.26	N/A
Grouper and Sturgeon	15	24,234,346,870.52	N/A
Whales	8	29,258,751,855.36	N/A
Critical Habitat (linear)	0	N/A	0
Critical Habitat (area)	4	19,844,269,332.06	N/A
Critical Habitat (lines as polygons)	1	1,381,037,908.12	N/A
Miscellaneous	0	0	N/A

Sea Turtles

#	Species	Status	Life Stage	Behavior	Zone
1	Green Sea Turtle	Threatened	Adults	Mating	Gulf of Mexico Neritic
2	Green Sea Turtle	Threatened	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Neritic
3	Green Sea Turtle	Threatened	Oceanic Juveniles and Post-Hatchlings	Foraging/Resting	Sea Turtle, Green, Proposed Critical Habitat: Sargassum
4	Green Sea Turtle	Threatened	Adults	Migrating & Foraging	Gulf of Mexico Tidally-Influenced Inshore
5	Green Sea Turtle	Threatened	Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Tidally-Influenced Inshore
6	Hawksbill Sea Turtle	Endangered	Adults	Mating	Gulf of Mexico Neritic
7	Hawksbill Sea Turtle	Endangered	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Neritic
8	Kemp's Ridley Sea Turtle	Endangered	Adults	Mating	Gulf of Mexico Neritic
9	Kemp's Ridley Sea Turtle	Endangered	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Neritic
10	Kemp's Ridley Sea Turtle	Endangered	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Tidally-Influenced Inshore
11	Loggerhead Sea Turtle	Threatened	Adults	Mating	Gulf of Mexico Neritic
12	Loggerhead Sea Turtle	Threatened	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Neritic
13	Loggerhead Sea Turtle	Threatened	Hatchlings	Migrating	Gulf of Mexico Neritic
14	Loggerhead Sea Turtle	Threatened	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Tidally-Influenced Inshore
15	Loggerhead Sea Turtle	Threatened	Adults	Nesting	Louisiana Coastal Parish Buffer
16	Loggerhead Sea Turtle	Threatened	Hatchlings	Migrating	Louisiana Coastal Parish Buffer
17	Loggerhead Sea Turtle	Threatened	Adults	Nesting	Louisiana Coastal Parishes
18	Loggerhead Sea Turtle	Threatened	Oceanic Juveniles and Post-Hatchlings	Migrating & Foraging	Sea Turtle, Loggerhead, Critical Habitat: Sargassum Habitat
19	Loggerhead Sea Turtle	Threatened	Adults	Nesting	Mississippi Coastal County Buffer
20	Loggerhead Sea Turtle	Threatened	Hatchlings	Migrating	Mississippi Coastal County Buffer
21	Loggerhead Sea Turtle	Threatened	Adults	Nesting	Mississippi Coastal Counties
22	Leatherback Sea Turtle	Endangered	Adults	Migrating & Foraging	Gulf of Mexico Coast to EEZ
23	Leatherback Sea Turtle	Endangered	Adults	Mating	Gulf of Mexico Coast to EEZ
24	Leatherback Sea Turtle	Endangered	Juveniles and Post-Hatchlings	Migrating & Foraging	Gulf of Mexico Coast to EEZ

#	Sub-ZONE	Date From	Until	Date From (2)	Until (2)
1	*No Data*	01/01	12/31	*No Data*	*No Data*
2	*No Data*	01/01	12/31	*No Data*	*No Data*
3	Unit NA01: Sargassum	1/1	12/31	*No Data*	*No Data*
4	*No Data*	01/01	12/31	*No Data*	*No Data*
5	*No Data*	01/01	12/31	*No Data*	*No Data*
6	*No Data*	01/01	12/31	*No Data*	*No Data*
7	*No Data*	01/01	12/31	*No Data*	*No Data*
8	*No Data*	01/01	12/31	*No Data*	*No Data*
9	*No Data*	01/01	12/31	*No Data*	*No Data*
10	*No Data*	01/01	12/31	*No Data*	*No Data*
11	*No Data*	01/01	12/31	*No Data*	*No Data*
12	*No Data*	01/01	12/31	*No Data*	*No Data*
13	*No Data*	01/01	12/31	*No Data*	*No Data*
14	*No Data*	01/01	12/31	*No Data*	*No Data*
15	Chandeleur Island	04/01	09/30	*No Data*	*No Data*
16	Chandeleur Island	05/15	11/30	*No Data*	*No Data*
17	Chandeleur Island	01/01	12/31	*No Data*	*No Data*
18	LOGG-S Units 01, 02	01/01	12/31	*No Data*	*No Data*
19	Harrison, Jackson	04/01	09/30	*No Data*	*No Data*
20	Harrison, Jackson	05/15	11/30	*No Data*	*No Data*
21	Harrison, Jackson	01/01	12/31	*No Data*	*No Data*
22	*No Data*	01/01	12/31	*No Data*	*No Data*
23	*No Data*	01/01	12/31	*No Data*	*No Data*
24	*No Data*	01/01	12/31	*No Data*	*No Data*

#	Notes	Feature ID	Area(ft²)
1	*No Data*	GRN_GMN_ADU_MAT	14,696,839,641.29
2	*No Data*	GRN_GMN_ANJ_MAF	14,696,839,641.29
3	*No Data*	GRN_GPS_OJP_FAR	11,767,530,898.78
4	The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GRN_GTD_ADU_MAF	8,597,136,165.16
5	The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GRN_GTD_NJV_MAF	8,597,136,165.16
6	*No Data*	HWK_GMN_ADU_MAT	14,696,839,641.29
7	*No Data*	HWK_GMN_ANJ_MAF	14,696,839,641.29
8	*No Data*	KMP_GMN_ADU_MAT	14,696,839,641.29
9	*No Data*	KMP_GMN_ANJ_MAF	14,696,839,641.29
10	The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	KMP_GTD_ANJ_MAF	8,597,152,380.44
11	*No Data*	LOG_GMN_ADU_MAT	14,696,839,641.29
12	*No Data*	LOG_GMN_ANJ_MAF	14,696,839,641.29
13	Waters within 1-mile seaward of nesting beaches are of particular importance to hatchlings. Projects in these areas must be evaluated for their potential impacts to hatchlings leaving nesting beaches.	LOG_GMN_HCH_MIG	14,696,839,641.29
14	The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	LOG_GTD_ANJ_MAF	8,597,152,380.44

15	Waters within 1-mile seaward of nesting beaches are of particular importance to nesting females. Projects in these areas must be evaluated for their potential impacts to nesting female ingress and egress as they approach or leave nesting beaches during nesting season. Nesting beach zones are based upon broad-scale presence of nesting activity. Not all shoreline habitats, including beaches, within the generalized zone have suitable nesting habitat or are utilized by sea turtles for nesting. Please inquire with state/local agencies or organizations and/or other information sources to determine if the shoreline near your specific project location is suitable for, and utilized as, nesting habitat by sea turtles.	LOG_LC1_ADU_NST	473,825,179.87
16	*No Data*	LOG_LC1_HCH_MIG	473,825,179.87
17	Nesting beaches for this species occur in this county. The U.S. Fish and Wildlife Service (USFWS) has jurisdiction for sea turtles on the beach and NOAA Fisheries has jurisdiction for sea turtles in the marine environment. Please contact the USFWS if a project may affect sea turtles or nests on the beach.	LOG_LCP_ADU_NST	26,752,308.25
18	Designated critical habitat	LOG_LSH_OJP_MAF	2,820,499,718.14
19	Waters within 1-mile seaward of nesting beaches are of particular importance to nesting females. Projects in these areas must be evaluated for their potential impacts to nesting female ingress and egress as they approach or leave nesting beaches during nesting season. Nesting beach zones are based upon broad-scale presence of nesting activity. Not all shoreline habitats, including beaches, within the generalized zone have suitable nesting habitat or are utilized by sea turtles for nesting. Please inquire with state/local agencies or organizations and/or other information sources to determine if the shoreline near your specific project location is suitable for, and utilized as, nesting habitat by sea turtles.	LOG_MC1_ADU_NST	43,741,665.35
20	Waters within 1-mile seaward of nesting beaches are of particular importance to hatchlings. Projects in these areas must be evaluated for their potential impacts to hatchlings leaving nesting beaches.	LOG_MC1_HCH_MIG	43,741,665.35
21	Nesting beaches for this species occur in this county. The U.S. Fish and Wildlife Service (USFWS) has jurisdiction for sea turtles on the beach and NOAA Fisheries has jurisdiction for sea turtles in the marine environment. Please contact the USFWS if a project may affect sea turtles or nests on the beach.	LOG_MCC_ADU_NST	1,981,076.48
22	*No Data*	LTR_GCZ_ADU_MAF	14,697,073,094.99
23	*No Data*	LTR_GCZ_ADU_MAT	14,697,073,094.99
24	*No Data*	LTR_GCZ_JPH_MAF	14,697,073,094.99

Sharks, Rays, Sawfish

#	Species	Status	Life Stage	Behavior	Zone
1	Giant Manta Ray	Threatened	Adults	Migrating & Foraging	Gulf of Mexico Coast to EEZ
2	Giant Manta Ray	Threatened	Adults	Mating	Gulf of Mexico Coast to EEZ
3	Giant Manta Ray	Threatened	Juveniles	Migrating & Foraging	Gulf of Mexico Coast to EEZ
4	Giant Manta Ray	Threatened	YOY	Migrating & Foraging	Gulf of Mexico Coast to EEZ
5	Giant Manta Ray	Threatened	Adults	Migrating & Foraging	Ray, Giant Manta, Inshore Gulf of Mexico
6	Giant Manta Ray	Threatened	Adults	Mating	Ray, Giant Manta, Inshore Gulf of Mexico
7	Giant Manta Ray	Threatened	Juveniles	Migrating & Foraging	Ray, Giant Manta, Inshore Gulf of Mexico
8	Giant Manta Ray	Threatened	YOY	Migrating & Foraging	Ray, Giant Manta, Inshore Gulf of Mexico
9	Oceanic Whitetip Shark	Threatened	Adults	Migrating & Foraging	Shark, Oceanic Whitetip, Gulf of Mexico Range
10	Oceanic Whitetip Shark	Threatened	Adults	Mating	Shark, Oceanic Whitetip, Gulf of Mexico Range
11	Oceanic Whitetip Shark	Threatened	Adults	Pupping	Shark, Oceanic Whitetip, Gulf of Mexico Range
12	Oceanic Whitetip Shark	Threatened	Juveniles	Migrating & Foraging	Shark, Oceanic Whitetip, Gulf of Mexico Range
13	Oceanic Whitetip Shark	Threatened	YOY	Migrating & Foraging	Shark, Oceanic Whitetip, Gulf of Mexico Range

#	Sub-Zone	Date From	Until	Date From (2)	Until (2)
1	*No Data*	01/01	12/31	*No Data*	*No Data*
2	*No Data*	01/01	12/31	*No Data*	*No Data*
3	*No Data*	01/01	12/31	*No Data*	*No Data*
4	*No Data*	01/01	12/31	*No Data*	*No Data*
5	*No Data*	01/01	12/31	*No Data*	*No Data*
6	*No Data*	01/01	12/31	*No Data*	*No Data*
7	*No Data*	01/01	12/31	*No Data*	*No Data*
8	*No Data*	01/01	12/31	*No Data*	*No Data*
9	*No Data*	01/01	12/31	*No Data*	*No Data*
10	*No Data*	01/01	12/31	*No Data*	*No Data*
11	*No Data*	01/01	12/31	*No Data*	*No Data*
12	*No Data*	01/01	12/31	*No Data*	*No Data*
13	*No Data*	01/01	12/31	*No Data*	*No Data*

#	Notes	Feature ID	Area(ft²)
1	*No Data*	GMR_GCZ_ADU_MAF	14,697,073,094.99
2	*No Data*	GMR_GCZ_ADU_MAT	14,697,073,094.99
3	*No Data*	GMR_GCZ_JUV_MAF	14,697,073,094.99
4	*No Data*	GMR_GCZ_YOY_MAF	14,697,073,094.99
5	The mapped boundary for inshore areas includes some areas (e.g., freshwater lakes and rivers, tidal and non-tidal marshes, mangroves, riparian areas) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GMR_RIG_ADU_MAF	7,055,953,793.92
6	The mapped boundary for inshore areas includes some areas (e.g., freshwater lakes and rivers, tidal and non-tidal marshes, mangroves, riparian areas) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GMR_RIG_ADU_MAT	7,055,953,793.92
7	The mapped boundary for inshore areas includes some areas (e.g., freshwater lakes and rivers, tidal and non-tidal marshes, mangroves, riparian areas) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GMR_RIG_JUV_MAF	7,055,953,793.92
8	The mapped boundary for inshore areas includes some areas (e.g., freshwater lakes and rivers, tidal and non-tidal marshes, mangroves, riparian areas) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GMR_RIG_YOY_MAF	7,055,953,793.92
9	*No Data*	OWT_ORG_ADU_MAF	885,007,480.12
10	*No Data*	OWT_ORG_ADU_MAT	885,007,480.12
11	*No Data*	OWT_ORG_ADU_PUP	885,007,480.12
12	*No Data*	OWT_ORG_JUV_MAF	885,007,480.12
13	*No Data*	OWT_ORG_YOY_MAF	885,007,480.12

Grouper and Sturgeon

#	Species	Status	Life Stage	Behavior	Zone
1	Gulf sturgeon	Threatened	Adults and Subadults	Migrating & Foraging	Sturgeon, Gulf, Critical Habitat: Unit 8 Lake Pontchartrain - Mississippi Sound
2	Gulf sturgeon	Threatened	Adults and Subadults	Overwintering	Sturgeon, Gulf, Critical Habitat: Unit 8 Lake Pontchartrain - Mississippi Sound
3	Gulf sturgeon	Threatened	Adults and Subadults	Overwintering	Gulf of Mexico Neritic
4	Gulf sturgeon	Threatened	Adults and Subadults	Overwintering	Gulf of Mexico Tidally-Influenced Inshore
5	Gulf sturgeon	Threatened	Juveniles	Overwintering	Gulf of Mexico Tidally-Influenced Inshore

#	Sub-Zone	Date From	Until	Date From (2)	Until (2)
1	*No Data*	10/01	04/30	*No Data*	*No Data*
2	*No Data*	10/01	04/30	*No Data*	*No Data*
3	*No Data*	10/01	04/30	*No Data*	*No Data*
4	*No Data*	10/01	04/30	*No Data*	*No Data*
5	*No Data*	10/01	04/30	*No Data*	*No Data*

#	Notes	Feature ID	Area(ft²)
1	While the major shipping channels of Gulf Sturgeon Critical Habitat Unit 8 Lake Pontchartrain - Mississippi Sound are excluded from Critical Habitat designation, impacts to species in these excluded area must still be considered in the context of section 7 consultations. This map only includes freshwater areas designated as Gulf sturgeon critical habitat and is not intended to be an accurate representation of all freshwater portions of the Gulf sturgeon range. In riverine units, the U.S. Fish and Wildlife Service will be responsible for all consultations regarding Gulf sturgeon and critical habitat.	GLF_G08_ASA_MAF	1,381,037,908.12
2	While the major shipping channels of Gulf Sturgeon Critical Habitat Unit 8 Lake Pontchartrain - Mississippi Sound are excluded from Critical Habitat designation, impacts to species in these excluded area must still be considered in the context of section 7 consultations. This map only includes freshwater areas designated as Gulf sturgeon critical habitat and is not intended to be an accurate representation of all freshwater portions of the Gulf sturgeon range. In riverine units, the U.S. Fish and Wildlife Service will be responsible for all consultations regarding Gulf sturgeon and critical habitat.	GLF_G08_ASA_WIN	1,381,037,908.12
3	*No Data*	GLF_GMN_ASA_WIN	8,873,272,214.92
4	NOAA Fisheries and the U.S. Fish and Wildlife Service divide consultation responsibility for Gulf sturgeon. Please request further clarification from NOAA Fisheries on the consultation lead in this area. The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GLF_GTD_ASA_WIN	6,299,499,419.68
5	NOAA Fisheries and the U.S. Fish and Wildlife Service divide consultation responsibility for Gulf sturgeon. Please request further clarification from NOAA Fisheries on the consultation lead in this area. The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GLF_GTD_JUV_WIN	6,299,499,419.68

Whales

#	Species	Status	Life Stage	Behavior	Zone
1	Rice's Whale	Endangered	Adults	Migrating & Foraging	Whale, Rice's, Gulf of Mexico Suitable Habitat
2	Rice's Whale	Endangered	Adults	Mating & Calving	Whale, Rice's, Gulf of Mexico Suitable Habitat
3	Rice's Whale	Endangered	Calves	Migrating	Whale, Rice's, Gulf of Mexico Suitable Habitat
4	Rice's Whale	Endangered	Juveniles	Migrating & Foraging	Whale, Rice's, Gulf of Mexico Suitable Habitat
5	Rice's Whale	Endangered	Adults	Migrating & Foraging	Whale, Rice's, Proposed Critical Habitat: Gulf of Mexico Unit
6	Rice's Whale	Endangered	Adults	Mating & Calving	Whale, Rice's, Proposed Critical Habitat: Gulf of Mexico Unit
7	Rice's Whale	Endangered	Calves	Migrating	Whale, Rice's, Proposed Critical Habitat: Gulf of Mexico Unit
8	Rice's Whale	Endangered	Juveniles	Migrating & Foraging	Whale, Rice's, Proposed Critical Habitat: Gulf of Mexico Unit

#	Sub-Zone	Date From	Until	Date From (2)	Until (2)
1	*No Data*	01/01	12/31	*No Data*	*No Data*
2	*No Data*	01/01	12/31	*No Data*	*No Data*
3	*No Data*	01/01	12/31	*No Data*	*No Data*
4	*No Data*	01/01	12/31	*No Data*	*No Data*
5	*No Data*	01/01	12/31	*No Data*	*No Data*
6	*No Data*	01/01	12/31	*No Data*	*No Data*
7	*No Data*	01/01	12/31	*No Data*	*No Data*
8	*No Data*	01/01	12/31	*No Data*	*No Data*

#	Notes	Feature ID	Area(ft²)
1	*No Data*	RYC_WRH_ADU_MAF	3,439,206,465.66
2	*No Data*	RYC_WRH_ADU_MCV	3,439,206,465.66
3	*No Data*	RYC_WRH_CLV_MIG	3,439,206,465.66
4	*No Data*	RYC_WRH_JUV_MAF	3,439,206,465.66
5	*No Data*	RYC_WRP_ADU_MAF	3,875,481,498.18
6	*No Data*	RYC_WRP_ADU_MCV	3,875,481,498.18
7	*No Data*	RYC_WRP_CLV_MIG	3,875,481,498.18
8	*No Data*	RYC_WRP_JUV_MAF	3,875,481,498.18

Critical Habitat (area)

#	Species	CH Status	CH Unit	Area(ft²)
1	Entire Species	Proposed	Gulf of Mexico Unit	3,875,481,496.50
2	Sea turtle, green [North Atlantic DPS]	Proposed	NA01: Sargassum	11,767,250,208.15
3	Sea turtle, loggerhead [Northwest Atlantic Ocean DPS]	Final	LOGG-S-02 Sargassum Habitat	2,820,499,719.72
4	Sturgeon, Atlantic (Gulf subspecies)	Final	8 Lake Pontchartrain - Mississippi Sound	1,381,037,907.70

Critical Habitat (lines as polygons)

#	Species	CH Status	CH Unit	Note	Area(ft²)
1	Sturgeon, Atlantic (Gulf subspecies)	Final	Unit 8 Lake Pontchartrain - Mississippi Sound	Some designated Critical Habitat units for Gulf Sturgeon and Atlantic Sturgeon are defined as river stems, formally depicted as linear features in the CFR. For overlay tools in the S7 Mapper to work properly, we extrapolated linear Critical Habitat units to the corresponding double river bank polygon features represented in NHD.	1,381,037,908.12

Drawn Action Area & Overlapping S7 Consultation Areas

Area of Interest (AOI) Information

Area : 8,244,598,920.39 ft²

Dec 3 2024 11:17:46 Central Standard Time

The Action Area included in this review excludes vessel access.

Summary

Name	Count	Area(ft²)	Length(ft)
Conchs	0	0	N/A
Corals	0	0	N/A
Sea Turtles	20	72,004,880,748.14	N/A
Sharks, Rays, Sawfish	12	32,850,578,983.51	N/A
Grouper and Sturgeon	5	11,868,408,472.54	N/A
Whales	0	0	N/A
Critical Habitat (linear)	0	N/A	0
Critical Habitat (area)	1	1,128,034,070.29	N/A
Critical Habitat (lines as polygons)	0	0	N/A
Miscellaneous	0	0	N/A

Sea Turtles

#	Species	Status	Life Stage	Behavior	Zone
1	Green Sea Turtle	Threatened	Adults	Mating	Gulf of Mexico Neritic
2	Green Sea Turtle	Threatened	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Neritic
3	Green Sea Turtle	Threatened	Oceanic Juveniles and Post-Hatchlings	Foraging/Resting	Sea Turtle, Green, Proposed Critical Habitat: Sargassum
4	Green Sea Turtle	Threatened	Adults	Migrating & Foraging	Gulf of Mexico Tidally-Influenced Inshore
5	Green Sea Turtle	Threatened	Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Tidally-Influenced Inshore
6	Hawksbill Sea Turtle	Endangered	Adults	Mating	Gulf of Mexico Neritic
7	Hawksbill Sea Turtle	Endangered	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Neritic
8	Kemp's Ridley Sea Turtle	Endangered	Adults	Mating	Gulf of Mexico Neritic
9	Kemp's Ridley Sea Turtle	Endangered	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Neritic
10	Kemp's Ridley Sea Turtle	Endangered	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Tidally-Influenced Inshore
11	Loggerhead Sea Turtle	Threatened	Adults	Mating	Gulf of Mexico Neritic
12	Loggerhead Sea Turtle	Threatened	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Neritic
13	Loggerhead Sea Turtle	Threatened	Hatchlings	Migrating	Gulf of Mexico Neritic
14	Loggerhead Sea Turtle	Threatened	Adults and Neritic Juveniles	Migrating & Foraging	Gulf of Mexico Tidally-Influenced Inshore
15	Loggerhead Sea Turtle	Threatened	Adults	Nesting	Louisiana Coastal Parish Buffer
16	Loggerhead Sea Turtle	Threatened	Hatchlings	Migrating	Louisiana Coastal Parish Buffer
17	Loggerhead Sea Turtle	Threatened	Adults	Nesting	Louisiana Coastal Parishes
18	Leatherback Sea Turtle	Endangered	Adults	Migrating & Foraging	Gulf of Mexico Coast to EEZ
19	Leatherback Sea Turtle	Endangered	Adults	Mating	Gulf of Mexico Coast to EEZ
20	Leatherback Sea Turtle	Endangered	Juveniles and Post-Hatchlings	Migrating & Foraging	Gulf of Mexico Coast to EEZ

#	Sub-ZONE	Date From	Until	Date From (2)	Until (2)
1	*No Data*	01/01	12/31	*No Data*	*No Data*
2	*No Data*	01/01	12/31	*No Data*	*No Data*
3	Unit NA01: Sargassum	1/1	12/31	*No Data*	*No Data*
4	*No Data*	01/01	12/31	*No Data*	*No Data*
5	*No Data*	01/01	12/31	*No Data*	*No Data*
6	*No Data*	01/01	12/31	*No Data*	*No Data*
7	*No Data*	01/01	12/31	*No Data*	*No Data*
8	*No Data*	01/01	12/31	*No Data*	*No Data*
9	*No Data*	01/01	12/31	*No Data*	*No Data*
10	*No Data*	01/01	12/31	*No Data*	*No Data*
11	*No Data*	01/01	12/31	*No Data*	*No Data*
12	*No Data*	01/01	12/31	*No Data*	*No Data*
13	*No Data*	01/01	12/31	*No Data*	*No Data*
14	*No Data*	01/01	12/31	*No Data*	*No Data*
15	Chandeleur Island	04/01	09/30	*No Data*	*No Data*
16	Chandeleur Island	05/15	11/30	*No Data*	*No Data*
17	Chandeleur Island	01/01	12/31	*No Data*	*No Data*
18	*No Data*	01/01	12/31	*No Data*	*No Data*
19	*No Data*	01/01	12/31	*No Data*	*No Data*
20	*No Data*	01/01	12/31	*No Data*	*No Data*

#	Notes	Feature ID	Area(ft²)
1	*No Data*	GRN_GMN_ADU_MAT	4,616,562,601.16
2	*No Data*	GRN_GMN_ANJ_MAF	4,616,562,601.16
3	*No Data*	GRN_GPS_OJP_FAR	1,128,034,071.55
4	The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GRN_GTD_ADU_MAF	3,625,923,198.67
5	The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GRN_GTD_NJV_MAF	3,625,923,198.67
6	*No Data*	HWK_GMN_ADU_MAT	4,616,562,601.16
7	*No Data*	HWK_GMN_ANJ_MAF	4,616,562,601.16
8	*No Data*	KMP_GMN_ADU_MAT	4,616,562,601.16
9	*No Data*	KMP_GMN_ANJ_MAF	4,616,562,601.16
10	The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	KMP_GTD_ANJ_MAF	3,625,923,198.67
11	*No Data*	LOG_GMN_ADU_MAT	4,616,562,601.16
12	*No Data*	LOG_GMN_ANJ_MAF	4,616,562,601.16
13	Waters within 1-mile seaward of nesting beaches are of particular importance to hatchlings. Projects in these areas must be evaluated for their potential impacts to hatchlings leaving nesting beaches.	LOG_GMN_HCH_MIG	4,616,562,601.16
14	The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	LOG_GTD_ANJ_MAF	3,625,923,198.67

15	Waters within 1-mile seaward of nesting beaches are of particular importance to nesting females. Projects in these areas must be evaluated for their potential impacts to nesting female ingress and egress as they approach or leave nesting beaches during nesting season. Nesting beach zones are based upon broad-scale presence of nesting activity. Not all shoreline habitats, including beaches, within the generalized zone have suitable nesting habitat or are utilized by sea turtles for nesting. Please inquire with state/local agencies or organizations and/or other information sources to determine if the shoreline near your specific project location is suitable for, and utilized as, nesting habitat by sea turtles.	LOG_LC1_ADU_NST	473,825,179.87
16	*No Data*	LOG_LC1_HCH_MIG	473,825,179.87
17	Nesting beaches for this species occur in this county. The U.S. Fish and Wildlife Service (USFWS) has jurisdiction for sea turtles on the beach and NOAA Fisheries has jurisdiction for sea turtles in the marine environment. Please contact the USFWS if a project may affect sea turtles or nests on the beach.	LOG_LCP_ADU_NST	26,752,308.25
18	*No Data*	LTR_GCZ_ADU_MAF	4,616,562,601.16
19	*No Data*	LTR_GCZ_ADU_MAT	4,616,562,601.16
20	*No Data*	LTR_GCZ_JPH_MAF	4,616,562,601.16

Sharks, Rays, Sawfish

#	Species	Status	Life Stage	Behavior	Zone
1	Giant Manta Ray	Threatened	Adults	Migrating & Foraging	Gulf of Mexico Coast to EEZ
2	Giant Manta Ray	Threatened	Adults	Mating	Gulf of Mexico Coast to EEZ
3	Giant Manta Ray	Threatened	Juveniles	Migrating & Foraging	Gulf of Mexico Coast to EEZ
4	Giant Manta Ray	Threatened	YOY	Migrating & Foraging	Gulf of Mexico Coast to EEZ
5	Giant Manta Ray	Threatened	Adults	Migrating & Foraging	Ray, Giant Manta, Inshore Gulf of Mexico
6	Giant Manta Ray	Threatened	Adults	Mating	Ray, Giant Manta, Inshore Gulf of Mexico
7	Giant Manta Ray	Threatened	Juveniles	Migrating & Foraging	Ray, Giant Manta, Inshore Gulf of Mexico
8	Giant Manta Ray	Threatened	YOY	Migrating & Foraging	Ray, Giant Manta, Inshore Gulf of Mexico

#	Sub-Zone	Date From	Until	Date From (2)	Until (2)
1	*No Data*	01/01	12/31	*No Data*	*No Data*
2	*No Data*	01/01	12/31	*No Data*	*No Data*
3	*No Data*	01/01	12/31	*No Data*	*No Data*
4	*No Data*	01/01	12/31	*No Data*	*No Data*
5	*No Data*	01/01	12/31	*No Data*	*No Data*
6	*No Data*	01/01	12/31	*No Data*	*No Data*
7	*No Data*	01/01	12/31	*No Data*	*No Data*
8	*No Data*	01/01	12/31	*No Data*	*No Data*

#	Notes	Feature ID	Area(ft²)
1	*No Data*	GMR_GCZ_ADU_MAF	4,616,562,601.16
2	*No Data*	GMR_GCZ_ADU_MAT	4,616,562,601.16
3	*No Data*	GMR_GCZ_JUV_MAF	4,616,562,601.16
4	*No Data*	GMR_GCZ_YOY_MAF	4,616,562,601.16
5	The mapped boundary for inshore areas includes some areas (e.g., freshwater lakes and rivers, tidal and non-tidal marshes, mangroves, riparian areas) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GMR_RIG_ADU_MAF	3,596,082,144.72
6	The mapped boundary for inshore areas includes some areas (e.g., freshwater lakes and rivers, tidal and non-tidal marshes, mangroves, riparian areas) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GMR_RIG_ADU_MAT	3,596,082,144.72
7	The mapped boundary for inshore areas includes some areas (e.g., freshwater lakes and rivers, tidal and non-tidal marshes, mangroves, riparian areas) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GMR_RIG_JUV_MAF	3,596,082,144.72
8	The mapped boundary for inshore areas includes some areas (e.g., freshwater lakes and rivers, tidal and non-tidal marshes, mangroves, riparian areas) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GMR_RIG_YOY_MAF	3,596,082,144.72

Grouper and Sturgeon

#	Species	Status	Life Stage	Behavior	Zone
1	Gulf sturgeon	Threatened	Adults and Subadults	Overwintering	Gulf of Mexico Neritic
2	Gulf sturgeon	Threatened	Adults and Subadults	Overwintering	Gulf of Mexico Tidally-Influenced Inshore
3	Gulf sturgeon	Threatened	Juveniles	Overwintering	Gulf of Mexico Tidally-Influenced Inshore

#	Sub-Zone	Date From	Until	Date From (2)	Until (2)
1	*No Data*	10/01	04/30	*No Data*	*No Data*
2	*No Data*	10/01	04/30	*No Data*	*No Data*
3	*No Data*	10/01	04/30	*No Data*	*No Data*

#	Notes	Feature ID	Area(ft²)
1	*No Data*	GLF_GMN_ASA_WIN	4,616,562,601.16
2	NOAA Fisheries and the U.S. Fish and Wildlife Service divide consultation responsibility for Gulf sturgeon. Please request further clarification from NOAA Fisheries on the consultation lead in this area. The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GLF_GTD_ASA_WIN	3,625,922,935.69
3	NOAA Fisheries and the U.S. Fish and Wildlife Service divide consultation responsibility for Gulf sturgeon. Please request further clarification from NOAA Fisheries on the consultation lead in this area. The mapped boundary for inshore areas includes some areas (e.g., saltmarsh, uplands) that are not habitat for this species. Please consider various factors such as habitat type, sighting information, and project details when determining whether to consult on this species in this area.	GLF_GTD_JUV_WIN	3,625,922,935.69

Critical Habitat (area)

#	Species	CH Status	CH Unit	Area(ft²)
1	Sea turtle, green [North Atlantic DPS]	Proposed	NA01: Sargassum	1,128,034,070.29

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

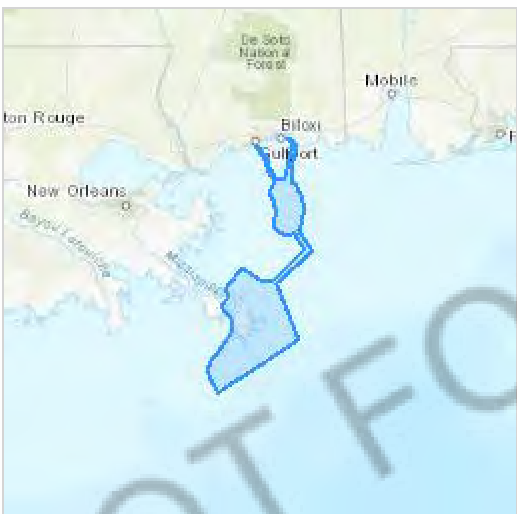
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Louisiana and Mississippi



Local offices

Mississippi Ecological Services Field Office

(601) 965-4900

6578 Dogwood View Parkway, Suite A
Jackson, MS 39213-7856

Louisiana Ecological Services Field Office

(337) 291-3100
(337) 291-3139

200 Dulles Drive
Lafayette, LA 70506

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Tricolored Bat Perimyotis subflavus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/10515	Proposed Endangered
West Indian Manatee Trichechus manatus Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/4469	Threatened Marine mammal

Birds

NAME	STATUS
Black-capped Petrel Pterodroma hasitata Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4748	Endangered

Eastern Black Rail Laterallus jamaicensis ssp. jamaicensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/10477	Threatened
Piping Plover Charadrius melodus There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/6039	Threatened
Rufa Red Knot Calidris canutus rufa Wherever found There is **proposed** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/1864	Threatened

Reptiles

NAME	STATUS
Alligator Snapping Turtle Macrochelys temminckii Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4658	Proposed Threatened
Gopher Tortoise Gopherus polyphemus No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6994	Threatened
Hawksbill Sea Turtle Eretmochelys imbricata Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3656	Endangered

Kemp's Ridley Sea Turtle Lepidochelys kempii | Endangered
Wherever found
There is **proposed** critical habitat for this species.
https://ecos.fws.gov/ecp/species/5523

Leatherback Sea Turtle Dermochelys coriacea | Endangered
Wherever found
There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/1493

Loggerhead Sea Turtle Caretta caretta | Threatened
There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/1110

Fishes

NAME	STATUS
Gulf Sturgeon Acipenser oxyrinchus (=oxyrhynchus) desotoi Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/651	Threatened
Pallid Sturgeon Scaphirhynchus albus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7162	Endangered

Insects

NAME	STATUS

Monarch Butterfly Danaus plexippus — Proposed Threatened
Wherever found
There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/9743

Ferns and Allies

NAME	STATUS
Louisiana Quillwort Isoetes louisianensis Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/7756	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Gulf Sturgeon Acipenser oxyrinchus (=oxyrhynchus) desotoi https://ecos.fws.gov/ecp/species/651#crithab	Final
Piping Plover Charadrius melodus https://ecos.fws.gov/ecp/species/6039#crithab	Final
Rufa Red Knot Calidris canutus rufa https://ecos.fws.gov/ecp/species/1864#crithab	Proposed

Bald & Golden Eagles

Bald and Golden Eagles are protected under the Bald and Golden Eagle Protection Act [2] and the Migratory Bird Treaty Act (MBTA) [1]. Any person or organization who plans or conducts activities that may result in impacts to Bald or Golden Eagles, or their habitats, should follow appropriate regulations and consider implementing appropriate avoidance and minimization measures, as described in the various links on this page.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

There are Bald Eagles and/or Golden Eagles in your project area.

Measures for Proactively Minimizing Eagle Impacts
For information on how to best avoid and minimize disturbance to nesting bald eagles, please review the National Bald Eagle Management Guidelines. You may employ the timing and activity-specific distance recommendations in this document when designing your project/activity to avoid and minimize eagle impacts. For bald eagle information specific to Alaska, please refer to Bald Eagle Nesting and Sensitivity to Human Activity.

The FWS does not currently have guidelines for avoiding and minimizing disturbance to nesting Golden Eagles. For site-specific recommendations regarding nesting Golden Eagles, please consult with the appropriate Regional Migratory Bird Office or Ecological Services Field Office.

If disturbance or take of eagles cannot be avoided, an incidental take permit may be available to authorize any take that results from, but is not the purpose of, an otherwise lawful activity. For assistance making this determination for Bald Eagles, visit the Do I Need A Permit Tool. For assistance making this determination for golden eagles, please consult with the appropriate Regional Migratory Bird Office or Ecological Services Field Office.

Ensure Your Eagle List is Accurate and Complete
If your project area is in a poorly surveyed area in IPaC, your list may not be complete and you may need to rely on other resources to determine what species may be present (e.g. your local FWS field office, state surveys, your own surveys). Please review the Supplemental Information on Migratory Birds and Eagles, to help you properly interpret the report for your specified location, including determining if there is sufficient data to ensure your list is accurate.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to bald or golden eagles on your list, see the "Probability of Presence Summary" below to see when these bald or golden eagles are most likely to be present and breeding in your project area.

Review the FAQs
The FAQs below provide important additional information and resources.

NAME	BREEDING SEASON
Bald Eagle Haliaeetus leucocephalus This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Sep 1 to Jul 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (■)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

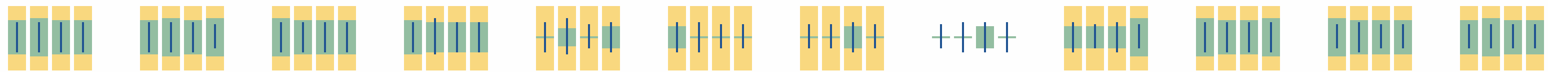
No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

■ probability of presence ■ breeding season | survey effort – no data

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

Bald Eagle
Non-BCC Vulnerable



Bald & Golden Eagles FAQs

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are an eagle (Bald and Golden Eagle Protection Act requirements may apply).

Proper interpretation and use of your eagle report

On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort line or no data line (red horizontal) means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide you in knowing when to implement avoidance and minimization measures to eliminate or reduce potential impacts from your project activities or get the appropriate permits should presence be confirmed.

How do I know if eagles are breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If an eagle on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:

The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Migratory birds

The Migratory Bird Treaty Act (MBTA) [1] prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service (Service). The incidental take of migratory birds is the injury or death of birds that results from, but is not the purpose, of an activity. The Service interprets the MBTA to prohibit incidental take.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Measures for Proactively Minimizing Migratory Bird Impacts

Your IPaC Migratory Bird list showcases birds of concern, including Birds of Conservation Concern (BCC), in your project location. This is not a comprehensive list of all birds found in your project area. However, you can help proactively minimize significant impacts to all birds at your project location by implementing the measures in the Nationwide avoidance and minimization measures for birds document, and any other project-specific avoidance and minimization measures suggested at the link Measures for avoiding and minimizing impacts to birds for the birds of concern on your list below.

Ensure Your Migratory Bird List is Accurate and Complete

If your project area is in a poorly surveyed area, your list may not be complete and you may need to rely on other resources to determine what species may be present (e.g. your local FWS field office, state surveys, your own surveys). Please review the Supplemental Information on Migratory Birds and Eagles document, to help you properly interpret the report for your specified location, including determining if there is sufficient data to ensure your list is accurate.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, see the "Probability of Presence Summary" below to see when these birds are most likely to be present and breeding in your project area.

Review the FAQs

The FAQs below provide important additional information and resources.

NAME	BREEDING SEASON
American Golden-plover *Pluvialis dominica* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds elsewhere

American Kestrel Falco sparverius paulus — Breeds Apr 1 to Aug 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/9587

American Oystercatcher Haematopus palliatus — Breeds Apr 15 to Aug 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8935

Bachman's Sparrow Peucaea aestivalis — Breeds May 1 to Sep 30

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/6177

Bald Eagle Haliaeetus leucocephalus — Breeds Sep 1 to Jul 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/1626

Black Scoter Melanitta nigra — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Black Skimmer Rynchops niger — Breeds May 20 to Sep 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/5234

Brown Pelican Pelecanus occidentalis | Breeds Jan 15 to Sep 30

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/6034

Brown-headed Nuthatch Sitta pusilla | Breeds Mar 1 to Jul 15

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Cerulean Warbler Setophaga cerulea | Breeds Apr 26 to Jul 20

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/2974

Chimney Swift Chaetura pelagica | Breeds Mar 15 to Aug 25

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Chuck-will's-widow Antrostomus carolinensis | Breeds May 10 to Jul 10

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Coastal (wayne s) Black-throated Green Warbler Setophaga virens waynei | Breeds May 1 to Aug 15

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Common Loon gavia immer | Breeds Apr 15 to Oct 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/4464

Dickcissel Spiza americana — Breeds May 5 to Aug 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Double-crested Cormorant phalacrocorax auritus — Breeds Apr 20 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/3478

Forster's Tern Sterna forsteri — Breeds Mar 1 to Aug 15

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Grasshopper Sparrow Ammodramus savannarum perpallidus — Breeds Jun 1 to Aug 20

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/8329

Great Shearwater Puffinus gravis — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Gull-billed Tern Gelochelidon nilotica — Breeds May 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9501

Kentucky Warbler Geothlypis formosa — Breeds Apr 20 to Aug 20

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

King Rail *Rallus elegans* — Breeds May 1 to Sep 5

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8936

Least Tern *Sternula antillarum antillarum* — Breeds Apr 25 to Sep 5

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Lesser Yellowlegs *Tringa flavipes* — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9679

Long-billed Curlew *Numenius americanus* — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/5511

Long-tailed Duck *Clangula hyemalis* — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
https://ecos.fws.gov/ecp/species/7238

Magnificent Frigatebird *Fregata magnificens* — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Marbled Godwit Limosa fedoa | Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9481

Painted Bunting Passerina ciris | Breeds Apr 25 to Aug 15

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Pectoral Sandpiper Calidris melanotos | Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Pomarine Jaeger Stercorarius pomarinus | Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Prairie Loggerhead Shrike Lanius ludovicianus excubitorides | Breeds Feb 1 to Jul 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA
https://ecos.fws.gov/ecp/species/8833

Prairie Warbler Setophaga discolor | Breeds May 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Prothonotary Warbler Protonotaria citrea | Breeds Apr 1 to Jul 31

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Red Knot Calidris canutus roselaari — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8880

Red-breasted Merganser Mergus serrator — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Red-headed Woodpecker Melanerpes erythrocephalus — Breeds May 10 to Sep 10

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Red-necked Phalarope Phalaropus lobatus — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Reddish Egret Egretta rufescens — Breeds Mar 1 to Sep 15

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/7617

Ring-billed Gull Larus delawarensis — Breeds elsewhere

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Royal Tern Thalasseus maximus — Breeds Apr 15 to Aug 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Ruddy Turnstone Arenaria interpres morinella — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Rusty Blackbird Euphagus carolinus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Sandwich Tern Thalasseus sandvicensis — Breeds Apr 25 to Aug 31

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Semipalmated Sandpiper Calidris pusilla — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Short-billed Dowitcher Limnodromus griseus — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9480

Sooty Tern Onychoprion fuscatus — Breeds Mar 10 to Jul 31

This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Surf Scoter Melanitta perspicillata — Breeds elsewhere
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Swallow-tailed Kite Elanoides forficatus — Breeds Mar 10 to Jun 30
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/8938

Whimbrel Numenius phaeopus hudsonicus — Breeds elsewhere
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

White-winged Scoter Melanitta fusca — Breeds elsewhere
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.

Willet Tringa semipalmata — Breeds Apr 20 to Aug 5
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Wilson's Plover Charadrius wilsonia — Breeds Apr 1 to Aug 20
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Wood Thrush Hylocichla mustelina — Breeds May 10 to Aug 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Yellow Rail Coturnicops noveboracensis — Breeds elsewhere

This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
https://ecos.fws.gov/ecp/species/9476

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read "Supplemental Information on Migratory Birds and Eagles", specifically the FAQ section titled "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

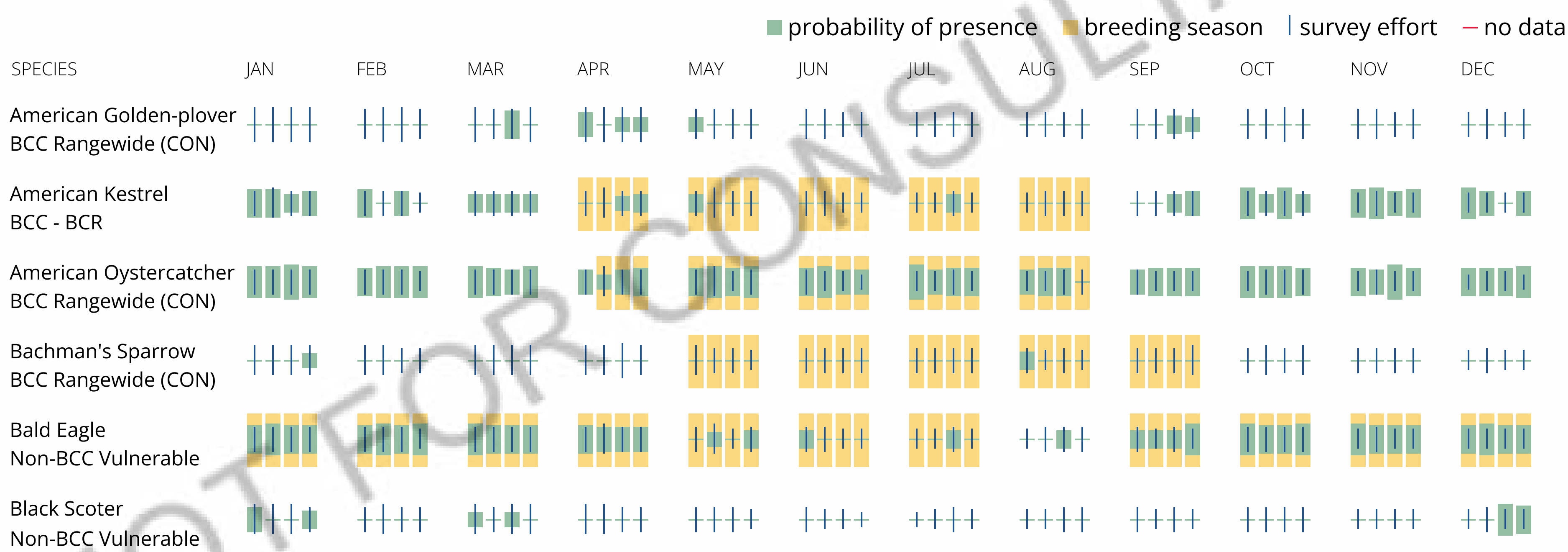
Breeding Season ( )
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Black Skimmer
BCC Rangewide (CON)

Brown Pelican
Non-BCC Vulnerable

Brown-headed Nuthatch
BCC - BCR

Cerulean Warbler
BCC Rangewide (CON)

Chimney Swift
BCC Rangewide (CON)

Chuck-will's-widow
BCC - BCR

SPECIES

Coastal (wayne s) Black-throated Green Warbler
BCC - BCR

Common Loon
Non-BCC Vulnerable

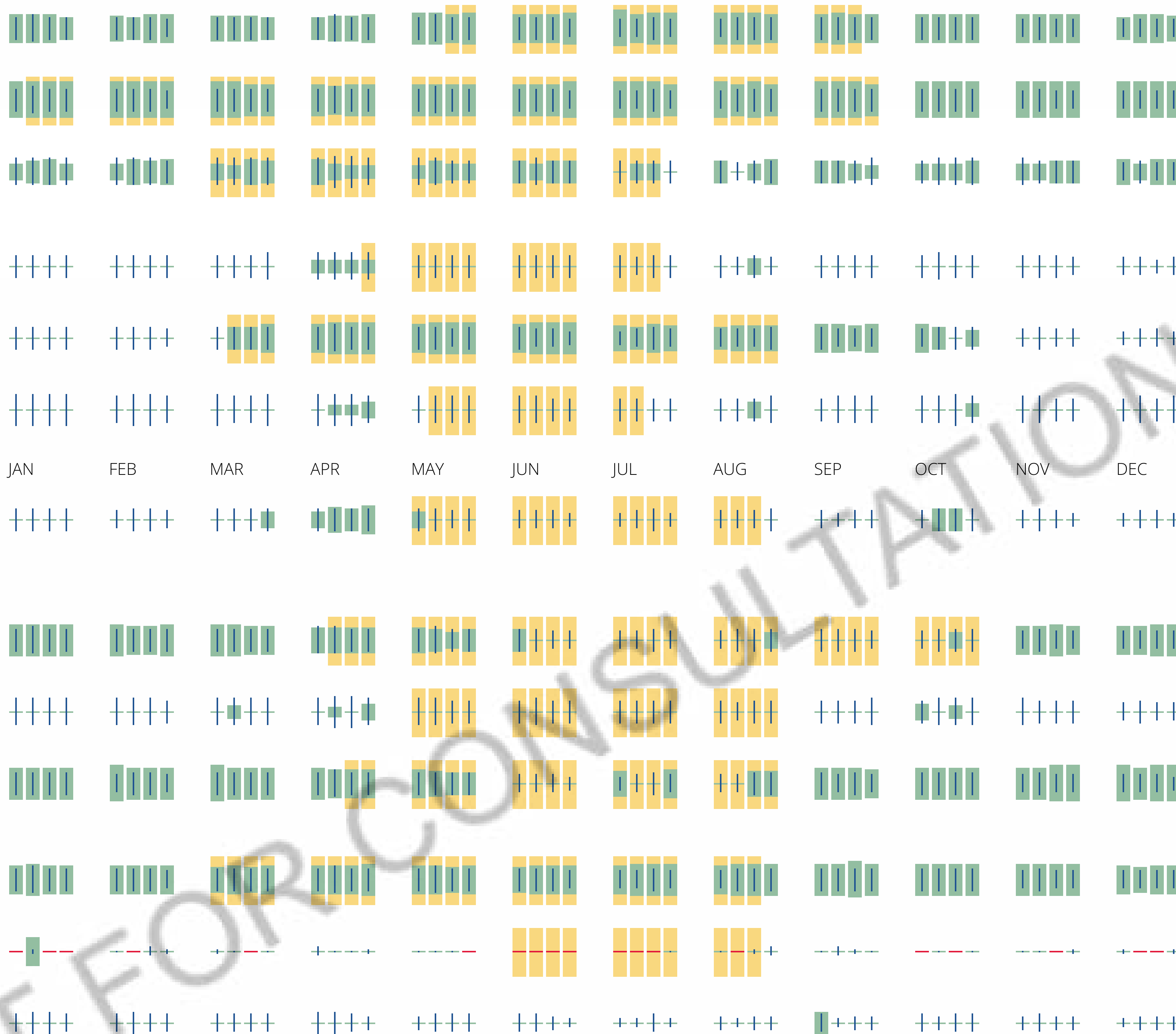
Dickcissel
BCC - BCR

Double-crested Cormorant
Non-BCC Vulnerable

Forster's Tern
BCC - BCR

Grasshopper Sparrow
BCC - BCR

Great Shearwater
Non-BCC Vulnerable



Gull-billed Tern
BCC Rangewide (CON)

Kentucky Warbler
BCC Rangewide (CON)

King Rail
BCC Rangewide (CON)

Least Tern
BCC Rangewide (CON)

Lesser Yellowlegs
BCC Rangewide (CON)

SPECIES

Long-billed Curlew
BCC - BCR

Long-tailed Duck
Non-BCC Vulnerable

Magnificent Frigatebird
BCC - BCR

Marbled Godwit
BCC Rangewide (CON)

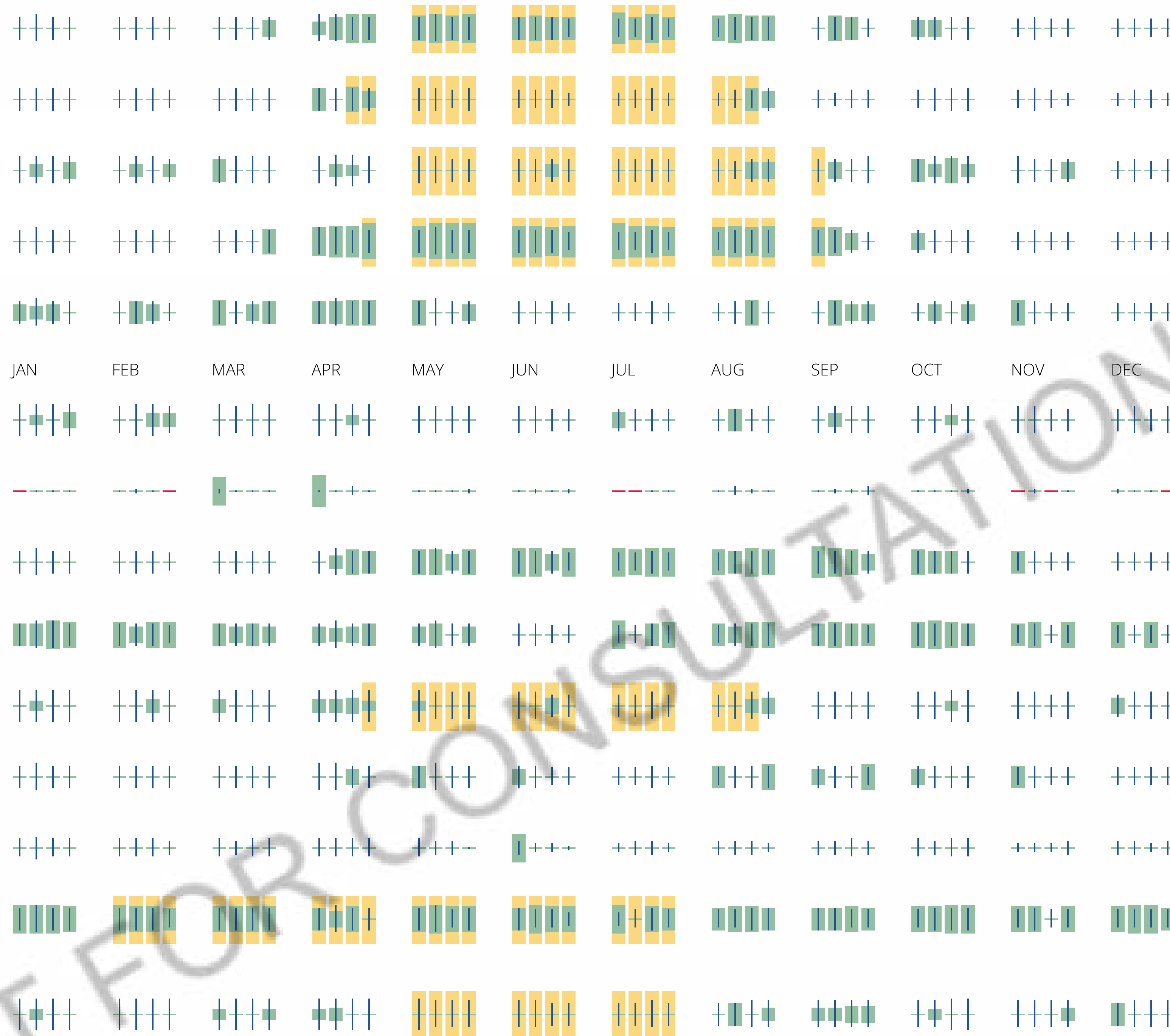
Painted Bunting
BCC - BCR

Pectoral Sandpiper
BCC Rangewide (CON)

Pomarine Jaeger
Non-BCC Vulnerable

Prairie Loggerhead Shrike
BCC - BCR

Prairie Warbler
BCC Rangewide (CON)



Prothonotary Warbler
BCC Rangewide (CON)

Red Knot
BCC Rangewide (CON)

Red-breasted Merganser
Non-BCC Vulnerable

SPECIES

Red-headed Woodpecker
BCC Rangewide (CON)

Red-necked Phalarope
Non-BCC Vulnerable

Reddish Egret
BCC Rangewide (CON)

Ring-billed Gull
Non-BCC Vulnerable

Royal Tern
Non-BCC Vulnerable

Ruddy Turnstone
BCC - BCR

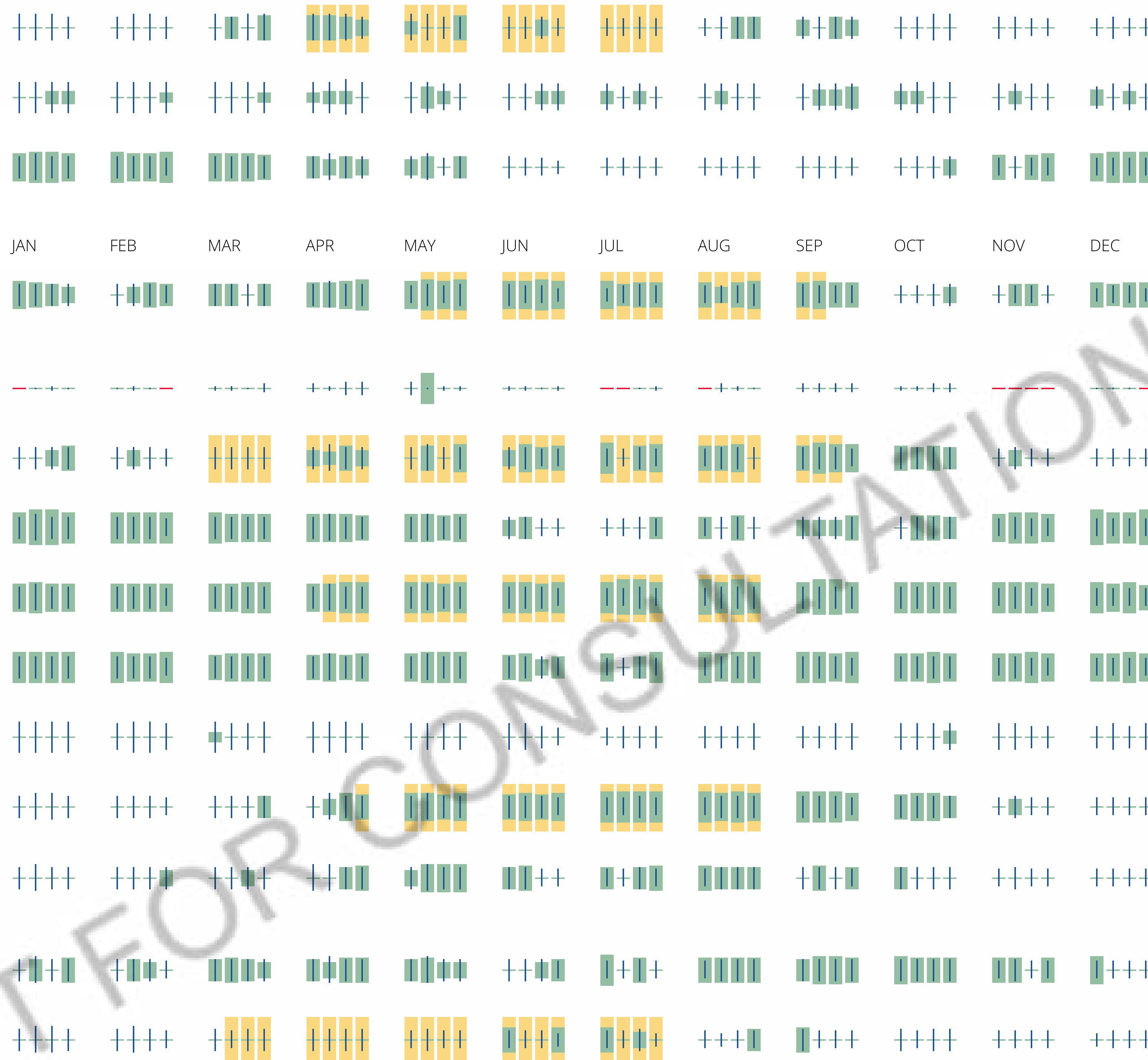
Rusty Blackbird
BCC - BCR

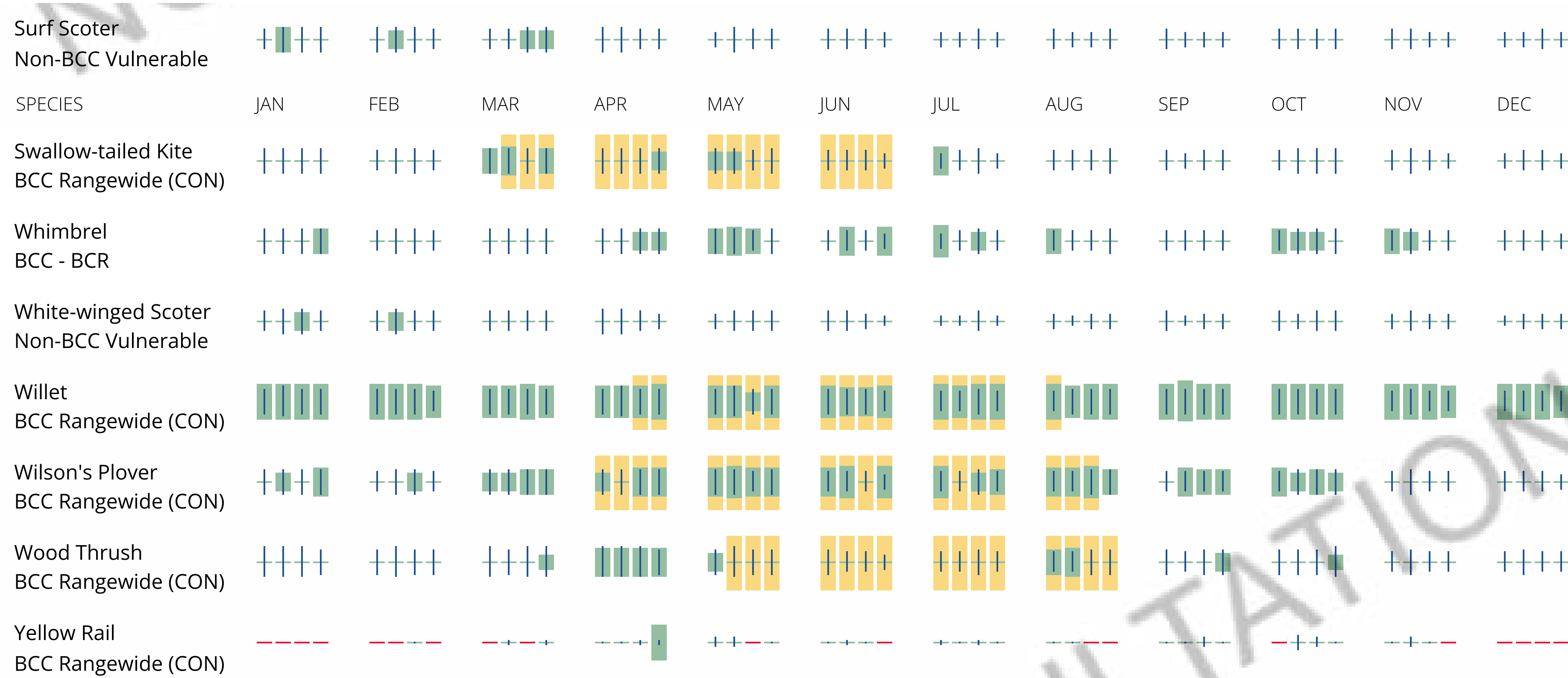
Sandwich Tern
BCC - BCR

Semipalmated Sandpiper
BCC - BCR

Short-billed Dowitcher
BCC Rangewide (CON)

Sooty Tern
Non-BCC Vulnerable





Migratory Bird FAQs

Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Avoidance & Minimization Measures for Birds describes measures that can help avoid and minimize impacts to all birds at any location year-round. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is one of the most effective ways to minimize impacts. To see when birds are most likely to occur and breed in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location, such as those listed under the Endangered Species Act or the Bald and Golden Eagle Protection Act and those species marked as "Vulnerable". See the FAQ "What are the levels of concern for migratory birds?" for more information on the levels of concern covered in the IPaC migratory bird species list.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) with which your project intersects. These species have been identified as warranting special attention because they are BCC species in that area, an eagle (Bald and Golden Eagle Protection Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, and to verify survey effort when no results present, please visit the Rapid Avian Information Locator (RAIL) Tool.

Why are subspecies showing up on my list?

Subspecies profiles are included on the list of species present in your project area because observations in the AKN for **the species** are being detected. If the species are present, that means that the subspecies may also be present. If a subspecies shows up on your list, you may need to rely on other resources to determine if that subspecies may be present (e.g. your local FWS field office, state surveys, your own surveys).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your “IPaC PROBABILITY OF PRESENCE SUMMARY” at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);

2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Bald and Golden Eagle Protection Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially BCC species. For more information on avoidance and minimization measures you can implement to help avoid and minimize migratory bird impacts, please see the FAQ "Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Proper interpretation and use of your migratory bird report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list does not represent all birds present in your project area. It is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide implementation of avoidance and minimization measures to eliminate or reduce potential impacts from your project activities, should presence be confirmed. To learn more about avoidance and minimization measures, visit the FAQ "Tell me about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:

The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()

A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Marine mammals

Marine mammals are protected under the Marine Mammal Protection Act. Some are also protected under the Endangered Species Act[1] and the Convention on International Trade in Endangered Species of Wild Fauna and Flora[2].

The responsibilities for the protection, conservation, and management of marine mammals are shared by the U.S. Fish and Wildlife Service [responsible for otters, walruses, polar bears, manatees, and dugongs] and NOAA Fisheries[3] [responsible for seals, sea lions, whales, dolphins, and porpoises]. Marine mammals under the responsibility of NOAA Fisheries are **not** shown on this list; for additional information on those species please visit the Marine Mammals page of the NOAA Fisheries website.

The Marine Mammal Protection Act prohibits the take of marine mammals and further coordination may be necessary for project evaluation. Please contact the U.S. Fish and Wildlife Service Field Office shown.

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1. The Endangered Species Act (ESA) of 1973.
2. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is a treaty to ensure that international trade in plants and animals does not threaten their survival in the wild.
3. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following marine mammals under the responsibility of the U.S. Fish and Wildlife Service are potentially affected by activities in this location:

NAME

West Indian Manatee Trichechus manatus
https://ecos.fws.gov/ecp/species/4469

Coastal Barrier Resources System

Projects within the John H. Chafee Coastal Barrier Resources System (CBRS) may be subject to the restrictions on Federal expenditures and financial assistance and the consultation requirements of the Coastal Barrier Resources Act (CBRA) (16 U.S.C. 3501 et seq.). For more information, please contact the local Ecological Services Field Office or visit the CBRA Consultations website. The CBRA website provides tools such as a flow chart to help determine whether consultation is required and a template to facilitate the consultation process.

This location overlaps the following CBRS unit(s):

System Unit (SU)

Most new Federal expenditures and financial assistance, including Federal flood insurance, are prohibited within System Units. ***Federally-funded projects within System Units require consultation with the Service.*** *Consultation is not required for projects using private, state, or local funds.*

MS-02 - SU 11/16/1990 - FI 11/16/1990
R02 - SU 10/18/1982 - FI 10/1/1983

Otherwise Protected Area (OPA)

OPAs are denoted with a "P" at the end of the unit number. The only prohibition within OPAs is on Federal flood insurance. ***CBRA consultation is not required for projects within OPAs.*** *However, agencies providing disaster assistance that is contingent upon a requirement to purchase flood insurance after the fact are advised to disclose the OPA designation and information on the restrictions on Federal flood insurance to the recipient prior to the commitments of funds.*

LA-03P - FI 11/16/1991
MS-01P - FI 11/16/1991

Data limitations

The CBRS boundaries used in IPaC are representations of the controlling boundaries, which are depicted on the official CBRS maps. The boundaries depicted in this layer are not to be considered authoritative for in/out determinations close to a CBRS boundary (i.e., within the "CBRS Buffer Zone" that appears as a hatched area on either side of the boundary). For projects that are very close to a CBRS boundary but do not clearly intersect a unit, you may contact the Service for an official determination by following the instructions here: https://www.fws.gov/service/coastal-barrier-resources-system-property-documentation

Data exclusions

CBRS units extend seaward out to either the 20- or 30-foot bathymetric contour (depending on the location of the unit). The true seaward extent of the units is not shown in the CBRS data, therefore projects in the offshore areas of units (e.g., dredging, breakwaters, offshore wind energy or oil and gas projects) may be subject to CBRA even if they do not intersect the CBRS data. For additional information, please contact CBRA@fws.gov.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

This location overlaps the following National Wildlife Refuge lands:

LAND	ACRES
BRETON NATIONAL WILDLIFE REFUGE	12,092.76 acres
DELTA NATIONAL WILDLIFE REFUGE	50,260.27 acres

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Wetland information is not available at this time

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Attachment D

Chandeleur Island Seagrass Survey Report

COASTAL PROTECTION AND RESTORATION AUTHORITY

CHANDELEUR ISLAND RESTORATION (PO-0199)

PHASE 2 - SEAGRASS SURVEY REPORT

PREPARED FOR
Coastal Engineering Consultants, Inc.

December 2023

PREPARED BY
SWCA Environmental Consultants

DRAFT COASTAL PROTECTION AND RESTORATION AUTHORITY CHANDELEUR ISLAND RESTORATION PROJECT (PO-0199) – SEAGRASS SURVEY REPORT

Prepared for

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SWCA Project No. 00081792-001

December 2023

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CONTENTS

Appendices

Figures

Tables

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1 INTRODUCTION

1.1 Project Overview

The Chandeleur Island Restoration (PO-0199) Project (Project) is located on the Chandeleur Islands in St. Bernard Parish, Louisiana (Figure 1). The Chandeleur Island system includes those lands between Chandeleur Sound and the Gulf of Mexico, consisting of Chandeleur Island, Gosier Islands, Grand Gosier Islands, Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands forming the Breton National Wildlife Refuge (Figure 2). This report’s Study Area includes Chandeleur and New Harbor Islands and the seagrass beds and water bottoms surrounding them (Figure 3).

The purpose of the Project is to engineer and design a restoration project benefitting the Chandeleur Islands and the many species that use them as defined in the Restoration Plan and Environmental Assessment Plan #1 of the Region-wide Trustee Implementation Group (2021). Phase 1 of the Project focuses on plan formulation for restoration of the main Chandeleur Island and New Harbor Island. The Coastal Protection and Restoration Authority (CPRA) serves as the designated State agency for the Project.

The purpose of this report is to provide methodology used to identify the seagrass community composition and map the extent of the seagrass beds at the main Chandeleur Island and New Harbor Island during late summer/early fall 2022 and present the results of the survey. The approach and methods are described in the SWCA 2022 Chandeleur Island Restoration Project (PO-0199) Seagrass Survey Plan (Appendix A).

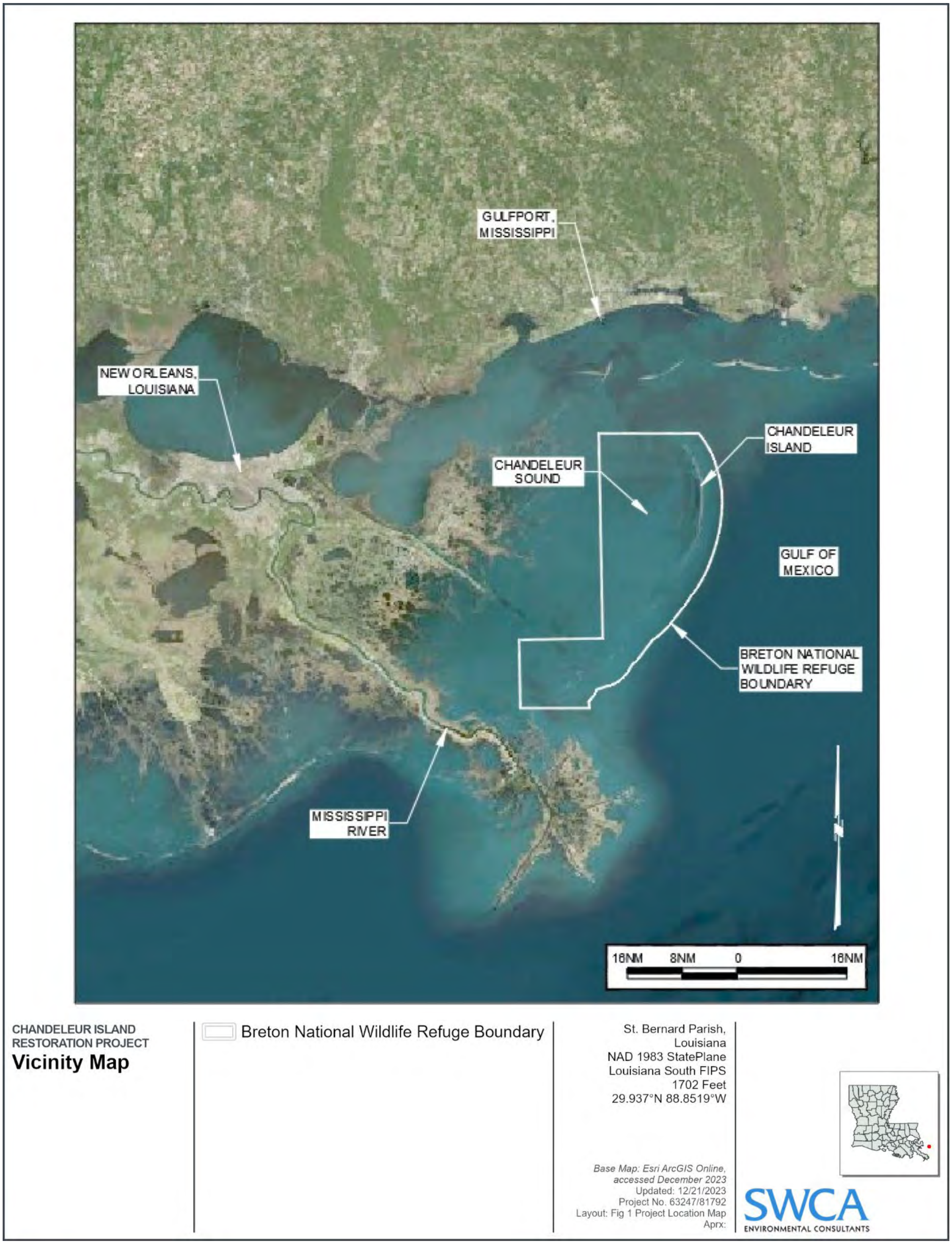


Figure 1. Project vicinity map.

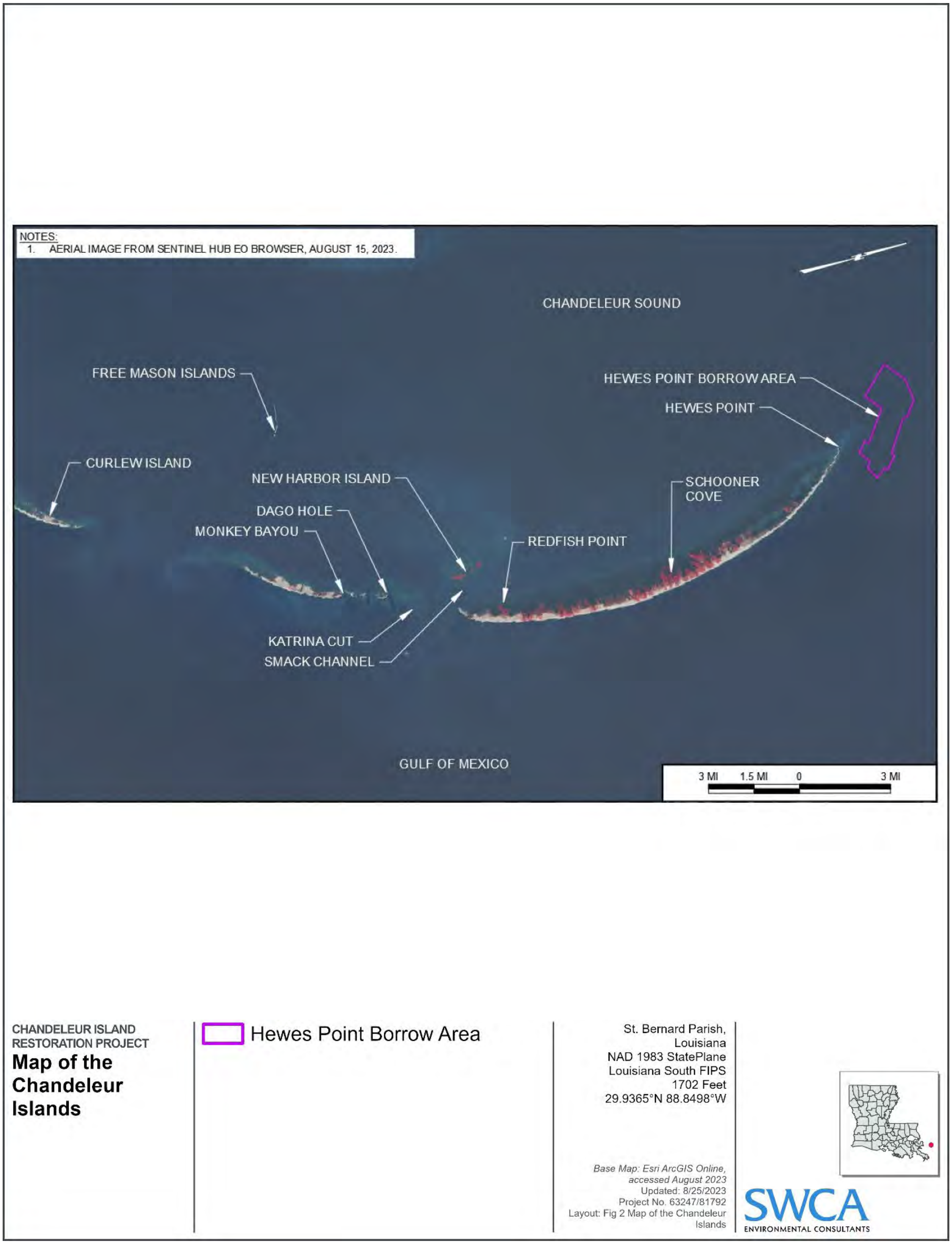
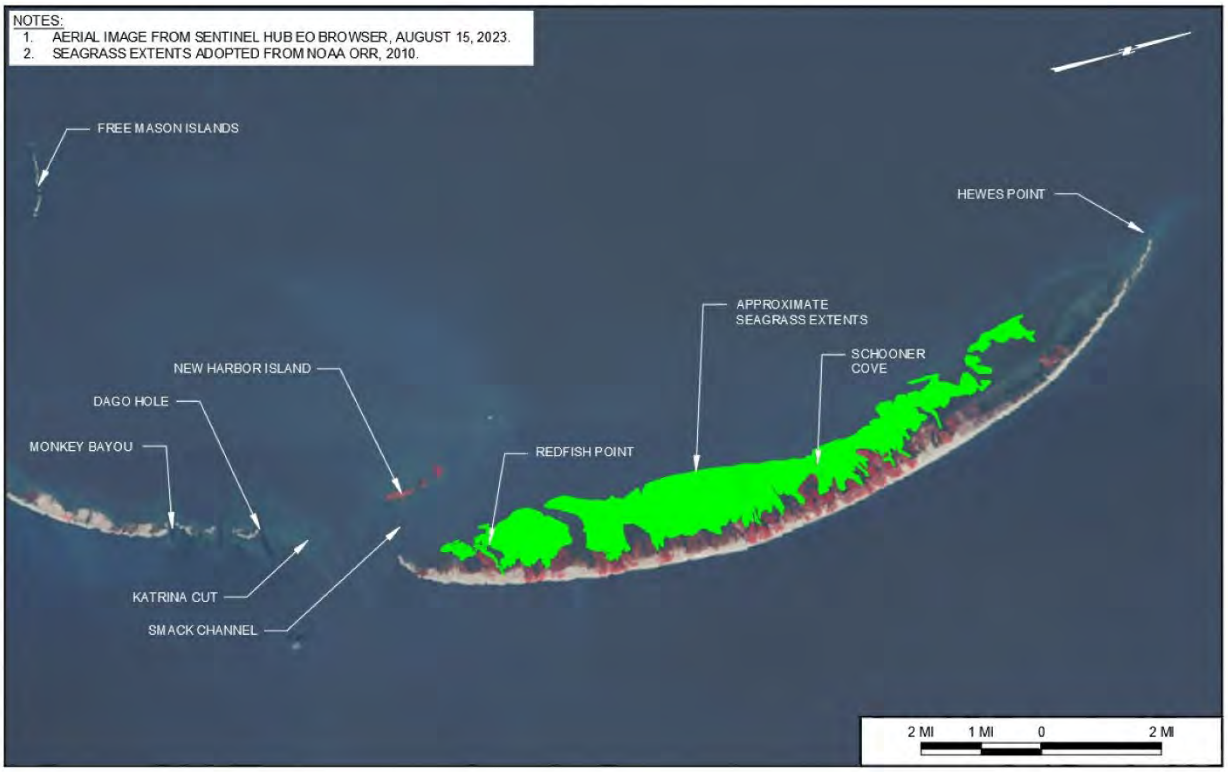


Figure 2. Map of the Chandeleur Islands and potential borrow area location.



CHANDELEUR ISLAND RESTORATION PROJECT

2010-2011 Seagrass Bed Mapping by NOAA (NOAA 2015)

2010-2011 Mapped Seagrass Extent

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana South FIPS 1702 Feet
29.9365°N 88.8498°W

Base Map: Esri ArcGIS Online, accessed August 2023
Updated: 8/25/2023
Project No. 63247/81792
Layout: Fig 3 2011 Seagrass bed mapping

SWCA ENVIRONMENTAL CONSULTANTS

Figure 3. 2010-2011 Seagrass bed extent mapped by NOAA (NOAA 2015)

1.2 Project Area Description

The Chandeleur Islands can be subdivided into two subsets, which are affected by different hydrologic inputs, energy regimes, barrier island dynamics, and environmental stressors. The northern islands include the main Chandeleur Island, New Harbor Island, and Freemason Island. The southern islands include Curlew Island, Grand Gosier Islands and Breton Island. The primary ecological drivers in the Chandeleur Islands system are attributed to natural coastal processes such as barrier island dynamics, disintegration of abandoned river deltas, and impacts from tropical storms and hurricanes. The southern islands are proximal to major outlets of the Mississippi River where they receive significant seasonal freshwater inputs and attendant high nutrient and turbidity levels. The northern islands experience only limited influence from riverine inputs as they are located farther from freshwater sources such as coastal Mississippi waters and inputs from the Pearl River and passes of Lake Pontchartrain. Importantly, the northern islands are far more stable due to higher sand content and robust backbarrier marshes compared to the southern islands that are sand-starved and lack significant backbarrier marshes. As a result, the northern islands respond differently to storm impacts than southern parts of the chain. Storm response in the north is characterized by barrier breaching and overwash processes that transfer the beach and dune system landward with backbarrier marshes providing a platform for sand deposition, maintaining subaerial exposure and healing of breaches during post storm recovery. In the south, major storms can result in complete island submergence with recovery and emergence significantly delayed and only after extended periods (years to decades) of minimal storm impacts. These contrasting barrier island storm responses are important to consider with respect to stability of seagrasses because of the protection afforded to the backbarrier seagrass communities by the more robust northern islands both during storms and the recovery period as breaches heal. The ephemeral island/shoal behavior that characterizes the southern islands does not provide for long term protection to the backbarrier from open Gulf conditions. As a result, seagrass meadows have persisted in the shelter of the northern islands at least for the historical record. However, as the northern island chain has undergone rapid land loss by thinning and shortening over the past three decades, the backbarrier area with sufficient protection to host resilient seagrass communities has also decreased (Miner et al. 2021). Along with protection from high-energy conditions, seagrass growth and persistence requires good overall water quality and clarity, habitats along the southern islands are not conducive to seagrass growth, whereas seagrass has developed and thrived in environment of the northern islands (Handley et al. 2007).

Studies throughout the past five decades have reported varying coverage of seagrasses along the Chandeleur Islands, however, as summarized in Poirrier and Handley (2007), and identified during species composition investigations after the Deepwater Horizon oil spill (Kenworth et al. 2017) the species composition has remained fairly consistent and includes turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*). Frequent damage due to passing hurricanes influences the species composition and abundance in certain areas. Areas that experience higher levels of damaging forces, such as locations where the protecting barrier island was breached during a storm and sediment overwash features with significant sediment deposition, and exposure to higher wave action, were found to have some turtle grass, but also manatee grass and shoal grass. Those areas that are sheltered from storm damage are dominated by dense turtle grass meadows (Franze 2002; Poirrier and Handley 2007). Star grass was found to be present in these disturbed areas but was quite rare (Handley et al. 2007). In a 20-year study of the region, using information on leaf tissue nutrient levels, specifically in *T. testudinum*, Darnell et al. (2017) concluded that high nutrient levels and eutrification, noted as the primary driver in seagrass loss along more coastal environments, there does not appear to be strong evidence that this is the case at the Chandeleurs. Furthermore, the 2014 study by Pham et al. provided a comparison of aerial mapping efforts at the Chandeleurs from 1992 to 2005, documenting an evolution of the Chandeleur Islands, documenting rapid rates of land loss and declining seagrass coverage, therefore supporting the causation between land loss and declining seagrass coverage.

The last comprehensive investigation for seagrass bed extent, viability, and species composition within the Chandeleur Islands was conducted by the NOAA and the United States Geological Survey (USGS) in 2010 and 2011. The investigation was conducted as part of the post-incident exposure of the Deepwater Horizon Oil Spill on seagrass vegetation throughout the northern Gulf of Mexico (NOAA 2015). The 2010 and 2011 seagrass coverage totaled approximately 2,385 acres, and 2,614 acres, respectively (NOAA 2015). The National Aeronautics and Space Administration (NASA) Tool CREOL (NASA 2021) also provided supporting aerial imagery of the Project Area to illustrate changes in seagrass extent. In addition to the summary of studies provided above, investigations are ongoing through the University of Mississippi.

2 METHODOLOGY

2.1 Defining the Survey Area

The limits of the 2010 and 2011 NOAA and USGS aerial data, as well as project-specific high resolution aerial photography collected in May 2022 were georeferenced to establish the preliminary Survey Area and allow for reproducibility in the 2022 survey efforts in order to: 1) verify the identification of the entire seagrass habitat or potential habitat, and 2) enable comparisons of species, community compositions, and densities over time.

To define the Survey Area (Figure 4), a single polygon was created, identifying the maximum bounds of the 2010/2011 seagrass extent (NOAA 2015) and the results of the photogrammetric interpretation of the aerial imagery acquired in May 2022. As the aerial photographs collected in May 2022 occurred prior to the start of the peak growing season in the Chandeleurs (mid-September to early October) (*pers. comm.* Darnell 2022)), additional satellite data was collected in September 2022 to confirm the current extent at the time of the seagrass field survey. The 50-cm resolution satellite data was obtained from Planet Labs SkySat for an approximately 105-sq km area encapsulating the known 2010 and 2011 seagrass and Survey Area extent. Considering the size of Survey Area, the use of aerial imagery is a cost-effective and more precise method for delineating seagrass fringe habitat than diver delineated methods. Obtaining the aerial imagery prior to field survey allowed for spot checking in the field rather than swimming the full edge of the Survey Area. Additional data to be collected under separate tasks, including the collection of topographic and bathymetric data during the Summer of 2023, and identification or collection of new aerial imagery, will provide further insights to characterize the area and refine the initial seagrass community discussion.

2.2 Fixed Station Location

The field survey plan utilized the methods outlined in Dunton et al. (2010) which allows for robust data collection and reproducibility over a large Survey Area. The recommended practice utilizes a grid of tessellated hexagons (500 meters per side) to identify sampling locations for all levels of seagrass monitoring. This hexagonal grid was overlaid onto the Survey Area to establish the sampling locations (Figure 4). One fixed sample location was randomly selected within each hexagon, for a total of 143 sample locations. The USM, by Principal Investigator, Kelly Darnell (*personal communication*, August 2022), is conducting ongoing research at the Chandeleur Islands. In order to contribute spatially consistent data, SWCA compared hexagonal grids and fixed locations, and in instances where a USM location was in an SWCA hexagon, the USM location was used and SWCA adopted the nomenclature. Locations belonging to USM are identified by C-###, whereas the SWCA location are identified by S-###.

For survey planning purposes beginning in March 2022, the hexagonal grid was overlaid on the most current publicly available, high resolution aerial data (Google Earth 2019). Due to the dynamic nature of the barrier islands and presumed migration of the island from the last large scale seagrass mapping effort (2011) to its current position, some survey grid locations containing historical seagrass data extensively overlap with the island and extend into the Gulf. Figure 4 illustrates how some survey hexagons were truncated to account for island overlap.

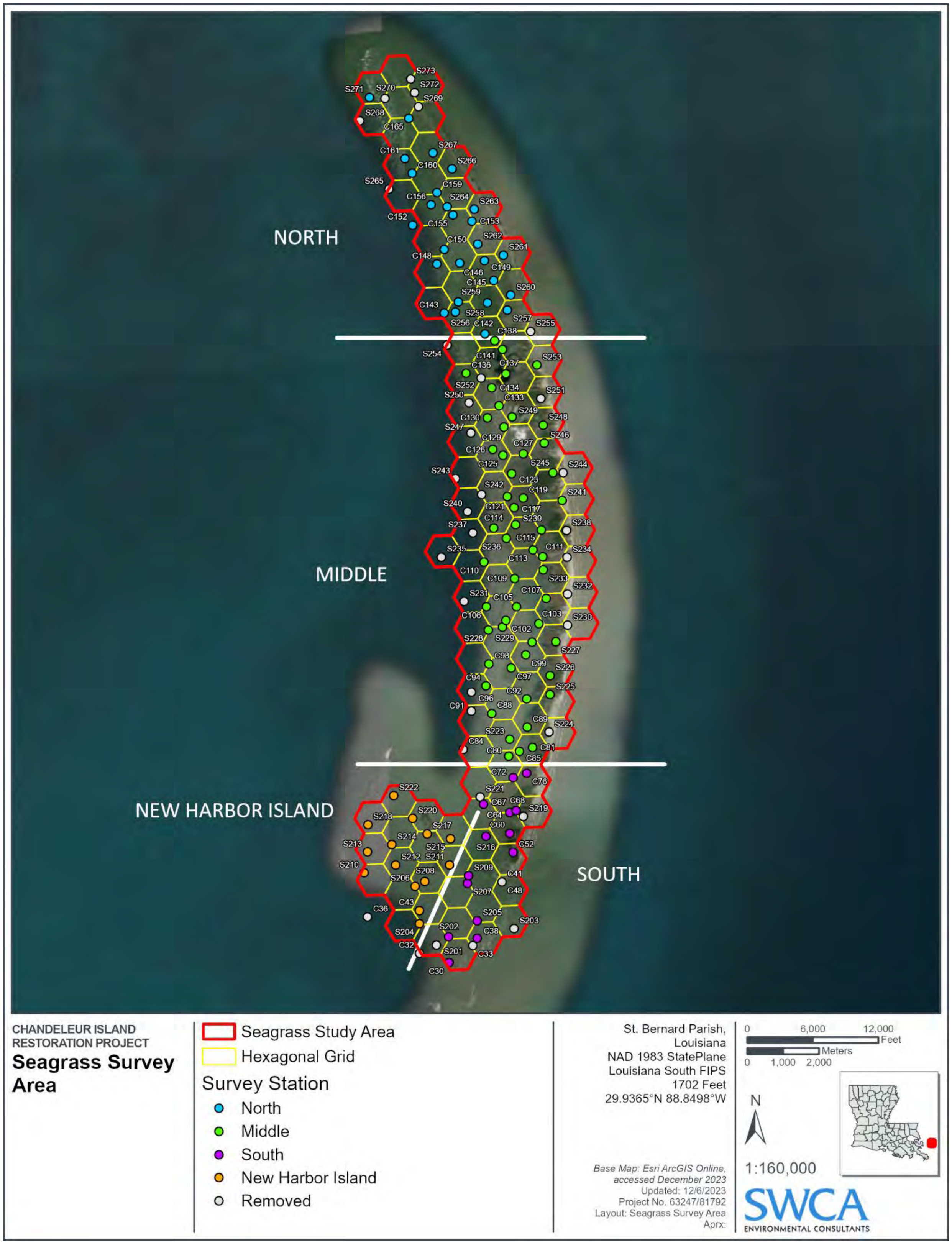


Figure 4. Seagrass Study area.

2.3 Field Data Collection

The field study was conducted from September 15 through September 25, 2022, known to be within the peak seagrass growing season at the Chandeleur Islands. While Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Environmental Quality do not stipulate a seagrass growing season, especially as it pertains to environmental surveys, initial guidance on timing for surveys utilized the Florida Department of Environmental Protection (FDEP 2020) regulatory season as June 1 and Sept. 30 for the Florida and the northern Gulf of Mexico coastal regions. However, personal communication with Kelly Darnell (USM) provided further detail that that the peak growing season at the Chandeleurs occurs from early to mid-September and can extend as late as early October.

The primary objective of the survey was to collect data metrics that would characterize the seagrass community, including species composition, percent cover, seagrass bed configuration (patchiness), and preliminary water quality information to establish a baseline condition at the peak of the 2022 growing season. The fixed location is to be navigated to with GPS accuracy of 4 meters or better. All location information was documented in ArcGIS Field Maps, and all water quality and seagrass metrics were recorded on hard copy datasheets for transcription into a database. The location was identified as having a 10-meter radius, and the four stations were sampled within this circle. In situ water quality parameters, water transparency, and photosynthetically active radiation (PAR) were collected prior to deployment of any benthic sampling equipment to minimize disturbance to the water column or sediment.

Species community composition and areal coverage were documented at each randomly selected, fixed location. Four replicate stations were sampled in set directions oriented around each location: forward starboard, aft starboard, aft port, forward port, (Figure 5). Direct observations were evaluated in the field within a 0.25 m^2 PVC quadrat frame with 100 subdivided cells. An underwater camera was used to document each quadrat. A summary of primary data metrics collected is described in Table 1.

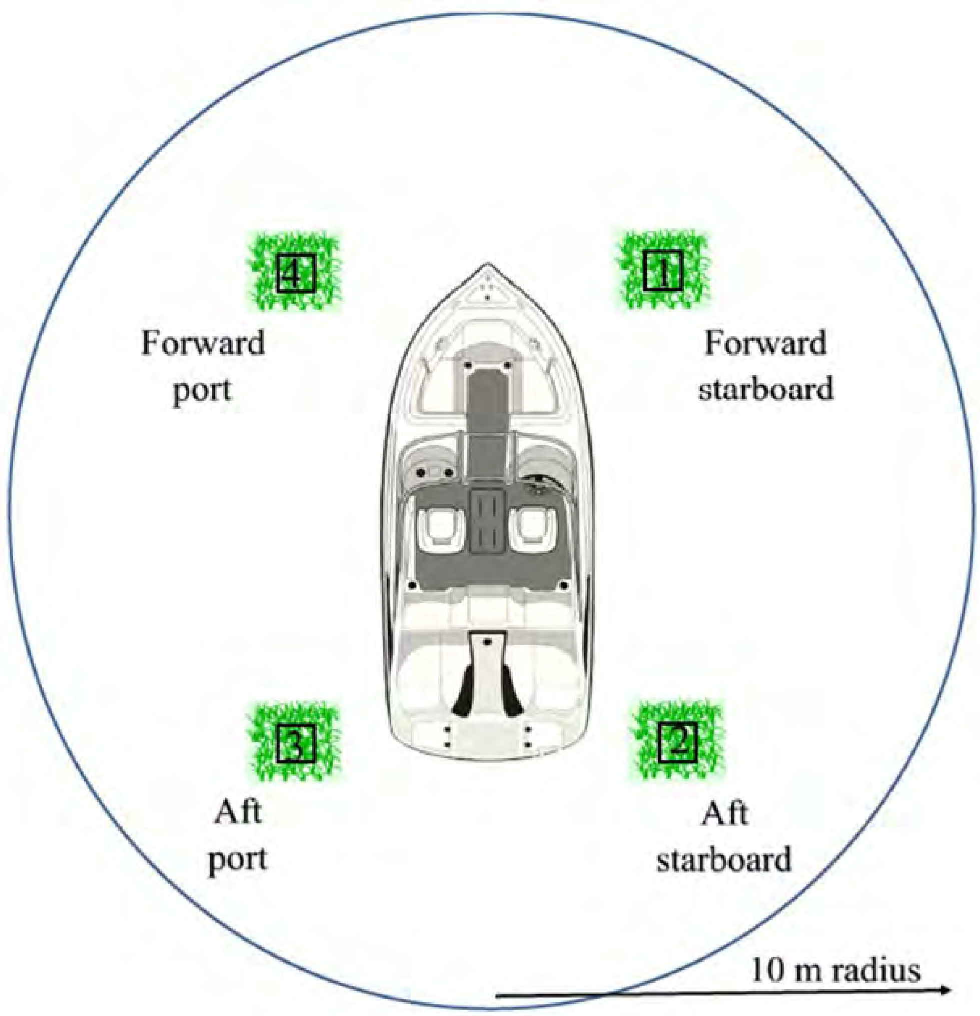


Figure 5. Sampling stations oriented around each randomly selected fixed location.

Table 1. Survey metrics for locations and stations.

Data Collection Location	Metrics	Equipment
	Date/Time	
	GPS location	GPS unit (submeter accuracy)
	Relative Water depth	Sounding rod
Vessel Location	Water temperature, salinity, conductivity, pH, dissolved oxygen	YSI Pro Series, multi-probe sonde
	Light attenuation	LI-COR (Li-192) Underwater PAR sensor
	Transparency	Secchi disk
	Sediment type	
	Species composition	Direct Observation using .25 m^2 PVC quadrat. (with underwater camera)
Stations	Total percent cover	
	Percent cover by species	
	Representative canopy height	Ruler

2.4 Data Validation

2.4.1 Water Quality

The United States Environmental Protection Agency (USEPA) in its *National Coastal Condition Assessment (NCCA) 2020 Quality Assurance Project Plan (QAPP)* (USEPA 2020) provides appropriate data reporting unit criteria for in situ measurements:

Table 2. Data report unit criteria for in situ measurements (USEPA 2020).

Measurement	Units	No. Significant Figures	Maximum No. Decimal Places
Temperature	ºC	2	1
Salinity	ppt	2	1
Conductivity	µS/cm at 25ºC	3	1
Dissolved Oxygen	mg/L	2	1
pH	pH units	3	Not reported
PAR	µE/m^2/s	2	1
Secchi Depth	Meters	3	1
Depth	Meters	3	1

As the Chandeleur Islands are a fairly unique environment removed from typical anthropogenic influence in Louisiana's coastal waters, and not considered an open ocean environment, SWCA used the range of values for the above water quality parameters as guidance for site specific values based previous research at the Chandeleur Islands. Table 3 presents the reported water quality values from previous studies conducted at the Chandeleur Islands.

Table 3. Summary of in situ water quality measurements from past research at the Chandeleur Islands.

Source	Sampling Timeframe	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	PAR (µE/m^2/s)	Secchi (m)
Darnell, *per. comm*. 2022 (range of values)	September and October 2018	25.2 to 35.4	21.8 to 30.1	4.8 to 13.8	53 to 1603	0 to Depth
Darnell et al. 2017 (average values)	October 2014, and April 2015	27.3 +/- 0.9	30.7 +/- 0.3	6.8 +/- 0.5	Not reported	Not reported
Robertson and Baltzer 2017 (range of values)	September and July of 2015 and 2016	23.8 to 31.1	23.0 to 30.8	2.6 to 10.5	Not reported	Not reported

2.4.2 Species Descriptions

The following species are known to occur within the northern Gulf of Mexico and documented during this survey at the Chandeleur Islands.

2.4.2.1 *HALODULE WRIGHTII* (SHOAL GRASS)

Halodule wrightii (shoal grass), a fairly ubiquitous species, plentiful along the Atlantic Coast from North Carolina, and into the Caribbean, is tolerant of low light, can tolerate a range of temperatures and salinities, and can survive in high wave energy and turbid environments (Gutierrez et al., 2010, Ray et al. 2014, and Florida Museum of Natural History 2018). *H. wrightii* is easily distinguished by its flat narrow blades that grow to a length of 10-15 cm and a width of 2-3 mm. These blades grow from a single node and are notched at the tip (Florida Museum of Natural History 2018). Reference photographs and illustrations are presented in Figure 7 (Meiman 2019).

Figure 6. Reference photographs and illustrations of *H. wrightii*.

2.4.2.2 *THALASSIA TESTUDINUM* (TURTLE GRASS)

Thalassia testudinum (turtle grass) is a subtropical and tropical marine seagrass, common in the Gulf of Mexico and Caribbean, typically found in waters with salinity between 24 and 35 parts per thousand (ppt), and temperatures ranging between 27 and 30ºC. The species occurs in narrow depth ranges, typically between 0.5 and 2 m, and within areas that are protected from wave energy and other factors causing high turbidity and poor water quality (TPWD 2012, McDonald et al. 2016, LDWF 2023). *T testudinum* is identified by flat, ribbon-like blades, with rounded tips, growing in small clusters up to 35 cm long or longer. During the flowering season, pale green to pink, fruit-producing flowers can be observed (LDWF 2023). Reference photographs and illustrations are presented in Figure 7 (Meiman 2019).

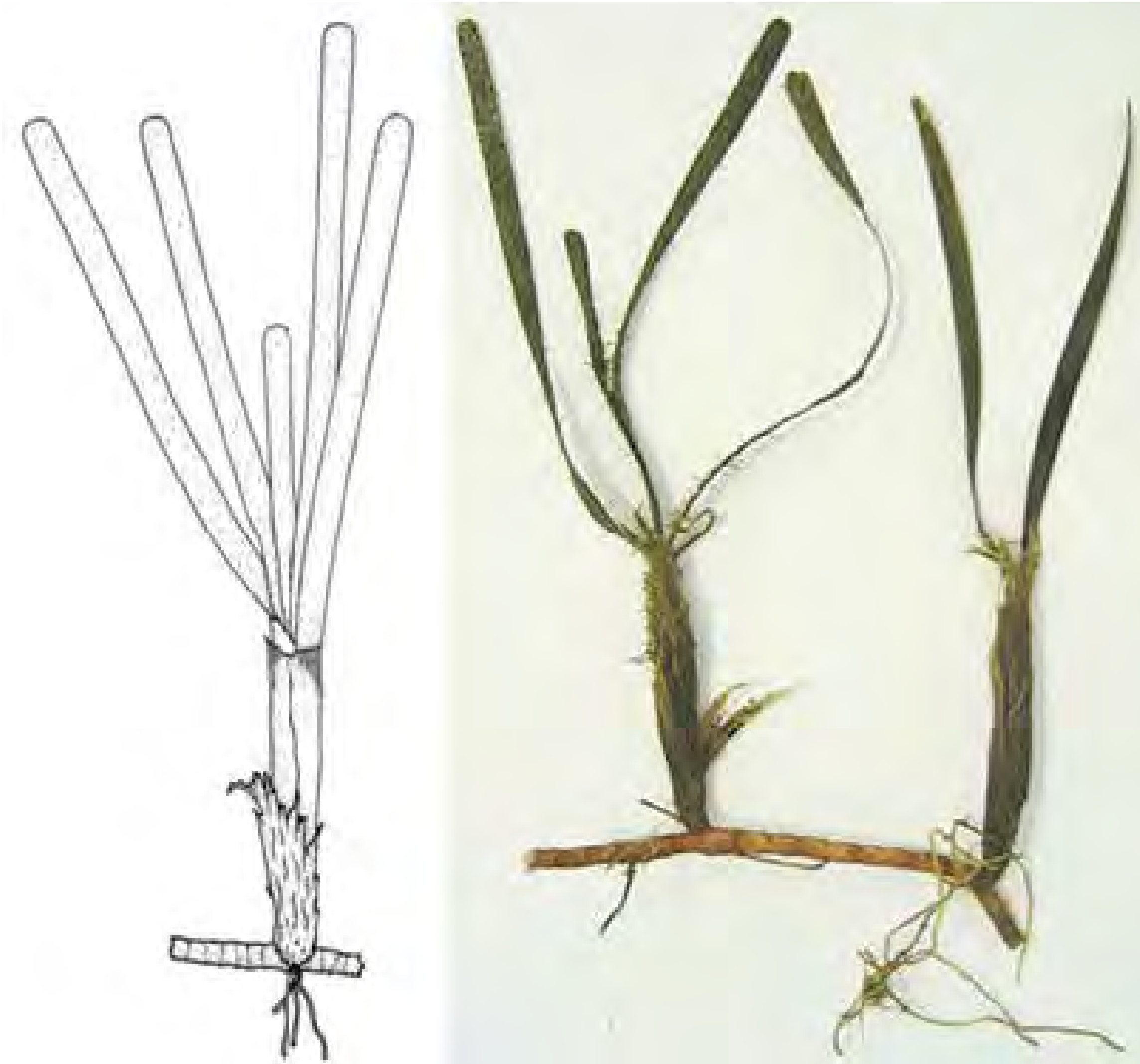


Figure 7. Reference photos and illustrations of *T. testudinum*.

2.4.2.3 *RUPPIA MARITIMA* (WIDGEON GRASS)

Ruppia maritima (widgeon grass) is a wide distributed seagrass, tolerating a broad range of salinity, temperature, light, and nutrient conditions, and can be found in waters as shallow as a few centimeters, and up to 4.5 m, depending on light penetration and wave disturbance. *R. maritima* occupies a wide range of habitats including tidally influenced rivers, bays, estuaries, and along barrier islands. *R. maritima* can colonize an area quickly due to a high shoot turnover and its ability to reproduce sexually and asexually and can be perennial or annual depending on temperature and salinity ranges, acting as a perennial species in areas of higher temperature and salinity maxima. R. maritima produces a large number of underwater flowers about 5 to 6 weeks after the onset of spring growth and within 1 to 2 weeks the flower spike develops, releasing pollen into the water column (Byrnes et al., 2022, Kantrud 1991, NatureServe 2023). *R. maritima* can be identified by shoots reaching lengths up to 2.5 m with leaves ranging between 5 and 20 cm, however when not reproducing, leaves only grow to a length of 1-2 mm. Leaf blades are wider at the base of the stem and slowly taper into long pointed tips (Byrnes et al. 2022). At the time of survey, *R. maritima* was not flowering, therefore requiring a further examination of the roots and rhizomes to

distinguish from shoal grass. Reference photographs and illustrations are presented in Figure 8 (iNaturalist 2023, Native Plant Trust 2023).

Figure 8. Reference photos and illustrations of *R. maritima*.

2.4.2.4 *HALOPHILA ENGELMANNII* (STAR GRASS)

H. engelmannii is known to thrive on sandy or muddy bottoms in depths ranging from near surface to 20 meters, in areas with low wave energy (NatureServe 2022). Unlike most seagrass species *H. engelmannii* can tolerate lower light levels, caused by depth or high turbidity, and found in typical marine environments which makes it more common in deeper waters of the Gulf of Mexico than other species (NatureServe 2022). *H. engelmannii* has 4 to 8 oblong leaves in a whorl at the end of each stem. These leaves are around 2.5 cm long and 0.6 cm wide. Stems do not usually exceed 10 cm in length (TPWD 2012). Reference photographs and illustrations are presented in Figure 9 (Meiman 2019).

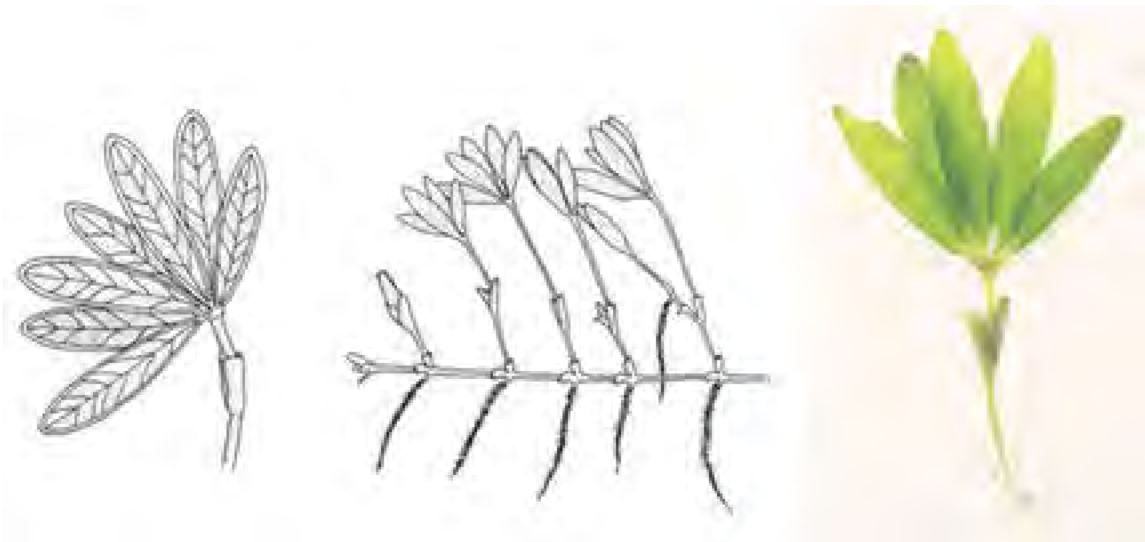


Figure 9. Reference photos and illustrations of *H. engelmannii*.

2.4.2.5 *SYRINGODIUM FILIFORME* (MANATEE GRASS)

S. filiforme is common along the Gulf Coast and the Caribbean in bays and shallow waters, ranging from 0.75 to 2.0 m in depth (TPWD 2012). Its cylindrical leaves help distinguish it from other species. *S. filiforme* has leaves that can reach 50 cm in length that often cluster in numbers of 2 to 4 with roots growing just below the surface (Florida Museum of Natural History 2018). *S. filiforme* is found in coastal waters with salinities of 20-36 ppt. This species often grows in small patches or in areas with other species of seagrass.

S. filiforme reproduces through sexual reproduction of seeds and vegetatively by rhizome elongation (Samper-Villarreal et al., 2020). Reproductive cymes (flat-topped cluster of flowers on a branch or a system of branches in which the central flowers open first, followed by the peripheral flowers) can be observed when the seagrass is reproducing. They usually only appear during the warmer months, however in the northern Gulf of Mexico this occurs in shorter intervals versus more tropical to subtropical locations (Samper-Villarreal et al., 2020). Reference photographs and illustrations are presented in Figure 10 (Meiman 2019).

Figure 10. Reference photos and illustrations of *S. filiforme*.

2.5 Data Analysis

2.5.1 Aerial Photogrammetric Interpretation

Seagrass was digitized using a mixture of photointerpretation and image analysis according to methodology described in *Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach* (NOAA Coastal Services Center 2001). Satellite imagery of study area was captured on September 14, 2022, by Planet Labs PBC through their Planet Tasking service. Planet Labs technology has 20 of its SkySat satellites in orbit, capable of high frequency fly over of a given area 5-7 times a day. SkySat produces 3 band natural color imagery at a resolution of 50cm, capable of download within a few hours of acquisition. The overflight photomosaics collected in May 2022 were not used during this analysis as those images were not collected during the peak growing season, and therefore would not provide the

maximum extent of seagrass coverage. Satellite imagery was acquired just days before the field survey, providing near real-time imagery for comparison and analysis.

The satellite imagery was first processed using the ArcGIS Pro 2.9 Image Analyst extension, using the Image Classification and Classification tools to digitize areas of contrast within the seagrass study area. This classification consisted of a machine learning model created from small areas of trained data input from geospatial scientists which focused on contrast changes within the imagery that specifically identified the difference between potential seagrass and open water. From there the delineation of seagrass was visually confirmed and revised to include all areas of seagrass discernable from the satellite imagery. This method included “heads-up digitization,” defined as manual digitization by tracing a mouse over features displayed on a computer monitor, used as a method of vectorizing raster data, focusing on outer boundaries and using a minimum mapping unit of 0.03 hectares (0.25 acres) to differentiate patchy seagrass as described in the reference methodology. The analog digitization and revisions of modeled seagrass boundaries were also completed in ArcGIS Pro 2.9. Focus was applied to determine the outer boundaries of the seagrass with the goal of capturing any areas above 10 percent cover as described in *Guidance for Benthic Habitat Mapping: An Aerial Photographic Approach* (NOAA Coastal Services Center 2001).

2.5.2 In situ Measurements and Observational Data

Water quality and seagrass coverage were examined as a function of relative water depth at the time of survey, and “zones” based on barrier island morphology within the Survey Area. For locations found in depths between 0 and 1.0 m, only one measurement was recorded at 0.3 m below the water line. Locations in depths > 1.0 m were recorded both at 0.3 m and at 1.0 m. For measurements in depths at or just over 1.0 m, readings were taken approximately 0.3 m from the bottom to avoid disturbing the bottom sediments. In this survey report, SWCA calculated the average water quality measurements within each zone at the surface and at 1.0 m, as applicable. All depth measurements discussed in the body of this report are relative depths. Tidally corrected depths are presented in Appendix B.

As the secchi reading is relative to the depth of the water column at each location, measured as the depth at which the Secchi disk is no longer visible when lowered into water from the shaded side of a boat, and the point at which it reappears after raising it.

As the Li-Cor sensor is highly sensitive, five replicate PAR readings were recorded at each depth (0.3 m, and as appropriate at 1.0 m or 0.3 m off the bottom) for each location, and the five readings were then averaged for each depth zone. The diffuse attenuation coefficient (K_d) for downward irradiance was calculated using the following equation: $K_d = [-\ln(l_o/L_z)]$.

General notes taken at each location also included substrate, which was categorized as sand (coarse, medium, fine grain), a combination of silt and sand, and silt. These notes were based on visual observation and did not include a detailed assessment or laboratory analysis for grain size.

2.5.3 Defining Island Zonation

Based on visual observation in the field, primarily related to the above sea level island land mass and vegetative properties, SWCA defined the following “Zones” within the Survey Area. The locations are color coded by zone in Figure 4, above.

North Zone: In general, there is minimal to no discernable land mass above sea level to provide protection to the backside of the island. There is no supporting backmarsh vegetation between the island

and the seagrass beds. There is evidence that sand bars separate the more inland areas from Chandeleur Sound. Twenty-seven of the 108 locations are found within the North Zone.

Middle Zone: These stations are in areas found behind the island with elevation above sea level, providing protection to the seagrasses from wind and wave action. Large tracts of marsh grasses further protect the shallow water seagrass. The most landward areas are characterized by slower moving, and protected waters. The middle zone is characterized by cuts between the marsh, draining of the island. As distance from the island increases, the water movement is influenced by the Chandeleur Sound, increasing in velocity. Fifty-two of the 108 locations are found within the Middle Zone.

South Zone: These locations are found in areas behind the island with above sea level land mass, however exhibit evidence of erosion. The lack of supporting back marsh systems indicates this area is fairly dynamic. At the southernmost point, locations are found in open water on the Gulf side, with no evidence of seagrass. Historic aerials indicate the point was more prominent and likely though wind and wave action, has eroded backwards. Fifteen of the 108 locations are found within the South Zone.

New Harbor Island (NHI Zone): The locations in this area border smaller mangrove islands and are separated from the main island by a deep and wide channel. Fourteen of the 108 locations are found within the NHI Zone.

2.5.4 Seagrass Distribution and Community Composition

The seagrass community composition was assessed similarly to the in-situ water quality data, where coverage was examined based on island zones and relative depth. The measured relative depth was refined into categories to identify trends in species distribution and coverage, defined as follows:

- Shallow: 0 to 0.6 m
- Mid: >0.6 m to 1.2 m
- Deep: >1.2 m to >2.0

Results below present species community composition and occurrence, coverage, and canopy height as a function of location, zone within the study area, relative depth zone, and general substrate observations.

To estimate the spatial pattern of seagrass community composition, SWCA estimated individual species percent cover within a quadrat based on standardized guidance on cover classifications, provided in Figure 11, as presented in Meiman (2019). This allowed for a rapid, visual, and repeatable classification product.

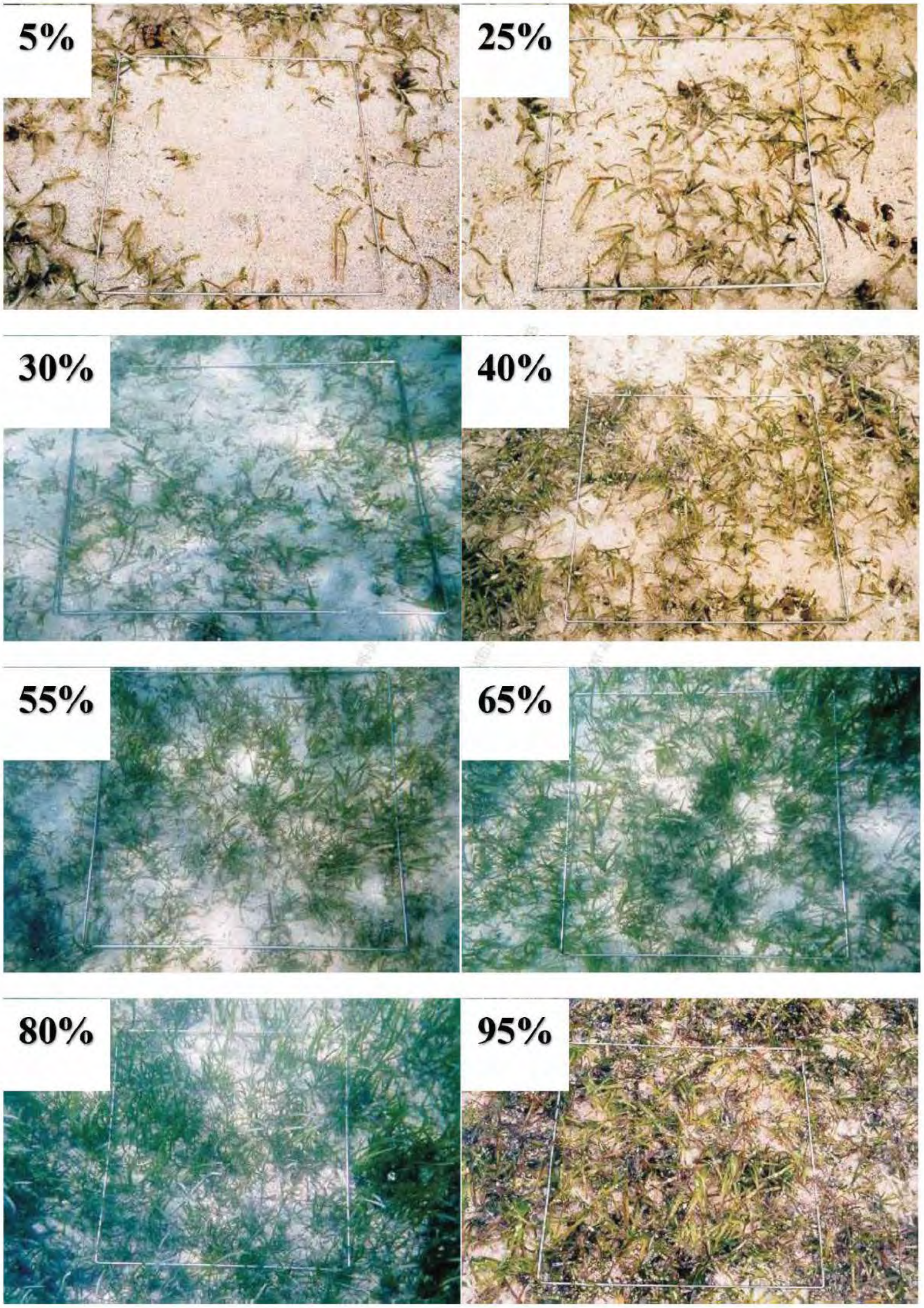


Figure 11. Standardization guidance for estimating percent seagrass cover.

The seagrass density analysis and modeling were completed using the ArcGIS suite of software and tools. The seagrass data and observations for each station were assessed using the percent cover values observed in the field. Each observation was recorded in the field and digitized into a geospatial database that tied the values of each species observation to the point at which it was recorded. Using this digitized field data, the density of seagrass was run through an ArcGIS Average Nearest Neighbor tool, to calculate seagrass coverage across the Study Area. The Average Nearest Neighbor returns the observed mean distance, expected mean distance, nearest neighbor index, z-score, and p-value for measures of statistical significance.

3 FIELD RESULTS

3.1 Water Quality Measurements

Of the 143 locations identified for survey, 108 locations fell within the sea grass coverage area identified and mapped using the September 2022 satellite imagery. Within each zone, the average relative depth of the randomly sampled locations was 1.0 m (SD ±0.8m) in the North Zone, 1.3 m (SD ±0.7m) in the Middle Zone, 1.4 m (SD ±0.7m) in the South Zone, and 1.7 m (SD ±0.6m) in the NHI Zone. A summary of the average water quality measurements are presented in Table 5, and described below.

For water temperature, pH, and PAR, measurements were fairly consistent between the zones. Surface temperature was characteristic for the time of year and exhibited only minor decrease between the surface measurement and the measurement at depth. Average surface temperature was fairly consistent between zones with averages between 30.0°C and 29.1°C, and measurements at 1.0 m averaged between 28.4°C and 29.5°C. pH measurements were consistent between zones and depths, ranging from 8.18 to 9.06. The average diffuse attenuation coefficient (K_d) ranged from 0.38 to 0.46, with the lowest occurring at NHI.

Salinity at the surface and at depth was lowest in the North Zone (26.3 ppt at surface; 28.5 ppt at depth), and gradually increased moving south through the Survey Area. The NHI Zone recorded 34.1 ppt at the surface and 35.2 ppt at depth. Similar trends are seen in the conductivity measurements.

Average dissolved oxygen was highest in the North Zone (8.4 mg/L at the surface [128.0%]; 7.6 mg/L [115.8%] at depth), and lowest in the NHI Zone (7.1 mg/L[110.0%] the surface;7.1 mg/L [117.6%] at depth). There were five locations where the dissolved oxygen was higher than 11 mg/L. A review of other environmental conditions indicate that these high dissolved oxygen values were at locations where the total water depth was less than 0.3 m. Due to the shallow water allowing for rapid exchange with the air, based on SWCA's professional opinion, these values were left in the data set. These values were primarily in the North Zone, and one in the Middle Zone, However, removal of these values would bring the average dissolved oxygen down to 7.4 mg/L, which is consistent with the other zones on the main Chandeleur Island.

Appendix B provides a complete summary of water quality data by station.

Table 4. Average water quality measurements per zone.

Average Measurements at Surface (0.3m)

Zone	Temp		Salinity		Conductivity		DO		pH	Secchi		PAR	
	°C	SD	ppt	SD	µS/cm	SD	mg/L	SD	range	Depth (m)	SD	K_d	SD
North Zone	30.0	2.5	26.3	3.0	48.1	4.8	8.4	2.2	8.17 - 8.73	1.0	0.8	0.46	0.15
Middle Zone	29.4	1.2	28.8	5.4	58.2	3.4	7.4	2.1	8.06 - 9.09	1.2	0.7	0.46	0.24
South Zone	29.1	0.4	24.6	0.5	64.5	2.2	7.7	1.4	8.36 - 8.90	1.1	0.5	0.45	0.13
NHI Zone	29.7	0.5	23.9	0.2	64.5	1.6	7.1	2.2	8.24 - 8.59	1.5	0.4	0.38	0.05

Average Measurements at Depth (1.0m)

Zone	Temp		Salinity		Conductivity		DO		pH	Secchi		PAR	
	°C	SD	ppt	SD	µS/cm	SD	mg/L	SD	range	Depth (m)	SD	K_d	SD
North Zone	28.4	*0.8*	28.5	*4.7*	50.2	6.9	7.6	1.7	8.18 - 8.71	--	--	--	--
Middle Zone	28.8	*0.6*	28.7	*6.7*	59.5	2.8	7.5	1.6	8.29 - 8.71	--	--	--	--
South Zone	28.9	*0.6*	24.9	*0.5*	64.6	2.0	7.5	0.9	8.36 - 8.60	--	--	--	--
NHI Zone	29.5	*0.6*	24.2	*0.4*	64.8	1.5	7.1	2.1	8.47 - 8.60	--	--	--	--

3.2 Direct Observation Occurrence and Coverage

Of the 108 locations surveyed for seagrass, 40 were bare, 46 were dominated (greater than 50% cover) by *H. wrightii*, 10 dominated by *T. testudinum*, 6 dominated by *R. maritima*, 3 had relatively even coverage of *H. wrightii* and *R. maritima*, 2 dominated by *H. engelmannii*, and 1 was evenly dominated by *H. wrightii* and *T. testudinum*. One location, C142, had a species richness of 4 species, and was the only location with documented *S. filiforme*. *T. testudinum* was not present at this location. This location was on the boundary between the North Zone and the Middle Zone. The Middle Zone supported the next highest species richness, with 3 species at C129: *H. wrightii*, *T. testudinum*, and *R. maritima*. Only one location in the NHI Zone contained seagrass: S217 supported *H. wrightii*. Table 5 presents the dominant species and distribution of those dominance classes within each zone.

Table 5. Dominant seagrass species by zone presented as count of locations.

	Bare	*H. wrightii*	*T. testudinum*	*R. maritima*	*H. wrightii/ R. maritima*	*H. engelmannii*	*H. wrightii/ T. testudinum*
North Zone	6	15	--	5	1	--	--
Middle Zone	11	27	10	1	2	2	
South Zone	10	3	--	--	--	--	1
NHI Zone	13	1	--	--	--	--	
Total	40	46	10	6	3	2	1

In the North Zone, the greatest percent cover of *H. wrightii* was found at the mid depth locations, while *R. maritima* had evenly distributed covers between shallow and deep locations.

In the Middle Zone, *H. wrightii* cover was greatest at shallow locations, and decreased in coverage into the mid and deep locations. *T. testudinum* showed similar trends, decreasing in coverage from shallow to deep locations. *H. engelmannii* was not present in shallow locations and had the highest coverage at locations at mid-depth locations. *R. maritima* had lower coverage than the other species present and had highest coverage at shallow locations.

In the South Zone, *H. wrightii* had the highest coverage at the shallow and mid depth locations, with minimal coverage at the deep locations. Only minimal coverage of *T. testudinum* was found at the deep locations, and the highest coverage of *R. maritima* was found at shallow locations.

In the NHI Zone, only minimal *H. wrightii* coverage was observed at a shallow location. Table 6 presents the average coverage by species in each zone and at relative depths.

Appendix C provides a complete summary of seagrass percent coverage data and canopy height by location.

Table 6. Average seagrass species percent cover per zone and depth

Zone	Depth	*H. wrightii*	*T. testudinum*	*S. filiforme*	*H. engelmannii*	*R. maritima*
	Shallow	5.2%	--	--	--	24.1%
North	Mid	74.3%	--	--	--	1.5%
	Deep	20.1%		3.8%	6.3%	28.8%
Middle	Shallow	44.9%	53.8%	--	--	4.7%

	Mid	39.1%	47.2%	--	21.0%	1.8%
	Deep	28.7%	48.8%	--	8.4%	--
South	Shallow	99.8%	--	--	--	45.5%
	Mid	89.9%	--	--	--	0.3%
	Deep	6.3%	4.0%	--	--	--
NHI	Shallow	16.8%	--	--	--	--
	Deep	--	--	--	--	--

3.3 Seagrass Data Interpolation and Cover Modeling

Through image processing of the September 2022 satellite imagery for total coverage as described above, maximum extent of acreage that supports seagrass growth within the Study Area is 2,102 hectares. 1,711 hectares of this area was classified as dense (51-100%) seagrass with the remaining 391 hectares considered patchy (50% or less). Results of the coverage mapping showing the maximum extent are presented in Figure 12. Appendix D presents the detailed results to depict the areas of dense cover and the areas of patchy cover. Cover classification mapping using the percent cover from the September 2022 field studies, and data interpolation for percent cover as described above, are provided for total seagrass coverage (Figure 13), and for each species identified during the field survey: *H. wrightii* (Figure 14), *T. testudinum* (Figure 15), *R. maritima* (Figure 16), *H. engelmannii* (Figure 17), and *S. filiforme* (Figure 18). Coverage classification mapping was completed using the nearest neighbor interpolation method within ArcGIS using coverage values per sampling station location. The maximum seagrass extent from aerial image processing (orange boundary in Figure 12), was overlaid on the data interpolation models, to provide context to the modeled high cover and low cover areas. The maximum 2022 extent from the imagery is seen as a black polygon layer over the modeled results in Figure 13 through Figure 18.

Figure 12. Total seagrass cover through satellite imagery interpretation, and direct observation for species counts.

Figure 13. Total seagrass coverage modeling results.

Figure 14. ***H. wrightii*** **coverage modeling results.**

Figure 15. ***T. testudinum*** **coverage modeling results.**

Figure 16. *R. maritima* coverage modeling results.

Figure 17. *H. engelmannii* coverage modeling results

Figure 18. *S. filiforme* coverage modeling results.

4 DISCUSSION

4.1 Seagrass Distribution Observations

In general, the in-situ water quality measurements were within similar ranges between zones and locations indicating that these parameters are likely not a limiting factor for the growth and coverage of the seagrasses at the Chandeleur Islands. Values were typical of a shallow, coastal environment with limited anthropogenic influence, and indicated overall good water quality.

Based on the defined zonation of the Northern Chandeleur Island, the North and South Zones supported higher coverage of *H. wrightii*, and also a relatively high coverage of *R. maritima* but in large, isolated patches, not interspersed with *H. wrightii*. The North and South Zones experience higher overall entropy from wave and tidal currents at the most extreme points. Additionally, in these Zones the more dominant substrate type was sand, with fewer sites documenting finer silt material. As these Zones experience the highest levels of periodic disturbance from large storm events, the recovery species *H. wrightii* and *R. maritima* will grow and thrive, as they can quickly grow during periods of calm, but are also quickly removed during storm and disturbance events with the ability to recover quickly after disturbance, acting as both perennial and annual species. *T. testudinum* was not dominant in these zones, as this species requires more stable conditions for growth as an annual species. In general, the lack of *T. testudinum* was consistent with previous studies, however the distribution of *H. wrightii* and *R. maritima* should be examined further. Previous studies indicate a larger distribution of specifically *R. maritima*, rather than isolated patches, as identified here. At the time of the study, flowering *R. maritima* was not observed, and required examination of roots and rhizomes for differences in identification between that and *H. wrightii*. With both *R. maritima* and *H. wrightii* considered weedy species, influenced by disturbance, the dominance of these species can change over time. Furthermore, one station documented *S. filiforme*. This is consistent with observations of rare coverage documented by Kenworthy et al. 2017, who notes that as this species flowers and produces seeds that remains buried in sediment seed banks for more than 12 months before germinating. Kenworthy et al. 2017 concluded that it is possible that seed banks were chronically exposed to contamination from *Deepwater Horizon*, with population level effects on this, and other seed producing species.

The Middle Zone supported the highest coverage of *T. testudinum*, with moderate coverage of *H. wrightii* and *H. engelmannii*. In this area, silt and sand combination, and silt were the dominant substrate. As the Middle Zone is more protected from wave energy from an observed higher land mass and supporting back marsh system, and lower water velocity based on distance from the Chandeleur Sound, the finer grain sediments have the opportunity to settle out. In areas of high *T. testudinum* coverage, these sediments are trapped within the dense foliage and thick root structure. In this area of good water quality, and minimal evidence of wash over and breeches in the island morphology, *T. testudinum* is the climax species thriving in the stable environment, and within its acceptable depth requirements. As the area becomes more unstable due to water velocity, depth limitations, and water quality, the more tolerant species, the *H. wrightii* and *H. engelmannii* succeed. At the shallow extent of *T. testudinum distribution*, there is an increase in *H. engelmannii* and *R. maritima.*

The NHI Zone is separated from the main Chandeleur Island by a deep channel. The buildup of the land mass and the establishment of the mangrove forest provides habitat for seagrass; however, the current dynamics and wave energy appears to be different. The overall water clarity was lower at the NHI Zone than the other zones. At the time of survey, the tide was slack, and water was calm, indicating this area may not receive adequate water movement, allowing for particulates in the water to remain suspended. Only one location in this Zone supported seagrass growth, with a relative low coverage of *H. wrightii*.

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Appendix A

Chandeleur Island Restoration Project (PO-0199) Seagrass Survey Plan

Chandeleur Island Restoration Project (PO-0199)

Seagrass Survey Plan

MAY 2022

PREPARED FOR

Coastal Engineering Consultants, Inc.

PREPARED BY

SWCA Environmental Consultants

CHANDELEUR ISLAND RESTORATION PROJECT (PO-)0199)
SEAGRASS SURVEY PLAN

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CONTENTS

Figures

Tables

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1 INTRODUCTION

1.1 Project Overview

The Chandeleur Island Restoration (PO-0199) Project (Project) is located on the Chandeleur Islands in St. Bernard Parish, Louisiana (Figure 1). The Chandeleur Islands include those lands between Chandeleur Sound and the Gulf of Mexico to include Chandeleur Island, Gosier Islands, Grand Gosier Islands, Curlew Islands, New Harbor Island, North Island, Freemason Island, and a few unnamed islands (Figure 2). This Project Area includes the Chandeleur Islands and the seagrass beds and water bottoms within the Breton National Wildlife Refuge (Figure 3).

The purpose of the Project is to engineer and design a restoration project benefitting the Chandeleur Islands and the many species that use them with a particular focus on birds as defined in the Restoration Plan and Environmental Assessment Plan #1 of the Region-wide Trustee Implementation Group. Phase 1 of the Project focuses on plan formulation for restoration of the main Chandeleur Island and New Harbor Island. The Coastal Protection and Restoration Authority (CPRA) serves as the designated State agency for the Project.

The purpose of this document it to define the Survey Area and present the Survey Plan to map the current extent and document the species composition and relative density of the seagrass beds in conjunction with the Project data collection efforts; and describe the changes to the seagrass beds over time.

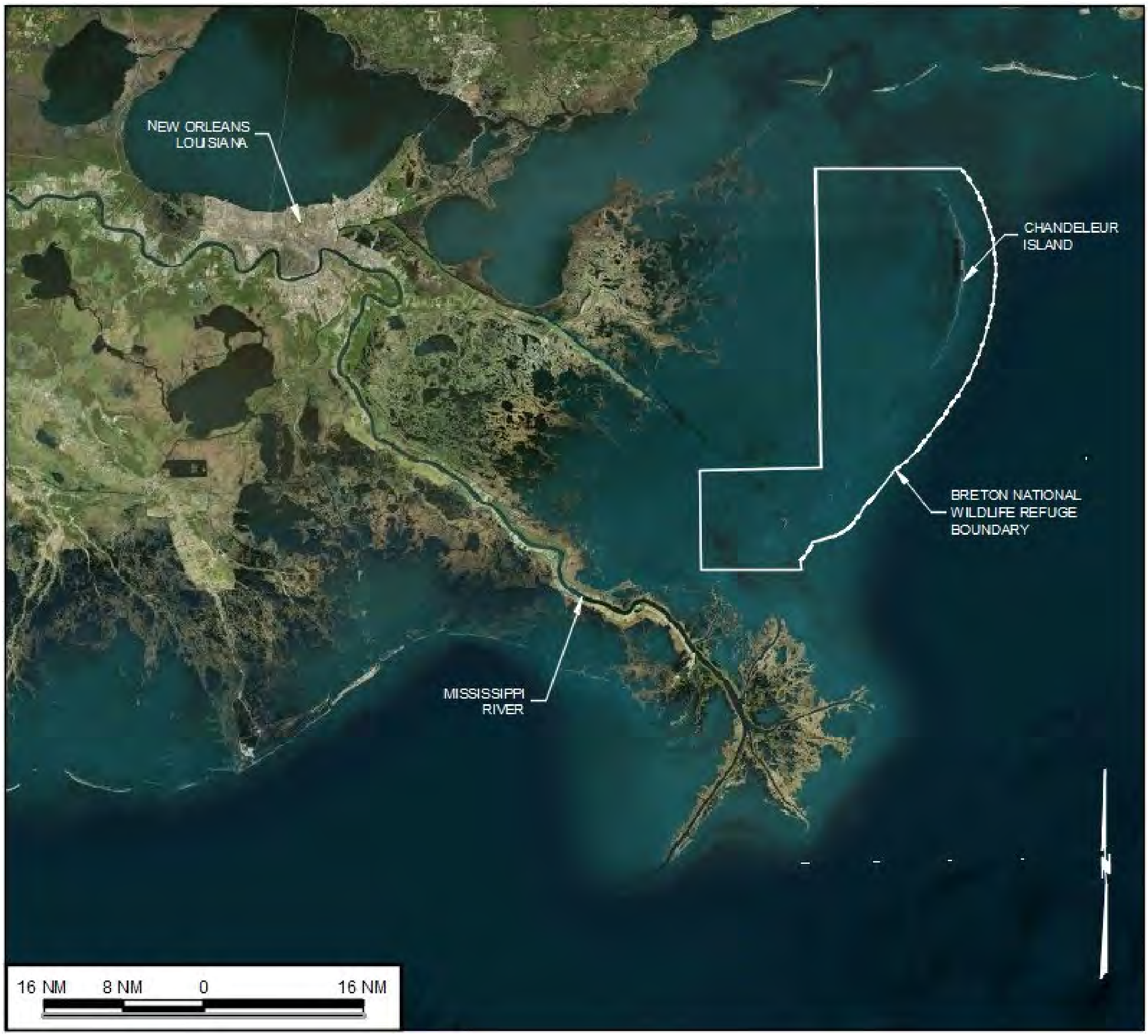

Figure 1. Project Location Map

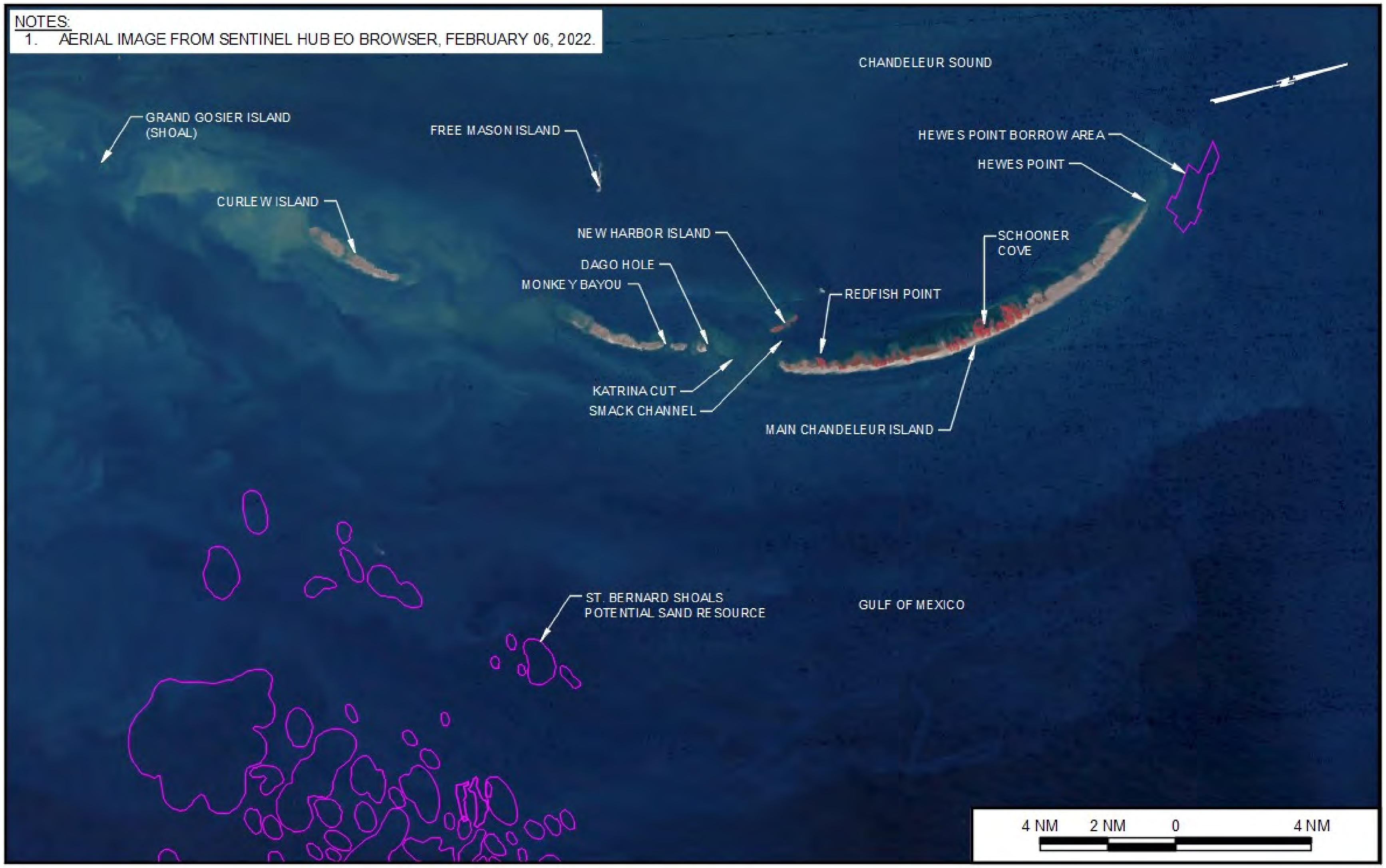

Figure 2. Chandeleur Islands

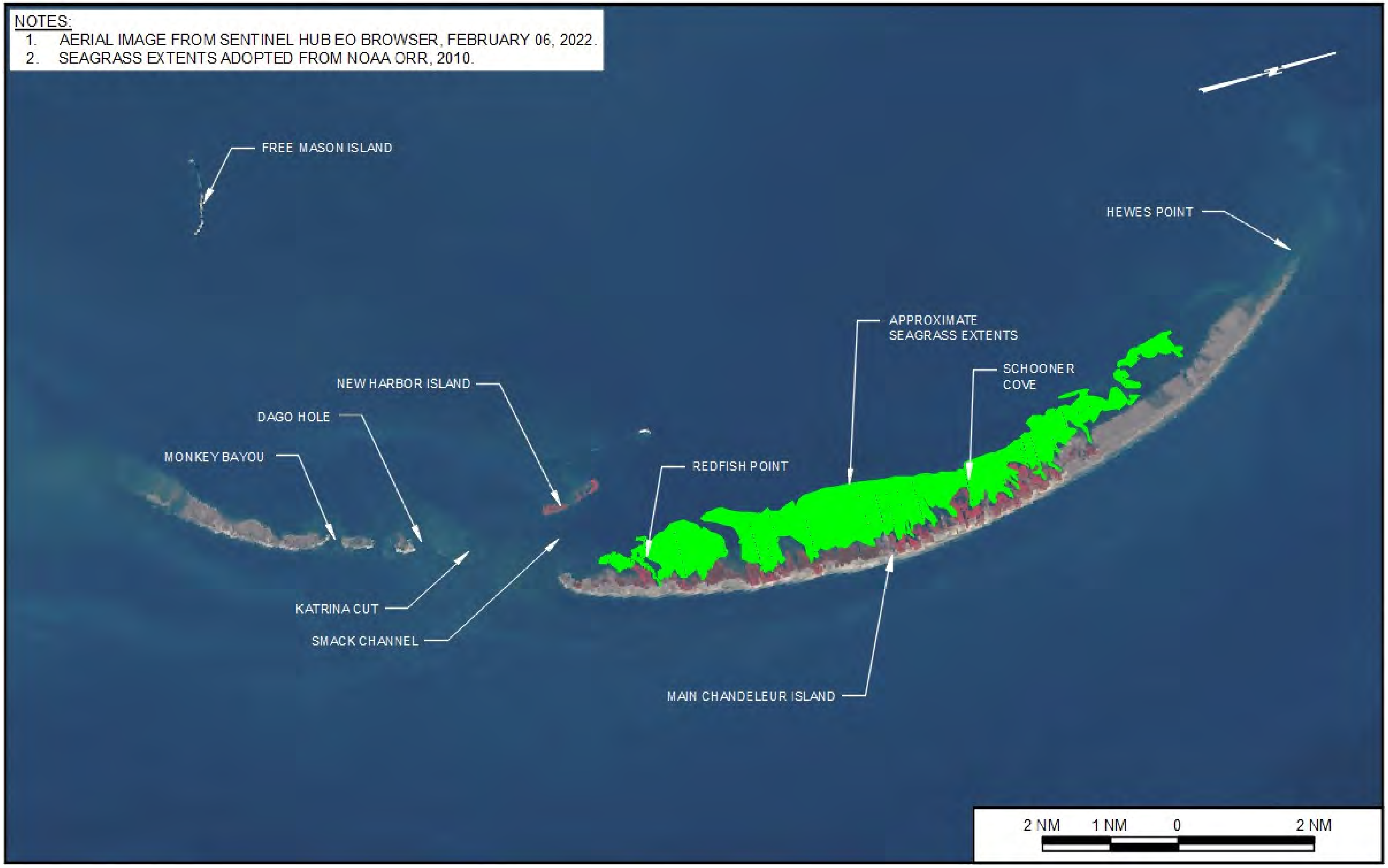

Figure 3. 2010-2011 Seagrass Bed Mapping by NOAA (NOAA 2015)

1.2 Project Area Description

The Chandeleurs Islands can be subdivided into two subsets, which are affected by different hydrologic inputs and environmental stressors. The northern islands include the main Chandeleur Island, New Harbor Island, Freemason Island, and Curlew Island. The southern islands include Grand Gosier Island and Breton Islands. The primary ecological drivers in the Project Area are attributed to natural coastal processes such as barrier island dynamics, abandoned river deltas, and damage from tropical storms and hurricanes. The southern islands are within close proximity to major passes of the Mississippi River. Due to the significant freshwater inputs, high nutrient levels and increased turbidity levels, seagrass development has been adversely impacted in this area. The northern islands are located far enough away from pollutant sources, including waters from coastal Mississippi, buffered by the Biloxi marsh system, and inputs from the Pearl River and passes of Lake Ponchartrain, and do not appear to have adverse impacts to seagrass development in this area (Handley et al. 2007).

Studies throughout the past five decades have reported varying coverage of seagrasses along the Chandeleur Islands, however the species composition has remained fairly consistent and includes turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), star grass (*Halophila engelmannii*), and widgeon grass (*Ruppia maritima*). Frequent damage due to passing hurricanes shown influences the species composition and abundance in certain areas. Those areas that are sheltered from damage are dominated by dense turtle grass meadows. Areas that experience higher levels of damaging forces, such as the creation of channel cuts and sediment washover features with high levels of sediment deposition, were found to have some turtle grass, but also manatee grass and shoal grass. Star grass was found to be present but was quite rare. The change in species composition from dense beds of turtle grass and manatee grass to gradual colonization of shoal grass and widgeon grass indicates a gradual pattern of stressors from storm damage over time (Handley et al. 2007).

The last comprehensive investigation for seagrass bed extent, viability, and species composition within the Chandeleur Islands was conducted by the National Oceanic and Atmospheric Administration (NOAA) and the United States Geological Survey (USGS) in 2010 and 2011. The investigation was conducted as part of the post-incident exposure of the Deepwater Horizon Oil Spill on seagrass vegetation throughout the northern Gulf of Mexico (NOAA 2015). The 2010 and 2011 seagrass coverage totals approximately 2,385 acres, and 2,614 acres, respectively (NOAA 2015). The National Aeronautics and Space Administration (NASA) Tool CREOL (NASA 2021) also provides supporting aerial imagery of the Project Area to illustrate changes in seagrass extent. The Project Area has been subjected to multiple storms of varying and increasing intensity storms. These storms have the potential to produce overwash and breaching of the dunes that can smother, bury, and otherwise impact water quality necessary for maintaining seagrass health and coverage.

2 SURVEY PLAN GOALS

The Survey Plan will utilize the available historic seagrass bed mapping and Project data to be collected including aerial photographs and imagery, topography, and bathymetry to establish the Survey Area for ground-truthing surveys of the seagrass beds. Detailed survey plan goals include:

1. Summarize the existing aerial and ground-truthed seagrass survey data from existing sources to give us an understanding of the historical seagrass bed extent and health through water quality, species composition, and biomass indicators, and to incorporate ground truthing data collection points for sample locations. The robust sampling plan will allow for consistency and reproducible data collection to evaluate trends in extent and health over time.

2. Determine the 2022 spatial distribution of seagrass beds utilizing new aerial data collected for the Project and Summer 2022 field surveys to verify boundary edges between aerial data collection timeline and field survey timeline.

3. Characterize the 2022 Seagrass communities. Primary data collection metrics will include species composition, percent cover, patchiness, and basic water quality parameters.

4. Determine and describe the biological and water quality health through secondary data collection at a subset of sampling locations, which will be used to guide future monitoring and restoration phases of the Project.

5. Set up and maintain a GIS platform (SWCA AI Platform) to evaluate in near real-time field data collection updates and compare between the 2022 aerial survey data with historic seagrass maps and aerial imagery.

2.1 Survey Plan

The limits of the 2010 and 2011 NOAA and USGS aerial data were georeferenced to establish the preliminary Survey Area and allow for reproducibility in the 2022 survey efforts: 1) verifying the entire seagrass habitat or potential habitat is identified, and 2) enable comparisons of species, compositions, and densities over time. Furthermore, the Survey Plan will incorporate Project Design Team data efforts to ensure proper data collection methods, logistics, and safety.

The work flow includes developing the preliminary Survey Area as presented herein, obtaining high resolution aerial photographs in May 2022 (separate task), mapping seagrasses utilizing the May 2022 aerial photographs, collecting topography and bathymetry in Summer 2022 (separate task), comparing and correlating Summer 2022 bathymetry to May 2022 seagrass mapping, obtaining satellite data in Summer 2022, refining seagrass edge mapping utilizing Summer 2022 data and satellite data, and finalizing the Survey Area to match the current extent of seagrasses. The seagrass survey field work is anticipated to be conducted within a two week period in August 2022 depending on weather and environmental constraints. Refining and finalizing the Survey Area will be an iterative process among the Project Design Team and CPRA.

2.2 Definition of Survey Area

In order to define a preliminary Survey Area (Figure 4), a single polygon was created identifying the maximum bounds of the 2010/2011 seagrass extent (NOAA 2015). This preliminary Survey Area will be refined based on results of the 2022 aerial data acquisition. The Survey Area will be confirmed based on the current extent of the seagrasses, which will be digitally mapped through photogrammetric interpretation. The aerial photographs will be collected in May 2022, prior to the start of the known seagrass growing season (June through September),. Topographic and bathymetric data and satellite data

will be collected in Summer 2022 to confirm the current extent at the time of the seagrass field survey The Survey Area will be refined as needed to capture the current extent of the seagrasses.

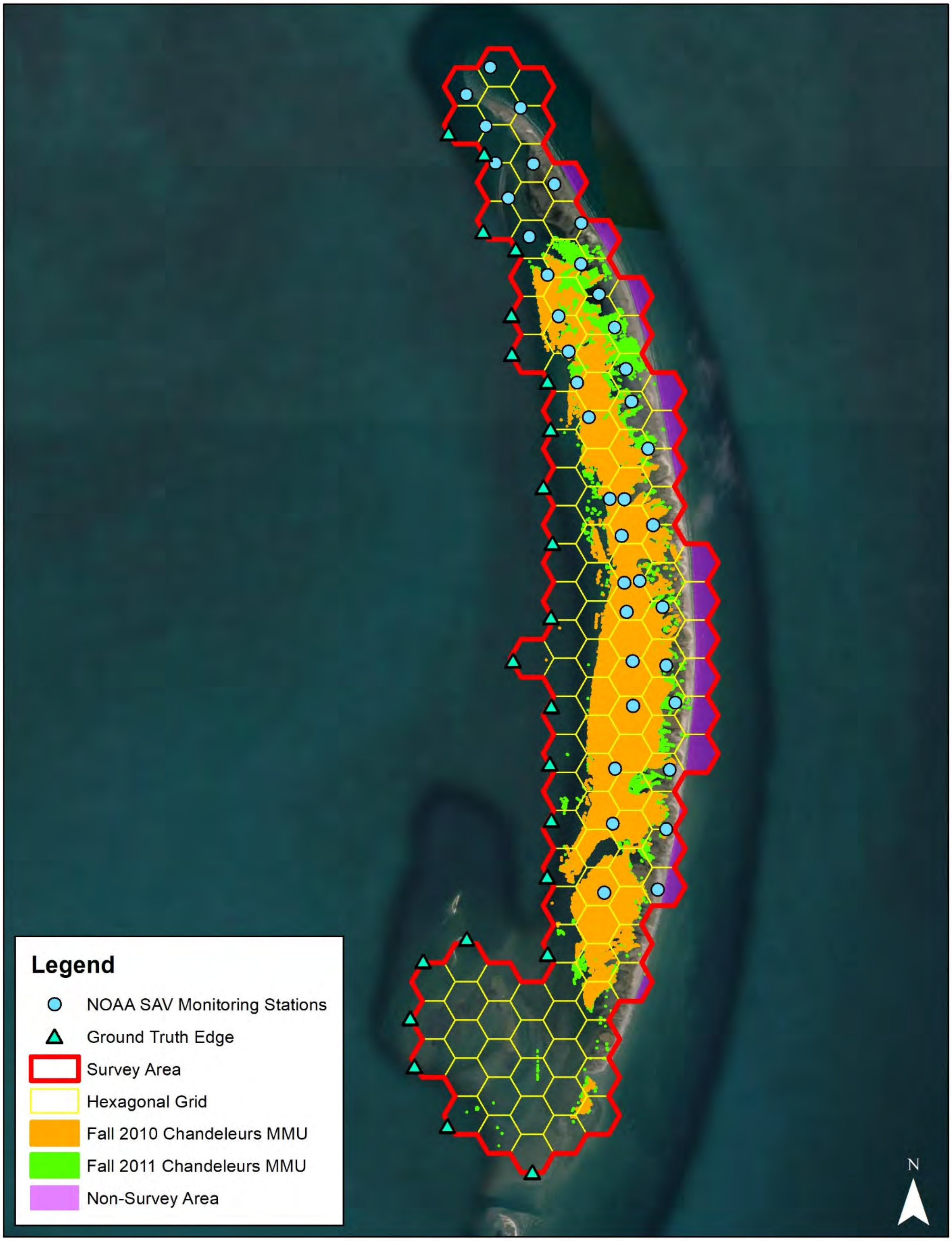

Figure 4. Seagrass Study Area

2.3 Field Survey Plan: Fixed Station Locations

The field survey plan utilizes the methods outlined in Dunton et al. (2010), as recommended by the National Academies of Sciences, Engineering and Medicine (2017), combined with the sampling locations from the 2010 and 2011 NOAA sampling program (NOAA 2015), allowing for robust data collection and reproducibility. The recommended practices utilize a grid of tessellated hexagons (500 meters per side) to identify sampling locations for all levels of seagrass monitoring. This hexagonal grid was overlaid on to the Survey Area to establish the sampling locations (Figure 4). Prior to the start of the field survey effort, one fixed sample location will be randomly selected within each hexagon, for a total of 123 sample locations. In situations where there are existing data points from the 2010 / 2011 NOAA sampling program, those station locations will be selected in lieu of the randomly selected data point for that hexagon.

For survey planning purposes, the hexagonal grid was overlaid on the most current publicly available, high resolution aerial data (Google Earth 2022). Due to the dynamic nature of the barrier islands and presumed migration of the island from the last large scale seagrass mapping effort (2011) to its current position, some survey grid locations containing historical seagrass data extensively overlap with the island and extend into the Gulf. Figure 4 illustrates how some survey hexagons will be truncated to account for island overlap. Once the April/May Project aerial data is collected, the survey grids will be similarly truncated to capture the most landward extent of the Survey Area.

Sampling will occur in the July – August 2022 time frame, during or shortly after the peak seagrass growing season for the region, which is mid to late summer. While Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Environmental Quality do not stipulate a seagrass growing season, especially as it pertains to environmental surveys, the Florida Department of Environmental Protection (FDEP 2020) further defines this season as June 1 and Sept. 30 for the Florida and the northern Gulf of Mexico coastal regions and will be utilized for this Survey Plan.

Primary Data Collection

The primary objective of the survey is to collect data metrics that will characterize the seagrass community, including species composition, percent cover, seagrass bed configuration (patchiness), and preliminary water quality information to establish a baseline condition at the peak of the 2022 growing season. Patchiness will be evaluated by the relative connectivity to surrounding seagrass beds (continuous vs patchy) and the relative biomass per unit (patchy vs very patchy). As outlined in Dunton et al. (2010) at each randomly selected, fixed location, four stations will be sampled in each of the cardinal directions surrounding the vessel. The fixed station is to be navigated to with GPS accuracy of 4 meters or better. The station is identified as having a 10-meter radius, and the four locations are sampled within this circle. Basic water quality parameters are collected with a data sonde prior to deployment of any benthic sampling equipment. Species composition and percent cover will be evaluated in the field within a 0.25 m^2 quadrat outfitted with an underwater camera to document coverage within the quadrat. Additionally, the primary data metrics will be collected during the diver-verified fringe locations, described further below. A summary primary data metrics to be collected are described in Table 1.

Secondary Data Collection

Secondary seagrass composition and metrics could be collected at a subset of the locations identified for primary data collection. These secondary data metrics would provide baseline health information that will support the restoration planning phase of the Project design and post-construction restoration monitoring and Adaptive Management (MAM). Secondary data collection could occur at 13 of the established hexagons, or 10% of the sample locations, selected accordingly to assess conditions in the shallow areas, shoaling habitats, and deeper established seagrass meadows from the northern to the southern extent of the seagrass beds. The secondary data collection locations will be selected based on final Study Area design, described above. A summary of secondary data metrics to be collected are described in Table 1.

Table 1. Survey and Sampling Metrics

Metrics	Metrics	Equipment
Primary Data Collection		
Vessel Location	Date/Time	GPS unit (submeter accuracy)
	GPS location	Sounding rod
	Water depth	Underwater light sensor
	Light attenuation	Multi-probe sonde
	Water temperature, salinity, pH, dissolved oxygen	
	Distance from shoreline	
Stations (N, E, S, W)	Sediment type	.25 m^2 quad (with underwater camera)
	Species composition	Ruler
	Total percent cover	
	Percent cover by species	
	Canopy height	
	Shoot density	
Secondary Data Collection (subset)		
Vessel Location	Biomass (above/below)	Benthic corer
	Root:shoot ratio	

2.4 Peak-Season Fringe Mapping: Remote Sensing

In order to capture the full coverage of the seagrass beds at peak or near-peak growing season (i.e. later than the May aerial photographs) and delineate the dense and patchy seagrass habitats, SWCA will obtain 50-cm resolution satellite data from Planet Labs SkySat for an approximately 105-sq km area encapsulating the known 2010 and 2011 seagrass and Study Area extent. Considering the size of Survey Area, the use of aerial imagery is a cost-effective and more precise method for delineating seagrass fringe habitat than diver delineated methods. Obtaining the aerial imagery prior to field survey will allow for spot checking in the field rather than swimming the full edge of the Survey Area. Divers will collect the primary data metrics, as outlined in Table 1, and will collect additional light attenuation measurements at depth, mid-water column, and subsurface to provide additional information to characterize that edge habitat.

2.5 Data Analysis

Aerial data interpretation will utilize colorimetric signatures to differentiate and delineate the various seagrass habitats including continuous and dense coverage, patchy coverage, sand bottom indicating no seagrass.

For standardization and rapid assessment of seagrass coverage, each of the quadrats will be scored utilizing the Braun-Blanquet classes (Dunton et al., 2010; Fourqurean et al., 2001) where the percent cover of seagrass may be visually assessed and reported to the nearest 5% or reported using the Braun-Blanquet cover-abundance scores. The abundance score for each species present within the quadrats will be scored.

ArcGIS software will be used to manage, analyze, and display water quality and seagrass data using techniques such as kriging interpolation. This process allows for accurate depiction of changes over a relatively small area and allows for the development of visually clear map products.

3 DELIVERABLES

SWCA will provide survey polygons and data mapping products as KMZs, shapefiles, required format.

SWCA will provide a Seagrass Bed Survey Report summarizing survey protocol, survey results, and data analysis including text, data tables, and maps and figures which will be provided in PDF format along with electronic files of all pictures, field notes, and data sheets.

SWCA will set up and maintain a GIS platform (SWCA AI Platform) to evaluate in near real-time field data collection updates and compare between the 2022 aerial survey data, the 2010/2011 aerial imagery, and NASA imagery.

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Appendix B

Water Quality Data By Location

Table B-1. Water quality data by location at 0.3 m

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C101	9/22/2022	10:45	0.8	0.8	29.6	53.8	58.6	35.4	105.3	6.56	8.63
C102	9/22/2022	10:09	1.8	1.8	29.3	37.68	--	23.78	123.8	8.38	8.5
C103	9/22/2022	11:55	1	1	30.4	35.18	--	22.02	147.7	9.88	8.74
C105	9/22/2022	10:37	1.4	1.4	29.5	37.52	--	25.37	124.1	8.33	8.51
C106	9/22/2022	8:48	2.7	2.7	28.8	37.27	--	23.51	128.8	8.73	8.37
C107	9/22/2022	11:05	0.6	0.6	30.4	34.44	--	34.51	126	8.36	8.56
C109	9/21/2022	13:04	1.5	1.5	29.7	37.42	--	23.59	139.0	9.26	8.53
C110	9/21/2022	9:00	2.6	2.6	28.2	37.32	--	23.56	114.3	7.84	8.27
C111	9/21/2022	12:02	0.6	0.6	30.0	34.92	--	21.85	123.4	8.30	8.54
C113	9/21/2022	11:42	0.9	0.9	29.4	36.93	--	23.28	113.5	7.63	8.47
C114	9/21/2022	13:03	1.7	1.7	29.2	52.60	56.70	34.50	117.1	7.40	8.54
C115	9/21/2022	10:24	1.0	1.0	28.8	36.88	--	23.24	100.8	6.86	8.41
C117	9/21/2022	10:54	1.2	1.2	28.2	52.20	55.40	34.20	74.1	4.81	8.33
C119	9/21/2022	10:24	0.8	0.8	28.2	53.3	56.5	35.0	43.2	2.74	8.15
C121	9/21/2022	9:26	0.9	0.9	28.2	52.2	55.4	34.23	93.3	5.96	8.4
C123	9/21/2022	9:50	1.3	1.3	28.4	52.60	56.00	34.54	99.8	6.43	8.46
C125	9/20/2022	12:49	1.4	1.4	29.3	37.78	--	23.86	151.4	10.20	8.54
C126	9/20/2022	13:11	2.6	0.8	29	37.8	--	23.87	132.7	8.97	8.44
C127	9/20/2022	12:15	0.9	--	29.9	36.92	--	23.24	147.9	9.89	8.67
C129	9/20/2022	10:20	1.1	1.1	27.7	37.47	--	23.68	80	5.51	8.17
C130	9/20/2022	9:25	>3	2.4	28.5	38.08	--	24.09	125.6	8.62	8.36
C133	9/20/2022	12:44	1.0	1.0	29.0	52.60	56.70	34.45	145.6	9.27	8.61
C134	9/20/2022	10:03	2.3	2.2	28.1	53.6	56.7	35.1	85.3	5.26	8.52
C136	9/20/2022	9:00	2.4	2.4	28.1	54.1	57.3	E	101	6.56	8.43
C137	9/20/2022	10:54	1.9	1.2	28.3	53.4	56.9	35.15	99.3	6.39	8.44

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C138	9/19/2022	11:45	1.4	1.4	27.7	52.20	54.90	34.30	94.4	6.20	8.54
C141	9/19/2022	1:31	0.2	0.2	33.2	46.00	53.50	30.66	206.7	14.42	9.09
C142	9/19/2022	10:48	1.7	1.7	28.5	52.10	55.60	34.24	93.6	6.01	8.40
C143	9/19/2022	9:21	2.5	2.5	28.2	42.32	44.99	27.08	95.5	6.40	8.32
C145	9/19/2022	11:35	0.05	0.05	32	39.09	--	24.5	140.5	9.13	8.34
C146	9/19/2022	9:46	1	--	28.5	37.37	--	23.52	103	7.04	8.54
C148	9/19/2022	9:00	1.9	1.9	28.3	38.04	--	24.07	119.3	8.16	8.31
C149	9/19/2022	10:25	0.4	0.4	28.5	38.93	--	24.69	105.2	7.12	8.36
C150	9/18/2022	10:20	1.7	1.7	26.8	37.05	--	23.41	91.6	6.35	8.34
C152	9/18/2022	9:15	2.5	2.5	27.8	38.44	--	24.39	90.7	6.24	8.17
C153	9/18/2022	13:45	0.1	0.1	34.2	38.91	--	24.54	201.2	12.47	8.73
C155	9/18/2022	12:10	0.9	0.9	27.6	38.3	--	24.07	133.6	9.27	8.44
C156	9/18/2022	15:32	1.2	1.2	29.0	41.77	46.00	26.68	137.2	9.24	8.66
C159	9/18/2022	15:03	0.5	0.5	34.4	42.70	50.40	27.10	136.5	8.20	8.60
C160	9/18/2022	10:28	1.3	1.3	27.0	42.15	43.81	27.00	82.8	5.63	8.45
C161	9/18/2022	9:42	1.0	1.0	27.1	41.96	43.62	26.80	72.8	4.91	8.52
C165	9/15/2022	14:50	0.5	--	29.5	40.27	43.78	25.61	104.5	6.92	8.32
C30	9/25/2022	11:32	0.9	0.9	29.6	62.2	67.6	E	96.5	5.8	8.4
C32	9/25/2022	--	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	1.4	1.4	29.2	59.6	64.4	E	109.5	67.5	8.45
C41	9/24/2022	11:21	2	1.3	29.1	39.63	--	25.15	122.4	8.22	8.36
C43	9/25/2022	10:52	2.4	1.3	29.3	61.5	66.5	E	103.4	6.3	8.5
C48	9/24/2022	--	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	0.3	0.3	29.1	39.24	--	24.88	126.3	8.47	8.4
C60	9/24/2022	10:30	0.6	0.6	28.3	38.435	--	24.33	108.8	7.43	8.47
C64	9/24/2022	9:37	1	1	28.9	38.319	--	24.24	108.6	7.34	8.44

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C67	9/24/2022	9:00	2.8	1.7	28.9	38.32	--	24.25	123.8	8.4	8.43
C68	9/24/2022	10:00	0.6	0.6	28.6	38.083	--	24.09	118.1	8.01	8.43
C72	9/24/2022	12:18	1.5	1.3	29.6	58.6	63.7	E	111.6	6.9	8.6
C76	9/24/2022	11:52	0.7	0.7	29.7	57.4	62.5	E	185.4	11.3	8.9
C80	9/24/2022	12:45	1.7	1.5	29.6	58.3	63.4	E	118.8	7.38	8.6
C81	9/24/2022	11:17	0.8	0.8	29	67.7	62.1	E	113	7.1	8.6
C84	9/24/2022	--	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	1.7	1.7	29.3	58.3	63.1	28.7	105.8	6.6	8.6
C88	9/24/2022	9:57	1.8	1.8	28.9	58.3	62.6	E	92.1	5.75	8.5
C89	9/24/2022	10:30	0.8	0.8	28.2	56.2	59.6	E	87	5.5	8.66
C91	9/24/2022	--	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	0.6	0.6	30.8	54	60	35.49	176.1	10.82	8.79
C94	9/22/2022	14:24	1.8	1.8	30.5	55.7	61.6	E	123	7.58	8.54
C96	9/22/2022	--	--	--	--	--	--	--	--	--	--
C97	9/22/2022	9:50	2.1	2.1	29	55.7	59.4	E	110.4	6.9	8.54
C98	9/22/2022	9:10	2.6	1.8	29.2	55.5	59.1	E	21.7	7.5	8.54
C99	9/22/2022	10:18	0.8	0.8	29	54	58.1	35.53	87.2	5.45	8.48
S201	9/25/2022	--	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	1.4	1.4	29.1	61.90	66.80	E	96.3	5.89	8.41
S203	9/25/2022	--	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	2.5	2.3	29.1	60.40	65.20	E	102.0	6.30	8.40
S205	9/25/2022	12:11	2.0	1.4	29.4	57.20	62.10	E	115.8	7.17	8.45
S206	9/25/2022	10:39	2.2	1.7	29.0	60.80	65.50	E	101.0	6.20	8.44
S207	9/24/2022	11:48	2	2	29.1	39.8	--	25.28	128.8	8.75	8.4
S208	9/25/2022	10:30	1.8	1.4	28.9	62.30	66.90	E	100.8	6.14	8.24
S209	9/24/2022	11:58	2.1	--	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1.4	1.4	29.7	57.70	62.80	E	106.7	6.60	8.48

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S211	9/24/2022	12:11	2.2	1.3	29.9	38.39	--	24.27	136	9.05	8.53
S212	9/24/2022	14:26	1.7	1.7	30.6	37.971	--	23.95	154.8	10.2	8.57
S213	9/25/2022	12:45	1.3	1.3	29.6	58.00	63.20	E	105.2	6.50	8.48
S214	9/24/2022	14:46	1.3	1.3	30.3	37.86	--	23.89	148.6	9.82	8.55
S215	9/24/2022	12:30	2.3	1.7	30.1	38.04	--	24.02	1.4	1.3	8.56
S216	9/24/2022	12:41	>3	--	--	--	--	--	--	--	--
S217	9/24/2022	15:17	0.4	0.4	30.4	37.44	--	23.59	139.7	9.26	8.51
S218	9/24/2022	14:55	1.7	1.7	29.9	58.8	64.4	E	112.9	6.9	8.58
S219	9/24/2022	--	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	1.7	1.7	29.4	58.3	63.1	E	116.4	7.2	8.59
S221	9/24/2022	--	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	1.4	1.4	29.7	57.5	62.6	E	111.6	7	8.55
S223	9/24/2022	10:53	1.7	1.7	28.8	58.6	67.8	E	74.6	4.6	8.5
S224	9/24/2022	--	--	--	--	--	--	--	--	--	--
S225	9/22/2022	13:50	0.3	0.3	32.9	53.4	61.5	25	140.7	8.37	8.44
S226	9/22/2022	13:04	0.8	0.8	31.5	53.4	60	35	118.4	7.15	8.45
S227	9/22/2022	11:10	0.4	0.4	29.7	51.6	56.2	33.8	30.9	2.06	8.06
S228	9/22/2022	9:19	2.2	2.2	28.9	37.68	--	23.8	126.5	8.59	8.48
S229	9/22/2022	9:48	2.1	2.1	29.2	37.759	--	23.84	137	9.22	8.55
S230	9/22/2022	--	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1.1	1.0	29.8	35.48	--	22.30	131.9	8.88	8.64
S234	9/21/2022	--	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	1.6	1.6	27.9	37.49	--	23.68	101.5	6.91	8.33
S237	9/20/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S238	9/21/2022	--	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1.8	1.8	29.2	52.9	57.1	34.73	97.5	6.1	8.4
S240	9/20/2022	--	--	--	--	--	--	--	--	--	--
S241	9/21/2022	11:48	0.2	0.2	29.2	50.3	54.3	32.76	110.0	7.00	8.42
S242	9/21/2022	--	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	0.7	0.6	29.2	51.30	55.50	33.60	60.5	3.80	8.12
S246	9/20/2022	11:32	0.9	0.9	29.6	37.04	--	23.33	121.6	8.18	8.5
S247	9/20/2022	--	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	0.3	0.3	29.6	36.822	--	23.18	123.7	8.34	8.44
S249	9/20/2022	13:26	0.6	0.6	30.6	48.1	53.3	31.25	103.8	6.55	8.49
S250	9/20/2022	--	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--	--
S252	9/20/2022	--	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	0.3	0.3	31.7	47.7	54	31.26	143.9	8.97	8.49
S254	9/19/2022	--	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1.6	1.6	29.6	51.20	55.70	33.49	128.8	8.21	8.56
S257	9/19/2022	14:40	0.27	--	33.2	38.84	--	24.49	215.8	13.63	8.65
S258	9/19/2022	13:35	1.2	--	29.2	36.98	--	23.31	147.8	10.00	8.64
S259	9/19/2022	14:45	1.4	1.4	29.9	51.50	56.20	33.66	105.7	9.26	8.46
S260	9/19/2022	14:13	0.11	--	34.7	39.58	--	24.96	202.7	12.42	8.47
S261	9/19/2022	10:50	0.3	0.3	28.7	39.27	--	24.92	125.1	8.48	8.49
S262	9/18/2022	14:26	0.4	0.4	35.1	39.20	--	24.68	200.6	12.23	8.66
S263	9/18/2022	12:58	0.3	0.3	30.3	38.51	--	24.34	124.3	8.24	8.33
S264	9/18/2022	14:19	0.9	0.9	29.6	42.17	45.92	26.97	122.1	8.11	8.54

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S265	9/18/2022	--	--	--	--	--	--	--	--	--	--
S266	9/18/2022	12:47	0.1	0.1	33.4	42.17	48.96	26.80	122.9	7.36	8.56
S267	9/18/2022	11:43	0.3	0.3	29.7	42.62	46.52	27.28	153.2	9.76	8.6
S268	9/15/2022	--	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	2.0	1.4	28.9	42.10	44.44	26.83	98.6	6.52	8.31
S272	9/15/2022	--	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--	--

E = outlier readings; potential sensor error

Table B-2. Water quality data by location at 1.0 m

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C101	9/22/2022	10:45	0.8	0.8	--	--	--	--	--	--	--
C102	9/22/2022	10:09	1.8	1.8	29.2	37.69	--	23.79	124.3	8.36	8.49
C103	9/22/2022	11:55	1	1	--	--	--	--	--	--	--
C105	9/22/2022	10:37	1.4	1.4	29.5	37.53	--	23.68	126.3	8.48	8.51
C106	9/22/2022	8:48	2.7	2.7	28.9	37.26	--	23,50	129.4	8.77	8.39
C107	9/22/2022	11:05	0.6	0.6	--	--	--	--	--	--	--
C109	9/21/2022	13:04	1.5	1.5	29.7	37.40	--	23.57	144.4	9.66	8.5
C110	9/21/2022	9:00	2.6	2.6	28.3	37.31	--	23.55	114.9	7.86	8.29
C111	9/21/2022	12:02	0.6	0.6	--	--	--	--	--	--	--
C113	9/21/2022	11:42	0.9	0.9	--	--	--	--	--	--	--
C114	9/21/2022	13:03	1.7	1.7	29.0	53.30	57.40	35.00	117.8	7.50	8.54
C115	9/21/2022	10:24	1.0	1.0	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C117	9/21/2022	10:54	1.2	1.2	28.2	52.20	55.40	34.26	70.1	4.50	8.34
C119	9/21/2022	10:24	0.8	0.8	--	--	--	--	--	--	--
C121	9/21/2022	9:26	0.9	0.9	--	--	--	--	--	--	--
C123	9/21/2022	9:50	1.3	1.3	28.2	53.30	56.70	35.10	86.5	5.63	8.39
C125	9/20/2022	12:49	1.4	1.4	29.1	37.79	--	23.86	153.2	10.32	8.54
C126	9/20/2022	13:11	2.6	0.8	29	38.22	--	24.17	141.5	9.58	8.48
C127	9/20/2022	12:15	0.9	--	--	--	--	--	--	--	--
C129	9/20/2022	10:20	1.1	1.1	--	--	--	--	--	--	--
C130	9/20/2022	9:25	>3	2.4	28.5	38.09	--	24.09	128.1	8.71	8.37
C133	9/20/2022	12:44	1.0	1.0	--	--	--	--	--	--	--
C134	9/20/2022	10:03	2.3	2.2	28.3	54.5	57.7	35.8	96.7	6.23	8.49
C136	9/20/2022	9:00	2.4	2.4	28.1	56.1	59.4	E	103.1	6.59	8.44
C137	9/20/2022	10:54	1.9	1.2	28.4	53.7	57.2	35.22	99.4	6.51	8.44
C138	9/19/2022	11:45	1.4	1.4	27.7	53.40	56.20	35.15	92.2	6.08	8.54
C141	9/19/2022	1:31	0.2	0.2	--	--	--	--	--	--	--
C142	9/19/2022	10:48	1.7	1.7	28.5	54.40	58.10	35.91	109.5	6.84	8.45
C143	9/19/2022	9:21	2.5	2.5	28.3	42.45	45.11	27.19	94.7	6.41	8.32
C145	9/19/2022	11:35	0.05	0.05	--	--	--	--	--	--	--
C146	9/19/2022	9:46	1	--	--	--	--	--	--	--	--
C148	9/19/2022	9:00	1.9	1.9	28.3	38.07	--	24.08	120	8.2	8.33
C149	9/19/2022	10:25	0.4	0.4	--	--	--	--	--	--	--
C150	9/18/2022	10:20	1.7	1.7	27.5	37.20	--	23.50	92.3	6.42	8.34
C152	9/18/2022	9:15	2.5	2.5	27.8	38.53	--	24.42	90.5	6.22	8.18
C153	9/18/2022	13:45	0.1	0.1	--	--	--	--	--	--	--
C155	9/18/2022	12:10	0.9	0.9	--	--	--	--	--	--	--
C156	9/18/2022	15:32	1.2	1.2	29.1	41.99	45.24	26.84	153.6	10.28	8.71
C159	9/18/2022	15:03	0.5	0.5	--	--	--	--	--	--	--
C160	9/18/2022	10:28	1.3	1.3	27.1	42.32	44.05	27.13	91.4	6.03	8.47

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (μs/cm)	Conductivity (μs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C161	9/18/2022	9:42	1.0	1.0	--	--	--	--	--	--	--
C165	9/15/2022	14:50	0.5	--	--	--	--	--	--	--	--
C30	9/25/2022	11:32	0.9	0.9	--	--	--	--	--	--	--
C32	9/25/2022	--	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	1.4	1.4	29	60.2	64.8	E	109	6.72	8.44
C41	9/24/2022	11:21	2	1.3	29.1	39.66	--	25.18	123.4	8.3	8.37
C43	9/25/2022	10:52	2.4	1.3	29.2	61.7	66.6	E	102.7	2.3	8.5
C48	9/24/2022	--	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	0.3	0.3	--	--	--	--	--	--	--
C60	9/24/2022	10:30	0.6	0.6	--	--	--	--	--	--	--
C64	9/24/2022	9:37	1	1	28	38.329	--	24.25	109	7.36	8.43
C67	9/24/2022	9:00	2.8	1.7	28	39.05	--	24.77	120.3	8.14	8.36
C68	9/24/2022	10:00	0.6	0.6	--	--	--	--	--	--	--
C72	9/24/2022	12:18	1.5	1.3	29.4	58.4	63.2	E	115.9	7.2	8.6
C76	9/24/2022	11:52	0.7	0.7	--	--	--	--	--	--	--
C80	9/24/2022	12:45	1.7	1.5	29.6	58.4	63.5	E	114.9	7.08	8.6
C81	9/24/2022	11:17	0.8	0.8	--	--	--	--	--	--	--
C84	9/24/2022	--	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	1.7	1.7	28.8	58.8	63	E	85.5	5.3	8.6
C88	9/24/2022	9:57	1.8	1.8	28.6	59	63	E	94	5.9	8.5
C89	9/24/2022	10:30	0.8	0.8	--	--	--	--	--	--	--
C91	9/24/2022	--	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	0.6	0.6	--	--	--	--	--	--	--
C94	9/22/2022	14:24	1.8	1.8	30	57.2	62.6	E	130.1	7.9	8.58
C96	9/22/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
C97	9/22/2022	9:50	2.1	2.1	29	55.7	60	E	106.7	6.6	8.54
C98	9/22/2022	9:10	2.6	1.8	29.2	55.8	60.2	E	113.5	7.4	8.54
C99	9/22/2022	10:18	0.8	0.8	--	--	--	--	--	--	--
S201	9/25/2022	--	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	1.4	1.4	29.2	62.30	67.30	E	97.6	5.96	8.41
S203	9/25/2022	--	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	2.5	2.3	29.0	60.80	65.50	E	101.3	6.24	8.40
S205	9/25/2022	12:11	2.0	1.4	29.4	58.00	63.00	E	116.4	7.20	8.45
S206	9/25/2022	10:39	2.2	1.7	28.9	61.60	66.10	E	98.9	6.10	8.45
S207	9/24/2022	11:48	2	2	29.1	39.79	--	25.28	128.3	8.86	8.4
S208	9/25/2022	10:30	1.8	1.4	28.8	62.50	67.00	E	99.5	6.10	8.42
S209	9/24/2022	11:58	2.1	--	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1.4	1.4	29.4	58.30	63.30	E	107.3	6.61	8.49
S211	9/24/2022	12:11	2.2	1.3	29.7	39.16	--	24.83	127.7	8.5	8.43
S212	9/24/2022	14:26	1.7	1.7	30.6	37.973	--	23.96	156.7	10.3	8.56
S213	9/25/2022	12:45	1.3	1.3	29.7	57.90	63.10	E	102.9	6.33	8.49
S214	9/24/2022	14:46	1.3	1.3	30.3	37.86	--	23.89	150.2	9.9	8.54
S215	9/24/2022	12:30	2.3	1.7	30	38.22	--	24.16	137.9	9.22	8.54
S216	9/24/2022	12:41	>3	--	--	--	--	--	--	--	--
S217	9/24/2022	15:17	0.4	0.4	--	--	--	--	--	--	--
S218	9/24/2022	14:55	1.7	1.7	29.9	59.4	65	E	114	7	8.58
S219	9/24/2022	--	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	1.7	1.7	29.1	59.1	63.7	E	115.5	7.1	8.58
S221	9/24/2022	--	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	1.4	1.4	29.3	58.5	63.3	E	114.4	7	8.54
S223	9/24/2022	10:53	1.7	1.7	28.9	58.2	62.4	E	83.8	5.2	8.5
S224	9/24/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S225	9/22/2022	13:50	0.3	0.3	--	--	--	--	--	--	--
S226	9/22/2022	13:04	0.8	0.8	--	--	--	--	--	--	--
S227	9/22/2022	11:10	0.4	0.4	--	--	--	--	--	--	--
S228	9/22/2022	9:19	2.2	2.2	28.9	37.69	--	23.8	129.1	8.72	8.47
S229	9/22/2022	9:48	2.1	2.1	29.2	37.767	--	23.85	137.7	9.24	8.54
S230	9/22/2022	--	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1.1	1.0	29.7	35.55	--	22.29	155.0	10.51	8.71
S234	9/21/2022	--	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	1.6	1.6	28.1	37.50	--	23.69	100.7	6.91	8.33
S237	9/20/2022	--	--	--	--	--	--	--	--	--	--
S238	9/21/2022	--	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1.8	1.8	28.8	53.2	57.1	35.1	97.8	6.1	8.4
S240	9/20/2022	--	--	--	--	--	--	--	--	--	--
S241	9/21/2022	11:48	0.2	0.2	--	--	--	--	--	--	--
S242	9/21/2022	--	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	0.7	0.6	--	--	--	--	--	--	--
S246	9/20/2022	11:32	0.9	0.9	--	--	--	--	--	--	--
S247	9/20/2022	--	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	0.3	0.3	--	--	--	--	--	--	--
S249	9/20/2022	13:26	0.6	0.6	--	--	--	--	--	--	--
S250	9/20/2022	--	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water depth (m)	Secchi (m)	Water Temp (°C)	Sp. Cond. (µs/cm)	Conductivity (µs/cm)	Salinity (ppt)	DO (%)	DO (mg/L)	pH
S252	9/20/2022	--	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	0.3	0.3	--	--	--	--	--	--	--
S254	9/19/2022	--	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1.6	1.6	29.4	53.00	57.50	34.80	142.3	9.00	8.57
S257	9/19/2022	14:40	0.27	--	--	--	--	--	--	--	--
S258	9/19/2022	13:35	1.2	--	--	--	--	--	--	--	--
S259	9/19/2022	14:45	1.4	1.4	29.7	52.30	57.10	34.30	168.2	10.50	8.69
S260	9/19/2022	14:13	0.11	--	--	--	--	--	--	--	--
S261	9/19/2022	10:50	0.3	0.3	--	--	--	--	--	--	--
S262	9/18/2022	14:26	0.4	0.4	--	--	--	--	--	--	--
S263	9/18/2022	12:58	0.3	0.3	--	--	--	--	--	--	--
S264	9/18/2022	14:19	0.9	0.9	--	--	--	--	--	--	--
S265	9/18/2022	--	--	--	--	--	--	--	--	--	--
S266	9/18/2022	12:47	0.1	0.1	--	--	--	--	--	--	--
S267	9/18/2022	11:43	0.3	0.3	--	--	--	--	--	--	--
S268	9/15/2022	--	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	2.0	1.4	28.2	41.78	44.30	26.72	95.3	6.55	8.32
S272	9/15/2022	--	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--	--

E = outlier readings; potential sensor error

Table B-3. Water quality data by location for PAR

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
C101	9/22/2022	10:45	1152.5	1141.9	1182.9	1166.2	1175.2	--	--	--	--	--
C102	9/22/2022	10:09	997.6	1102.9	967.7	1039.5	910.7	636.4	620.5	625.7	634.2	661.2
C103	9/22/2022	11:55	1337.6	1303.6	1298.5	1301.5	1310.0	944.1	908.2	884.6	885.5	845.2
C105	9/22/2022	10:37	1059.7	1150.8	1097.7	1098.7	1099.0	813.1	687.7	793.0	902.5	831.5
C106	9/22/2022	8:48	704.4	724.1	778.5	811.4	820.0	558.9	557.5	504.6	527.7	529.8
C107	9/22/2022	11:05	1346.6	1331.4	1286.5	1279.7	1294.2	--	--	--	--	--
C109	9/21/2022	13:04	1444.4	1403.3	1425.6	1446.6	1405.5	939.4	916.3	945.8	987.7	920.6
C110	9/21/2022	9:00	348.9	340.4	332.4	333.6	330.4	230.2	231.5	238.8	242.4	238.6
C111	9/21/2022	12:02	687.3	1046.0	870.5	1079.8	927.8	631.7	762.2	588.8	452.0	477.5
C113	9/21/2022	11:42	734.8	1462.4	684.3	600.8	609.8	324.4	299.6	289.5	294.5	308.3
C114	9/21/2022	13:03	1074.2	1123.0	998.5	930.8	870.5	820.0	824.7	934.2	939.4	908.2
C115	9/21/2022	10:24	372.0	390.2	411.8	401.0	412.8	202.2	213.7	222.0	175.8	162.8
C117	9/21/2022	10:54	1264.2	1143.1	1166.7	1165.0	1168.4	901.3	901.7	909.9	916.3	888.9
C119	9/21/2022	10:24	1137.5	1079.4	1090.5	1097.3	1146.1	--	--	--	--	--
C121	9/21/2022	9:26	1101.6	1072.1	1215.0	1187.2	1162.8	751.9	744.2	665.9	712.1	685.6
C123	9/21/2022	9:50	868.8	832.4	955.2	913.3	1000.6	644.9	598.0	552.6	547.6	550.5
C125	9/20/2022	12:49	1503.1	1393.1	1494.5	1344.7	1358.4	990.3	954.8	927.8	910.7	841.4
C126	9/20/2022	13:11	1468.0	1438.4	1477.0	1447.5	1405.5	966.4	906.9	937.2	895.3	919.3
C127	9/20/2022	12:15	1530.9	1462.8	1422.2	1452.1	1466.7	1150.4	1180.4	1190.2	1177.4	1196.2
C129	9/20/2022	10:20	1228.3	1182.5	1158.5	1189.8	1144.4	752.8	719.0	699.7	749.8	740.4
C130	9/20/2022	9:25	857.7	908.2	922.7	914.6	952.2	615.8	615.0	615.0	621.4	628.2
C133	9/20/2022	12:44	1329.7	1294.2	1211.8	1159.0	1155.1	763.5	754.9	816.6	783.6	774.2
C134	9/20/2022	10:03	1206.0	1016.9	1059.2	1220.6	1233.0	763.9	711.3	661.2	665.9	659.6
C136	9/20/2022	9:00	680.0	608.6	595.3	611.5	642.8	417.9	423.8	424.0	407.3	414.3
C137	9/20/2022	10:54	1000.6	1087.9	1167.1	1129.0	1129.0	594.9	624.0	624.0	630.8	592.3
C138	9/19/2022	11:45	1072.5	1076.8	1073.8	1040.0	1011.3	481.8	491.4	501.8	484.6	473.4

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
C141	9/19/2022	1:31	1025.0	1029.3	1053.7	1043.8	1031.4	--	--	--	--	--
C142	9/19/2022	10:48	1188.9	1090.9	1059.7	1058.4	1048.8	658.2	681.3	679.6	582.0	595.6
C143	9/19/2022	9:21	1508.6	1485.5	1448.7	1349.0	1408.9	969.8	1003.2	1006.6	1009.5	1001.5
C145	9/19/2022	11:35	--	--	--	--	--	--	--	--	--	--
C146	9/19/2022	9:46	816.6	801.2	805.2	802.0	771.6	548.6	557.2	573.9	590.6	592.7
C148	9/19/2022	9:00	812.7	817.9	801.6	815.7	847.4	456.6	468.6	453.2	470.5	467.5
C149	9/19/2022	10:25	1171.8	1178.2	1121.3	1156.8	1130.7	--	--	--	--	--
C150	9/18/2022	10:20	1065.0	1071.0	1011.0	938.6	988.7	787.3	782.2	743.8	739.7	768.5
C152	9/18/2022	9:15	943.3	861.0	777.9	795.9	777.5	592.7	573.8	552.0	543.8	195.3
C153	9/18/2022	13:45	1491.5	1458.4	1641.8	1420.3	1119.5	--	--	--	--	--
C155	9/18/2022	12:10	1398.1	1451.6	1317.9	1400.2	1463.6	--	--	--	--	--
C156	9/18/2022	15:32	786.0	759.0	765.5	745.7	641.6	452.9	447.3	435.5	387.2	446.8
C159	9/18/2022	15:03	843.4	828.0	822.4	790.3	709.7	--	--	--	--	--
C160	9/18/2022	10:28	739.5	772.9	769.5	756.6	719.8	417.8	404.4	450.3	401.9	357.4
C161	9/18/2022	9:42	616.7	643.7	656.9	673.2	718.1	--	--	--	--	--
C165	9/15/2022	14:50	946.3	973.7	836.2	1152.5	1221.5	--	--	--	--	--
C30	9/25/2022	11:32	1405.5	1372.5	1309.7	1296.8	1523.3	849.1	859.8	936.4	931.2	922.3
C32	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	--	--	--	--	--	--	--	--	--	--
C41	9/24/2022	11:21	1087.0	1236.1	1229.1	126.6	1231.3	875.6	867.1	833.7	825.1	822.6
C43	9/25/2022	10:52	--	--	--	--	--	--	--	--	--	--
C48	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	1560.8	1475.2	1465.4	1483.8	1462.8	--	--	--	--	--
C60	9/24/2022	10:30	952.2	930.8	976.2	957.0	945.0	--	--	--	--	--
C64	9/24/2022	9:37	780.0	778.5	781.9	800.3	790.5	420.2	411.0	414.6	410.5	412.2
C67	9/24/2022	9:00	782.8	827.7	772.5	755.8	728.8	428.4	489.2	490.9	484.0	483.3

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
C68	9/24/2022	10:00	796.9	853.8	852.5	849.5	871.8	--	--	--	--	--
C72	9/24/2022	12:18	--	--	--	--	--	--	--	--	--	--
C76	9/24/2022	11:52	--	--	--	--	--	--	--	--	--	--
C80	9/24/2022	12:45	--	--	--	--	--	--	--	--	--	--
C81	9/24/2022	11:17	--	--	--	--	--	--	--	--	--	--
C84	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	--	--	--	--	--	--	--	--	--	--
C88	9/24/2022	9:57	--	--	--	--	--	--	--	--	--	--
C89	9/24/2022	10:30	--	--	--	--	--	--	--	--	--	--
C91	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	1270.2	1224.4	1227.0	1270.6	1228.7	--	--	--	--	--
C94	9/22/2022	14:24	1496.6	1489.0	1474.4	1508.6	1478.7	984.7	926.1	906.9	986.5	918.0
C96	9/22/2022	--	--	--	--	--	--	--	--	--	--	--
C97	9/22/2022	9:50	1467.1	1053.2	1138.0	1203.0	1235.1	687.3	702.7	716.8	730.1	706.1
C98	9/22/2022	9:10	1522.8	1309.5	1380.7	1481.2	1470.5	1183.8	1219.7	1176.9	1149.5	1180.8
C99	9/22/2022	10:18	1099.6	1135.4	1162.8	1123.4	1160.7	--	--	--	--	--
S201	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	--	--	--	--	--	--	--	--	--	--
S203	9/25/2022	--	--	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	1321.1	1315.2	1241.5	1241.5	1194.9	843.1	820.8	862.8	789.2	829.4
S205	9/25/2022	12:11	1061.8	876.1	578.2	1441.0	1419.2	867.5	774.6	909.9	659.5	642.0
S206	9/25/2022	10:39	1222.3	1226.6	1233.0	1212.9	1208.2	820.8	812.3	791.3	803.7	773.3
S207	9/24/2022	11:48	1136.2	1298.5	1261.2	1292.0	1220.6	933.0	942.8	924.4	1000.2	906.4
S208	9/25/2022	10:30	--	--	--	--	--	--	--	--	--	--
S209	9/24/2022	11:58	--	--	--	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1470.1	1434.1	1394.8	1462.0	1446.1	1012.6	1004.0	934.7	903.0	931.2
S211	9/24/2022	12:11	1341.7	1380.2	1345.6	1313.9	1295.5	897.9	873.1	900.0	864.1	840.1
S212	9/24/2022	14:26	932.1	974.1	1010.9	1108.5	1034.0	825.1	736.5	726.6	721.1	721.1

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
S213	9/25/2022	12:45	--	--	--	--	--	--	--	--	--	--
S214	9/24/2022	14:46	1000.6	984.7	964.7	1007.5	924.4	747.7	565.3	695.5	719.4	740.0
S215	9/24/2022	12:30	1314.3	1435.9	1407.4	1385.8	1393.1	1013.5	1028.0	993.3	1045.5	988.6
S216	9/24/2022	12:41	--	--	--	--	--	--	--	--	--	--
S217	9/24/2022	15:17	1049.8	1029.3	1065.2	912.0	1193.6	--	--	--	--	--
S218	9/24/2022	14:55	--	--	--	--	--	--	--	--	--	--
S219	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	--	--	--	--	--	--	--	--	--	--
S221	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	--	--	--	--	--	--	--	--	--	--
S223	9/24/2022	10:53	--	--	--	--	--	--	--	--	--	--
S224	9/24/2022	--	--	--	--	--	--	--	--	--	--	--
S225	9/22/2022	13:50	1223.1	1165.0	1169.2	1155.5	1133.7	--	--	--	--	--
S226	9/22/2022	13:04	1296.3	1223.6	1215.9	1221.9	1185.9	--	--	--	--	--
S227	9/22/2022	11:10	1114.9	891.9	1163.6	1158.5	1038.2	--	--	--	--	--
S228	9/22/2022	9:19	855.9	316.0	288.0	288.3	294.0	218.8	572.2	499.8	602.1	456.6
S229	9/22/2022	9:48	272.2	263.8	244.4	238.9	240.1	145.9	203.2	236.5	335.4	256.8
S230	9/22/2022	--	--	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1430.3	1405.0	1403.8	1350.3	1391.8	704.4	722.8	744.2	789.6	780.6
S234	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	444.9	485.3	712.1	695.9	663.8	401.5	432.7	384.7	225.6	218.8
S237	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S238	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1175.2	1174.8	1142.2	1138.8	1094.7	690.3	312.6	174.2	841.8	821.7
S240	9/20/2022	--	--	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
S241	9/21/2022	11:48	795.6	580.3	594.0	629.1	568.6	--	--	--	--	--
S242	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	897.5	973.6	944.1	972.4	963.4	448.4	292.6	360.4	425.7	248.9
S246	9/20/2022	11:32	1255.2	1227.5	1382.4	1372.5	1323.3	--	--	--	--	--
S247	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	1345.6	1325.0	1379.8	1321.1	1346.4	--	--	--	--	--
S249	9/20/2022	13:26	1345.1	1349.0	1348.5	1326.7	1318.2	--	--	--	--	--
S250	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S252	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	1266.4	1250.1	1256.5	1254.4	1253.5	--	--	--	--	--
S254	9/19/2022	--	--	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1528.3	1506.5	1505.6	1518.9	1492.0	1194.9	1203.9	1191.9	1182.5	1160.7
S257	9/19/2022	14:40	1400.8	1389.6	1419.2	1402.5	1381.9	--	--	--	--	--
S258	9/19/2022	13:35	1414.5	1456.8	1402.1	1413.6	1414.5	779.8	827.7	700.6	749.4	751.9
S259	9/19/2022	14:45	1294.2	1338.7	1375.5	1387.1	1325.0	1029.7	1016.9	1063.1	1049.4	1022.0
S260	9/19/2022	14:13	1377.2	1424.3	1563.4	1426.5	1464.1	--	--	--	--	--
S261	9/19/2022	10:50	1203.9	1219.3	1214.6	1313.0	1269.0	--	--	--	--	--
S262	9/18/2022	14:26	1170.0	1175.6	1218.9	1234.7	1236.9	--	--	--	--	--
S263	9/18/2022	12:58	1415.2	1446.5	1415.2	1399.8	1427.6	--	--	--	--	--
S264	9/18/2022	14:19	719.6	645.4	501.0	522.0	569.1	--	--	--	--	--
S265	9/18/2022	--	--	--	--	--	--	357.4	--	--	--	--
S266	9/18/2022	12:47	--	--	--	--	--	--	--	--	--	--
S267	9/18/2022	11:43	789.6	795.2	807.2	791.7	810.6	--	--	--	--	--

Station ID	Date	Time	PAR Surface (Io)					PAR Depth at 2ft=0.61 m (Iz)				
			Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
S268	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	1435.8	1399.3	1454.2	1425.0	1419.0	677.1	846.4	828.0	960.5	1013.5
S272	9/15/2022	--	--	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--	--	--

Table B-4. Calculated diffuse attenuation coefficient (K_d)

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C101	9/22/2022	10:45	0.8	--	--	--	--	--	--	--
C102	9/22/2022	10:09	1.8	0.45	0.58	0.44	0.49	0.32	0.46	0.08
C103	9/22/2022	11:55	1	0.35	0.36	0.38	0.39	0.44	0.38	0.03
C105	9/22/2022	10:37	1.4	0.26	0.51	0.33	0.20	0.28	0.32	0.11
C106	9/22/2022	8:48	2.7	0.23	0.26	0.43	0.43	0.44	0.36	0.09
C107	9/22/2022	11:05	0.6	--	--	--	--	--	--	--
C109	9/21/2022	13:04	1.5	0.43	0.43	0.41	0.38	0.42	0.41	0.02
C110	9/21/2022	9:00	2.6	0.42	0.39	0.33	0.32	0.33	0.36	0.04
C111	9/21/2022	12:02	0.6	0.08	0.32	0.39	0.87	0.66	0.47	0.27
C113	9/21/2022	11:42	0.9	0.82	1.59	0.86	0.71	0.68	0.93	0.33
C114	9/21/2022	13:03	1.7	0.27	0.31	0.07	-0.01	-0.04	0.12	0.14
C115	9/21/2022	10:24	1	0.61	0.60	0.62	0.82	0.93	0.72	0.14
C117	9/21/2022	10:54	1.2	0.34	0.24	0.25	0.24	0.27	0.27	0.04
C119	9/21/2022	10:24	0.82	--	--	--	--	--	--	--
C121	9/21/2022	9:26	0.9	0.38	0.37	0.60	0.51	0.53	0.48	0.09

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C123	9/21/2022	9:50	1.3	0.30	0.33	0.55	0.51	0.60	0.46	0.12
C125	9/20/2022	12:49	1.4	0.42	0.38	0.48	0.39	0.48	0.43	0.04
C126	9/20/2022	13:11	2.6	0.42	0.46	0.45	0.48	0.42	0.45	0.02
C127	9/20/2022	12:15	0.9	0.29	0.21	0.18	0.21	0.20	0.22	0.04
C129	9/20/2022	10:20	1.1	0.49	0.50	0.50	0.46	0.44	0.48	0.03
C130	9/20/2022	9:25	>3	0.33	0.39	0.41	0.39	0.42	0.39	0.03
C133	9/20/2022	12:44	0.95	0.55	0.54	0.39	0.39	0.40	0.46	0.07
C134	9/20/2022	10:03	2.3	0.46	0.36	0.47	0.61	0.63	0.50	0.10
C136	9/20/2022	9:00	2.4	0.49	0.36	0.34	0.41	0.44	0.41	0.05
C137	9/20/2022	10:54	1.9	0.52	0.56	0.63	0.58	0.65	0.59	0.05
C138	9/19/2022	11:45	1.4	0.80	0.78	0.76	0.76	0.76	0.77	0.02
C141	9/19/2022	1:31	0.2	--	--	--	--	--	--	--
C142	9/19/2022	10:48	1.7	0.59	0.47	0.44	0.60	0.57	0.53	0.06
C143	9/19/2022	9:21	2.5	0.44	0.39	0.36	0.29	0.34	0.37	0.05
C145	9/19/2022	11:35	0.05	--	--	--	--	--	--	--
C146	9/19/2022	9:46	1	0.40	0.36	0.34	0.31	0.26	0.33	0.05
C148	9/19/2022	9:00	1.9	0.58	0.56	0.57	0.55	0.59	0.57	0.02
C149	9/19/2022	10:25	0.4	--	--	--	--	--	--	--
C150	9/18/2022	10:20	1.7	0.30	0.31	0.31	0.24	0.25	0.28	0.03
C152	9/18/2022	9:15	2.5	0.46	0.41	0.34	0.38	1.38	0.60	0.40
C153	9/18/2022	13:45	0.14	--	--	--	--	--	--	--
C155	9/18/2022	12:10	0.9	--	--	--	--	--	--	--
C156	9/18/2022	15:32	1.2	0.55	0.53	0.56	0.66	0.36	0.53	0.10
C159	9/18/2022	15:03	0.5	--	--	--	--	--	--	--
C160	9/18/2022	10:28	1.3	0.57	0.65	0.54	0.63	0.70	0.62	0.06
C161	9/18/2022	9:42	1	--	--	--	--	--	--	--
C165	9/15/2022	14:50	0.5	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C30	9/25/2022	11:32	0.9	0.50	0.47	0.34	0.33	0.50	0.43	0.08
C32	9/25/2022	--	--	--	--	--	--	--	--	--
C33	9/25/2022	--	--	--	--	--	--	--	--	--
C36	9/25/2022	--	--	--	--	--	--	--	--	--
C38	9/25/2022	12:55	1.4	--	--	--	--	--	--	--
C41	9/24/2022	11:21	2	0.22	0.35	0.39	0.43	0.40	0.36	0.07
C43	9/25/2022	10:52	2.4	--	--	--	--	--	--	--
C48	9/24/2022	--	--	--	--	--	--	--	--	--
C52	9/24/2022	10:50	0.3	--	--	--	--	--	--	--
C60	9/24/2022	10:30	0.6	--	--	--	--	--	--	--
C64	9/24/2022	9:37	1	0.62	0.64	0.63	0.67	0.65	0.64	0.02
C67	9/24/2022	9:00	2.8	0.60	0.53	0.45	0.45	0.41	0.49	0.07
C68	9/24/2022	10:00	0.6	--	--	--	--	--	--	--
C72	9/24/2022	12:18	1.5	--	--	--	--	--	--	--
C76	9/24/2022	11:52	0.7	--	--	--	--	--	--	--
C80	9/24/2022	12:45	1.7	--	--	--	--	--	--	--
C81	9/24/2022	11:17	0.8	--	--	--	--	--	--	--
C84	9/24/2022	--	--	--	--	--	--	--	--	--
C85	9/24/2022	11:33	1.7	--	--	--	--	--	--	--
C88	9/24/2022	9:57	1.8	--	--	--	--	--	--	--
C89	9/24/2022	10:30	0.8	--	--	--	--	--	--	--
C91	9/24/2022	--	--	--	--	--	--	--	--	--
C92	9/22/2022	12:43	0.6	--	--	--	--	--	--	--
C94	9/22/2022	14:24	1.8	0.42	0.47	0.49	0.42	0.48	0.46	0.03
C96	9/22/2022	--	--	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
C97	9/22/2022	9:50	2.1	0.76	0.40	0.46	0.50	0.56	0.54	0.12
C98	9/22/2022	9:10	2.6	0.25	0.07	0.16	0.25	0.22	0.19	0.07
C99	9/22/2022	10:18	0.8	--	--	--	--	--	--	--
S201	9/25/2022	--	--	--	--	--	--	--	--	--
S202	9/25/2022	11:20	1.4	--	--	--	--	--	--	--
S203	9/25/2022	--	--	--	--	--	--	--	--	--
S204	9/25/2022	12:03	2.5	0.45	0.47	0.36	0.45	0.37	0.42	0.05
S205	9/25/2022	12:11	2	0.20	0.12	0.55	0.78	0.79	0.49	0.28
S206	9/25/2022	10:39	2.2	0.40	0.41	0.44	0.41	0.45	0.42	0.02
S207	9/24/2022	11:48	2	0.20	0.32	0.31	0.26	0.30	0.28	0.05
S208	9/25/2022	10:30	1.8	--	--	--	--	--	--	--
S209	9/24/2022	11:58	2.1	--	--	--	--	--	--	--
S210	9/25/2022	12:30	1.4	0.37	0.36	0.40	0.48	0.44	0.41	0.05
S211	9/24/2022	12:11	2.2	0.40	0.46	0.40	0.42	0.43	0.42	0.02
S212	9/24/2022	14:26	1.7	0.12	0.28	0.33	0.43	0.36	0.30	0.10
S213	9/25/2022	12:45	1.3	--	--	--	--	--	--	--
S214	9/24/2022	14:46	1.3	0.29	0.55	0.33	0.34	0.22	0.35	0.11
S215	9/24/2022	12:30	2.3	0.26	0.33	0.35	0.28	0.34	0.31	0.04
S216	9/24/2022	12:41	>3	--	--	--	--	--	--	--
S217	9/24/2022	15:17	0.4	--	--	--	--	--	--	--
S218	9/24/2022	14:55	1.7	--	--	--	--	--	--	--
S219	9/24/2022	--	--	--	--	--	--	--	--	--
S220	9/24/2022	14:42	1.7	--	--	--	--	--	--	--
S221	9/24/2022	--	--	--	--	--	--	--	--	--
S222	9/24/2022	15:06	1.4	--	--	--	--	--	--	--
S223	9/24/2022	10:53	1.7	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
S224	9/24/2022	--	--	--	--	--	--	--	--	--
S225	9/22/2022	--	--	--	--	--	--	--	--	--
S226	9/22/2022	13:04	0.8	--	--	--	--	--	--	--
S227	9/22/2022	11:10	0.4	--	--	--	--	--	--	--
S228	9/22/2022	9:19	2.2	1.36	-0.59	-0.55	-0.74	-0.44	-0.19	0.78
S229	9/22/2022	9:48	2.1	0.62	0.26	0.03	-0.34	-0.07	0.10	0.32
S230	9/22/2022	--	--	--	--	--	--	--	--	--
S231	9/21/2022	--	--	--	--	--	--	--	--	--
S232	9/22/2022	--	--	--	--	--	--	--	--	--
S233	9/21/2022	12:36	1.1	0.71	0.66	0.63	0.54	0.58	0.62	0.06
S234	9/21/2022	--	--	--	--	--	--	--	--	--
S235	9/20/2022	--	--	--	--	--	--	--	--	--
S236	9/21/2022	9:44	1.6	0.10	0.11	0.62	1.13	1.11	0.61	0.45
S237	9/20/2022	--	--	--	--	--	--	--	--	--
S238	9/21/2022	--	--	--	--	--	--	--	--	--
S239	9/21/2022	13:24	1.8	0.53	1.32	1.88	0.30	0.29	0.87	0.63
S240	9/20/2022	--	--	--	--	--	--	--	--	--
S241	9/21/2022	11:48	0.2	--	--	--	--	--	--	--
S242	9/21/2022	--	--	--	--	--	--	--	--	--
S243	9/21/2022	--	--	--	--	--	--	--	--	--
S244	9/21/2022	--	--	--	--	--	--	--	--	--
S245	9/21/2022	11:24	0.65	0.69	1.20	0.96	0.83	1.35	1.01	0.24
S246	9/20/2022	11:32	0.9	--	--	--	--	--	--	--
S247	9/20/2022	--	--	--	--	--	--	--	--	--
S248	9/20/2022	11:04	0.3	--	--	--	--	--	--	--

Station ID	Date	Time	Water Depth (m)	K_d (rep 1)	K_d (rep 2)	K_d (rep 3)	K_d (rep 4)	K_d (rep 5)	Average K_d	Std Dev
S249	9/20/2022	13:26	0.6	--	--	--	--	--	--	--
S250	9/20/2022	--	--	--	--	--	--	--	--	--
S251	9/20/2022	--	--	--	--	--	--	--	--	--
S252	9/20/2022	--	--	--	--	--	--	--	--	--
S253	9/20/2022	14:31	0.3	--	--	--	--	--	--	--
S254	9/19/2022	--	--	--	--	--	--	--	--	--
S255	9/20/2022	--	--	--	--	--	--	--	--	--
S256	9/19/2022	14:16	1.6	0.25	0.22	0.23	0.25	0.25	0.24	0.01
S257	9/19/2022	14:40	0.27	--	--	--	--	--	--	--
S258	9/19/2022	13:35	1.2	0.60	0.57	0.69	0.63	0.63	0.62	0.04
S259	9/19/2022	14:45	1.4	0.23	0.27	0.26	0.28	0.26	0.26	0.02
S260	9/19/2022	14:13	0.11	--	--	--	--	--	--	--
S261	9/19/2022	10:50	0.3	--	--	--	--	--	--	--
S262	9/18/2022	14:26	0.415	--	--	--	--	--	--	--
S263	9/18/2022	12:58	0.26	--	--	--	--	--	--	--
S264	9/18/2022	14:19	0.9	--	--	--	--	--	--	--
S265	9/18/2022	--	--	--	--	--	--	--	--	--
S266	9/18/2022	12:47	0.1	--	--	--	--	--	--	--
S267	9/18/2022	11:43	0.3	--	--	--	--	--	--	--
S268	9/15/2022	--	--	--	--	--	--	--	--	--
S269	9/15/2022	--	--	--	--	--	--	--	--	--
S270	9/15/2022	--	--	--	--	--	--	--	--	--
S271	9/15/2022	12:56	2	0.75	0.50	0.56	0.39	0.34	0.51	0.14
S272	9/15/2022	--	--	--	--	--	--	--	--	--
S273	9/15/2022	--	--	--	--	--	--	--	--	--

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APPENDIX C

Seagrass Cover and Stem Height Data

Table C-1. Seagrass cover data by location (*H. wrightii, T. testudinum, S. filiforme, and H. engelmannii*)

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C101	60	70	75	80	0	0	0	0	0	0	0	0	0	0	0	0
C102	100	95	100	65	0	0	0	0	0	0	0	0	0	0	0	0
C103	0	0	0	0	95	95	90	95	0	0	0	0	0	0	0	0
C105	0	0	0	0	100	95	20	100	0	0	0	0	0	0	0	0
C106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C107	84	80	25	35	0	0	0	0	0	0	0	0	0	0	0	0
C109	0	0	0	0	100	0	85	95	0	0	0	0	0	0	0	0
C110	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
C111	40	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0
C113	0	0	1	0	0	100	0	0	0	0	0	0	0	0	0	0
C114	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0
C115	0	0	0	1	0	0	0	0	0	0	0	0	35	0	20	29
C117	0	0	0	0	95	95	80	80	0	0	0	0	0	0	0	0
C119	75	5	0	0	0	55	85	95	0	0	0	0	0	0	0	0
C121	85	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0
C123	65	0	80	90	0	0	0	0	0	0	0	0	0	0	0	0
C125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C127	0	0	0	0	100	100	100	85	0	0	0	0	0	0	0	0
C129	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
C130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C133	0	30	1	0	0	0	0	0	0	0	0	0	0	0	0	0
C134	25	8	10	15	0	0	0	0	0	0	0	0	0	0	0	0
C136	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
C137	10	5	5	2	0	0	0	0	0	0	0	0	0	0	0	5

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C138	95	90	75	95	0	0	0	0	0	0	0	0	0	0	0	0
C141	90	90	70	75	0	0	0	0	0	0	0	0	0	0	0	0
C142	40	0	0	30	0	0	0	0	0	0	15	0	0	25	0	0
C143	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
C145	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C146	100	100	95	100	0	0	0	0	0	0	0	0	0	0	0	0
C148	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C149	1	5	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C150	0	2	15	1	0	0	0	0	0	0	0	0	0	0	0	0
C152	1	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0
C153	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C155	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0
C156	75	95	85	90	0	0	0	0	0	0	0	0	0	0	0	0
C159	3	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C160	0	80	20	80	0	0	0	0	0	0	0	0	0	0	0	0
C161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C165	0	35	1	1	0	0	0	0	0	0	0	0	0	0	0	0
C30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C64	85	95	94	80	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C68	100	100	99	100	0	0	0	0	0	0	0	0	0	0	0	0
C72	20	5	0	0	0	5	1	10	0	0	0	0	0	0	0	0
C76	90	95	95	85	0	0	0	0	0	0	0	0	0	0	0	0
C80	10	30	45	2	0	0	0	0	0	0	0	0	0	0	0	0
C81	65	60	55	50	0	0	0	0	0	0	0	0	0	0	0	0
C84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C85	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
C88	20	35	25	15	0	0	0	0	0	0	0	0	0	0	0	0
C89	95	80	90	95	0	0	0	0	0	0	0	0	0	0	0	0
C91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C92	60	55	80	90	0	0	0	0	0	0	0	0	0	0	0	0
C94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C97	0	0	0	0	60	60	90	80	0	0	0	0	0	0	0	0
C98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C99	95	95	85	70	0	0	0	0	0	0	0	0	0	0	0	0
S201	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S202	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S203	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S204	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S207	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S208	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S209	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S211	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S212	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S213	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S216	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S217	35	1	1	30	0	0	0	0	0	0	0	0	0	0	0	0
S218	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S219	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S220	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S222	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S223	35	15	10	0	1	0	0	0	0	0	0	0	0	0	0	0
S224	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S225	95	90	95	95	0	0	0	0	0	0	0	0	0	0	0	0
S226	60	70	10	5	0	0	5	0	0	0	0	0	0	0	0	0
S227	45	5	10	50	0	0	0	0	0	0	0	0	0	0	0	0
S228	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S229	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0
S230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S233	100	85	0	95	0	0	90	0	0	0	0	0	0	0	0	0
S234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S236	40	95	75	0	5	0	0	85	0	0	0	0	0	0	0	0
S237	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	**AFT STB**	**AFT PRT**	**FWD PRT**	**FWD STB**	**AFT STB**	**AFT PRT**	**FWD PRT**	**FWD STB**	**AFT STB**	**AFT PRT**	**FWD PRT**	**FWD STB**	**AFT STB**	**AFT PRT**	**FWD PRT**
S238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S239	0	0	0	0	0	0	0	0	0	0	0	0	15	75	5	0
S240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S241	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0
S242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S245	40	35	70	10	0	0	0	0	0	0	0	0	0	0	0	0
S246	1	0	0	1	64	95	0	0	0	0	0	0	0	0	0	1
S247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S248	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S249	90	0	5	5	0	95	90	30	0	0	0	0	0	0	0	0
S250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S251	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S252	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S253	2	5	5	15	0	0	0	0	0	0	0	0	0	0	0	0
S254	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S256	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S257	15	5	15	15	0	0	0	0	0	0	0	0	0	0	0	0
S258	35	65	98	100	0	0	0	0	0	0	0	0	0	0	0	0
S259	85	70	80	45	0	0	0	0	0	0	0	0	0	0	0	0
S260	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
S261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S262	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S263	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S264	90	100	75	80	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*H. wrightii* % Cover				*T. testudinum* % Cover				*S. filiforme* % Cover				*H. engelmannii* % Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S266	5	5	4	15	0	0	0	0	0	0	0	0	0	0	0	0
S267	5	10	40	15	0	0	0	0	0	0	0	0	0	0	0	0
S268	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S269	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S270	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S271	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S272	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S273	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-2. Seagrass cover data by location (*R. maritima,* Bare Ground, and Total Cover)

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C101	0	0	0	0	40	30	25	20	60	70	75	80
C102	0	0	0	0	0	5	0	0	100	95	100	100
C103	0	0	0	0	5	5	10	5	95	95	90	95
C105	0	0	0	0	0	5	80	0	100	95	20	100
C106	0	0	0	0	100	100	100	100	0	0	0	0
C107	1	0	0	0	15	20	75	65	85	80	25	35
C109	0	0	0	0	0	100	15	5	100	0	85	95
C110	0	0	0	0	100	100	100	100	0	1	0	0
C111	0	0	1	0	60	100	100	0	40	0	1	100

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C113	0	0	0	0	100	0	100	100	0	100	1	0
C114	0	0	0	0	100	98	100	98	0	2	0	2
C115	0	0	0	0	65	100	80	70	35	0	20	30
C117	0	0	0	0	5	5	20	20	95	95	80	80
C119	0	0	0	0	25	40	15	5	75	60	85	95
C121	5	0	0	0	10	100	100	65	90	0	0	35
C123	0	0	0	0	35	100	20	10	65	0	80	90
C125	0	0	0	0	100	100	100	100	0	0	0	0
C126	0	0	0	0	100	100	100	100	0	0	0	0
C127	0	0	0	0	0	0	0	15	100	100	100	85
C129	0	1	0	0	100	100	100	100	0	1	1	1
C130	0	0	0	0	100	100	100	100	0	0	0	0
C133	0	0	0	0	100	70	99	100	0	30	1	0
C134	0	0	0	0	75	92	90	85	25	8	10	15
C136	0	0	0	0	100	100	100	100	0	0	0	1
C137	0	0	0	0	90	95	95	93	10	5	5	7
C138	0	0	0	0	5	10	25	5	95	90	75	95
C141	1	0	0	0	9	10	30	25	91	90	70	75
C142	0	5	0	5	60	70	85	65	40	30	15	35
C143	0	0	0	0	96	100	98	100	4	0	2	0
C145	0	0	0	0	100	99	99	99	0	1	1	1
C146	0	0	0	0	0	0	5	0	100	100	95	100
C148	0	0	0	0	100	100	100	100	0	0	0	0
C149	0	0	0	0	99	95	99	99	1	5	1	1
C150	0	0	0	0	100	98	85	100	0	2	15	1
C152	0	0	0	0	100	100	97	100	1	1	3	1
C153	1	1	1	1	100	100	98	100	2	2	2	2

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C155	0	0	0	0	0	0	0	0	100	100	100	100
C156	0	0	5	0	25	5	10	10	75	95	90	90
C159	0	0	5	5	97	80	95	95	3	20	5	5
C160	100	20	80	20	0	0	0	0	100	100	100	100
C161	0	0	0	0	100	100	100	100	0	0	0	0
C165	0	0	0	0	100	65	100	100	0	35	1	1
C30	0	0	0	0	100	100	100	100	0	0	0	0
C32	0	0	0	0	0	0	0	0	0	0	0	0
C33	0	0	0	0	0	0	0	0	0	0	0	0
C36	0	0	0	0	0	0	0	0	0	0	0	0
C38	0	0	0	0	100	100	100	100	0	0	0	0
C41	0	0	0	0	100	100	100	100	0	0	0	0
C43	0	0	0	0	100	100	100	100	0	0	0	0
C48	0	0	0	0	0	0	0	0	0	0	0	0
C52	0	0	0	0	100	100	100	100	0	0	0	0
C60	95	75	98	95	5	25	2	5	95	75	98	95
C64	0	0	1	0	15	5	5	20	85	95	95	80
C67	0	0	0	0	100	100	100	100	0	0	0	0
C68	0	0	1	0	0	0	0	0	100	100	100	100
C72	0	0	0	0	80	90	99	90	20	10	1	10
C76	0	0	0	0	10	5	5	15	90	95	95	85
C80	0	0	0	0	90	70	55	98	10	30	45	2
C81	0	0	0	0	45	40	45	50	65	60	55	50
C84	0	0	0	0	0	0	0	0	0	0	0	0
C85	0	0	0	0	100	100	100	99	0	0	0	1
C88	0	0	0	0	80	65	75	85	20	35	25	15
C89	0	0	0	0	5	20	10	5	95	80	90	95

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
C91	0	0	0	0	0	0	0	0	0	0	0	0
C92	0	0	0	0	40	45	20	10	60	55	80	90
C94	0	0	0	0	100	100	100	100	0	0	0	0
C96	0	0	0	0	0	0	0	0	0	0	0	0
C97	0	0	0	0	40	40	10	20	60	60	90	80
C98	0	0	0	0	100	100	100	100	0	0	0	0
C99	0	0	15	0	5	5	0	30	95	95	100	70
S201	0	0	0	0	0	0	0	0	0	0	0	0
S202	0	0	0	0	100	100	100	100	0	0	0	0
S203	0	0	0	0	0	0	0	0	0	0	0	0
S204	0	0	0	0	100	100	100	100	0	0	0	0
S205	0	0	0	0	100	100	100	100	0	0	0	0
S206	0	0	0	0	100	100	100	100	0	0	0	0
S207	0	0	0	0	100	100	100	100	0	0	0	0
S208	0	0	0	0	100	100	100	100	0	0	0	0
S209	0	0	0	0	100	100	100	100	0	0	0	0
S210	0	0	0	0	100	100	100	100	0	0	0	0
S211	0	0	0	0	100	100	100	100	0	0	0	0
S212	0	0	0	0	100	100	100	100	0	0	0	0
S213	0	0	0	0	100	100	100	100	0	0	0	0
S214	0	0	0	0	100	100	100	100	0	0	0	0
S215	0	0	0	0	100	100	100	100	0	0	0	0
S216	0	0	0	0	100	100	100	100	0	0	0	0
S217	0	0	0	0	65	99	99	70	35	1	1	30
S218	0	0	0	0	100	100	100	100	0	0	0	0
S219	0	0	0	0	0	0	0	0	0	0	0	0
S220	0	0	0	0	100	100	100	100	0	0	0	0

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S221	0	0	0	0	0	0	0	0	0	0	0	0
S222	0	0	0	0	100	100	100	100	0	0	0	0
S223	0	0	0	0	64	85	90	100	36	15	10	0
S224	0	0	0	0	0	0	0	0	0	0	0	0
S225	0	0	0	0	5	10	5	5	95	90	95	95
S226	0	0	0	0	40	30	90	95	60	70	10	5
S227	25	10	5	30	30	85	85	20	70	15	15	80
S228	0	0	0	0	100	100	100	100	0	0	0	0
S229	0	0	0	0	100	95	100	99	0	5	0	1
S230	0	0	0	0	0	0	0	0	0	0	0	0
S231	0	0	0	0	0	0	0	0	0	0	0	0
S232	0	0	0	0	0	0	0	0	0	0	0	0
S233	0	0	0	0	0	15	10	5	100	85	90	95
S234	0	0	0	0	0	0	0	0	0	0	0	0
S235	0	0	0	0	0	0	0	0	0	0	0	0
S236	0	0	0	0	55	5	25	15	45	95	75	85
S237	0	0	0	0	0	0	0	0	0	0	0	0
S238	0	0	0	0	0	0	0	0	0	0	0	0
S239	0	0	0	0	85	25	95	100	15	75	5	0
S240	0	0	0	0	0	0	0	0	0	0	0	0
S241	0	0	0	20	100	100	100	50	0	0	0	50
S242	0	0	0	0	0	0	0	0	0	0	0	0
S243	0	0	0	0	0	0	0	0	0	0	0	0
S244	0	0	0	0	0	0	0	0	0	0	0	0
S245	0	0	0	0	60	65	30	90	40	35	70	10
S246	0	0	0	0	35	5	100	99	>65	95	0	>2
S247	0	0	0	0	0	0	0	0	0	0	0	0

Station ID	*R. maritima* % Cover				% Bare				Total % Seagrass Cover			
	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT	FWD STB	AFT STB	AFT PRT	FWD PRT
S248	0	0	0	0	100	100	100	100	0	0	0	0
S249	0	0	0	0	10	5	5	65	90	95	95	35
S250	0	0	0	0	0	0	0	0	0	0	0	0
S251	0	0	0	0	0	0	0	0	0	0	0	0
S252	0	0	0	0	0	0	0	0	0	0	0	0
S253	0	10	0	10	98	85	95	75	2	15	5	25
S254	0	0	0	0	0	0	0	0	0	0	0	0
S255	0	0	0	0	0	0	0	0	0	0	0	0
S256	0	0	0	0	100	98	100	100	0	2	0	0
S257	5	30	40	60	80	65	35	25	20	35	65	75
S258	5	0	2	0	60	35	0	0	40	65	100	100
S259	0	0	0	0	15	30	20	55	85	70	80	45
S260	1	1	1	0	98	98	98	100	2	2	2	0
S261	75	65	85	80	25	35	15	20	75	65	85	80
S262	1	100	70	0	100	0	30	100	2	100	70	0
S263	1	0	1	0	100	100	100	100	1	1	1	0
S264	0	0	0	0	10	0	25	20	90	100	75	80
S265	0	0	0	0	0	0	0	0	0	0	0	0
S266	0	0	1	0	95	95	95	85	5	5	5	15
S267	65	80	20	70	30	10	40	15	70	90	60	85
S268	0	0	0	0	0	0	0	0	0	0	0	0
S269	0	0	0	0	0	0	0	0	0	0	0	0
S270	0	0	0	0	0	0	0	0	0	0	0	0
S271	0	0	0	0	100	100	100	100	0	0	0	0
S272	0	0	0	0	0	0	0	0	0	0	0	0
S273	0	0	0	0	0	0	0	0	0	0	0	0

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-3. Seagrass stem height data by location (*H. wrightii* and *T. testudinum*)

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C101	27	23	29	19	13	14	23	14	18	19	16	17	--	--	--	--	--	--	--	--	--	--	--	--
C102	28	22	30.5	39.5	35	38	24	22.5	30	37	30.5	30	--	--	--	--	--	--	--	--	--	33	35	33
C103	--	--	--	--	--	--	--	--	--	--	--	--	32.5	31.5	38	40.5	41.5	45.5	30.5	38	40.5	24	35.5	39
C105	--		--	--	--	--	--	--	--	--	--	--	30.5	27.5	30	40.5	31.5	41.5	30.5	16.5	31	25	27	31.5
C106	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C107	30.5	27	26	12	20.5	25.5	19	24.5	17.5	13	17	27.5	--	--	--	--	--	--	--	--	--	--	--	--
C109	--	--	--	--	--	--	--	--	--	--	--	--	39.5	34.5	38	--	--	--	40	20	22.5	38	40.5	39.5
C110	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C111	5	55	4.5	--	--	--	65	5	4.5	30.5	23.5	25	--	--	--	--	--	--	--	--	--	--	--	--
C113	--	--	--	--	--	--	5.5	7	4	--	--	--	--	--	--	38	15.5	37.5	--	--	--	--	--	--
C114	--	--	--	2	3	5	--	--	--	17	20	18.5	--	--	--	--	--	--	--	--	--	--	--	--
C115	--	--	--	--	--	--	--	--	--	13.5	17	-	--	--	--	--	--	--	--	--	--	--	--	--
C117	--	--	--	--	--	--	--	--	--	--	--	--	40	45.5	42	49	45	40	38	13	28	29	23	35.5
C119	19	22	24	9	3	4	--	--	--	--	--	--	--	--	--	7	16	25	22	23	29.5	32	34	42
C121	12	14	15	--	--	--	--	--	--	15	11	12	--	--	--	--	--	--	--	--	--	--	--	--
C123	21	22	18	--	--	--	22	19	23	25	19	13	--	--	--	--	--	--	--	--	--	--	--	--
C125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C126	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C127	--	--	--	--	--	--	--	--	--	--	--	--	36	51	38.5	39	34.5	35	29.5	28.5	26.5	17.5	22.5	24
C129	--	--	--	--	--	--	--	--	--	4.5	--	--	--	--	--	--	--	--	22.5	--	--	--	--	--
C130	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C133	--	--	--	5	9	13.5	6	2	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C134	19	20	17	7	8.5	6	14	15	10	11	16	20	--	--	--	--	--	--	--	--	--	--	--	--
C136	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C137	11	12	12.5	7	6	9	10	13	9	5	6	4	--	--	--	--	--	--	--	--	--	--	--	--
C138	45	40	41	56	47	52	48.5	44	34	38	40	43	--	--	--	--	--	--	--	--	--	--	--	--
C141	38	22.5	24.5	21	22	22	25.5	27	20	8	22.5	21.5	--	--	--	--	--	--	--	--	--	--	--	--
C142	3	4	8	--	--	--	--	--	--	28	28.5	22	--	--	--	--	--	--	--	--	--	--	--	--
C143	3	4	3.5	--	--	--	1.5	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C145	--	--	--	7.5	4	--	5	11.5	2.5	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C146	28	29	28	26	32	34	24	26	23.5	33	38	31	--	--	--	--	--	--	--	--	--	--	--	--
C148	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C149	4.5	7.5	6	12	17	6	8	2	7	5	5.5	6	--	--	--	--	--	--	--	--	--	--	--	--
C150	--	--	--	17	--	--	14	27	20	11	17	10	--	--	--	--	--	--	--	--	--	--	--	--
C152	21	19	--	7.5	8	8	7.5	7.5	8.5	9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C153	5	--	--	5.5	13.5	--	4.5	11.5	5	7	5	6.5	--	--	--	--	--	--	--	--	--	--	--	--
C155	30.5	38.5	33	45	46	38	44.5	46.5	51	38	43	41	--	--	--	--	--	--	--	--	--	--	--	--
C156	31	32.5	31.5	30	38	28	30	38	28	20	32	34	--	--	--	--	--	--	--	--	--	--	--	--
C159	14	8	18.5	16	14	14.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C160	--	--	--	26	29	28	28	32	27	33	35	26	--	--	--	--	--	--	--	--	--	--	--	--
C161	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C165	--	--	--	8	6	6.5	1	2	2	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C36	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C43	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C64	25	35.5	34	36.5	35	37.5	34	36	37.5	40	30	39.5	--	--	--	--	--	--	--	--	--	--	--	--
C67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C68	31.5	23	23.5	30	21.5	27	29.5	23	22.5	39	29	25.5	--	--	--	--	--	--	--	--	--	--	--	--
C72	21	12	18	6	8	10.5	--	--	--	4	5	-	--	--	--	28	36	34	16	--	--	24	15	23
C76	26	30	23	24	24	16	30	20	28	21	29	18	--	--	--	--	--	--	--	--	--	--	--	--
C80	18	15	11	10	20	17	10	17	15	6	7	4	--	--	--	--	--	--	--	--	--	--	--	--
C81	12	12	19	10	11	11	13	14	17	13	13	18	--	--	--	--	--	--	--	--	--	--	--	--
C84	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C85	--	--	--	--	--	--	--	--	--	4	5	--	--	--	--	--	--	--	--	--	--	--	--	--
C88	7	10	12	11.5	8	12	14	13	19	14	13.5	12	--	--	--	--	--	--	--	--	--	--	--	--
C89	30	22	23	20	26	18	22	23	22	33	27	28	--	--	--	--	--	--	--	--	--	--	--	--
C91	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C92	24	25	21.5	25	27.5	28	29	25	21	19	22	30	--	--	--	--	--	--	--	--	--	--	--	--
C94	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C97	--	--	--	--	--	--	--	--	--	--	--	--	22	23	33	31	27	34	36	37	44	31	42	43
C98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C99	22	29	27	27	25	31	22	18	20	17	23	19	--	--	--	--	--	--	--	--	--	--	--	--
S201	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S202	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S203	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S204	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S205	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S206	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S207	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S208	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S209	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S210	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S211	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S212	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S213	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S214	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S215	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S216	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S217	7.5	8	6	6	3.5	3.5	2	-	-	6	5.5	5	--	--	--	--	--	--	--	--	--	--	--	--
S218	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S219	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S220	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S221	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S222	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S223	25	17	24	14	12	10	114	17	8	--	--	--	34	--	--	--	--	--	--	--	--	--	--	--
S224	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S225	22	25	24	22	25	23	24	26	23	25.5	26	24	--	--	--	--	--	--	--	--	--	--	--	--
S226	7	12	15	12	12	14	7	4	8	3	2	4	--	--	--	--	--	--	10	5	8	--	--	--
S227	13	12	10	8	6	7	11.5	11	10	15.5	10.5	12	--	--	--	--	--	--	--	--	--	--	--	--
S228	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S229	--	--	--	7.5	9	8.5	--	--	--	4	2.5	7	--	--	--	--	--	--	--	--	--	--	--	--
S230	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S231	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S232	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S233	42	21	19.5	32.5	38	36	--	--	--	31.5	33	16	--	--	--	--	--	--	24	31	32	--	--	--
S234	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S235	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S236	31.5	27.5	12	32.5	33	23	34.5	27	45.5	--	--	--	32	32.5	37.5	--	--	--	--	--	--	20	25.5	35.5
S237	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S239	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S241	--	--	--	--	--	--	--	--	--	7	9	6	--	--	--	--	--	--	--	--	--	--	--	--
S242	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S243	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S244	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S245	13	16	11	11.6	6	17	31	22	34	5	8	10.5	--	--	--	--	--	--	--	--	--	--	--	--
S246	4.5	12	19.5	--	--	--	--	--	--	3	2	--	14	12	9.5	29.5	12	24	--	--	--	--	--	--
S247	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S249	8.5	7.5	6	--	--	--	9	11	13	4	5	5.5	--	--	--	22	10	9	10	2.4	22	9.5	6	10
S250	7.5	--	--	--	--	--	9	11	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S251	6	--	--	--	--	--	9	11	13	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S252	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S253	4	4.5	5	13	12	10	5.5	8	10	7	7	7.5	--	--	--	--	--	--	--	--	--	--	--	--
S254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S255	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S256	--	--	--	9.5	13	11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S257	11	6	17.5	6.5	8	10	17	10.5	8	19	10	19.5	--	--	--	--	--	--	--	--	--	--	--	--
S258	10.5	12.5	4	15	15.5	27.5	30	26	34	20	32	31	--	--	--	--	--	--	--	--	--	--	--	--
S259	44.5	50	43.5	41	38	41.5	34	38	40	22	10	16	--	--	--	--	--	--	--	--	--	--	--	--
S260	15.5	15	14	7.5	7.5	9	11	7	9.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*H. wrightii* Stem Height (cm)												*T. testudinum* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S261	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S262	24.4	15.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S263	--	--	--	4	22.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S264	31	20.5	10	31.5	44	35	9.5	8	6	40	34	31	--	--	--	--	--	--	--	--	--	--	--	--
S265	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S266	8	7	8	7.5	8	8.5	5	6	6	6.5	5	7	--	--	--	--	--	--	--	--	--	--	--	--
S267	10	9	11	8	7	6	12	12	8	10	12.5	7	--	--	--	--	--	--	--	--	--	--	--	--
S268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S269	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S270	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S271	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S272	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S273	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-4. Seagrass stem height data by location (*S. filiforme and H. engelmannii*)

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii Stem Height (cm)*											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C101	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C102	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C103	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C105	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C106	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C107	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C109	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C110	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	1.5	0.5	--	--	--	--	--	--
C111	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C113	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C114	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C115	--	--	--	--	--	--	--	--	--	--	--	--	2	2.5	3	--	--	--	3	3.5	3	4.5	3	3
C117	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C119	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C121	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C123	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C126	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C127	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C129	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C130	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C133	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C134	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C136	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C137	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	6	4
C138	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C141	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C142	--	--	--	--	--	--	32	22	17	--	--	--	--	--	--	6	7	5	--	--	--	--	--	--
C143	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C145	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C146	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C148	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C149	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C152	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C153	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C155	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C156	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C159	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C160	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C161	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C165	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C33	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C36	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C43	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C48	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C52	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C64	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C67	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C68	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C72	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C76	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C80	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
C81	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C84	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C85	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C88	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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S204	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S205	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S206	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S207	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S208	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S209	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S210	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S211	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S212	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S213	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S214	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S215	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S216	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S217	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S218	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S219	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S220	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S221	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S222	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S223	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S224	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S225	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S226	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
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S230	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S231	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S232	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S233	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S234	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S235	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S236	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S237	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S239	--	--	--	--	--	--	--	--	--	--	--	--	5.5	6	4	5.5	6	7	2	2.5	3	--	--	--
S240	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S241	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S242	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S243	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S244	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S245	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S246	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	1	0.5
S247	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S249	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S250	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S251	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S252	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S253	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S255	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S256	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S257	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S258	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S259	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S260	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S261	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S262	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S263	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S264	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S265	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S266	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*S. filiforme* Stem Height (cm)												*H. engelmannii* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT			FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
S267	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S269	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S270	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S271	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S272	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S273	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Table C-5. Seagrass stem height data by location (*R. maritima*)

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C101	--	--	--	--	--	--	--	--	--	--	--	--
C102	--	--	--	--	--	--	--	--	--	--	--	--
C103	--	--	--	--	--	--	--	--	--	--	--	--
C105	--	--	--	--	--	--	--	--	--	--	--	--
C106	--	--	--	--	--	--	--	--	--	--	--	--
C107	16.5	20.5	21.5	--	--	--	--	--	--	--	--	--
C109	--	--	--	--	--	--	--	--	--	--	--	--
C110	--	--	--	--	--	--	--	--	--	--	--	--
C111	--	--	--	--	--	--	7.5	3.5	--	--	--	--
C113	--	--	--	--	--	--	--	--	--	--	--	--
C114	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C115	--	--	--	--	--	--	--	--	--	--	--	--
C117	--	--	--	--	--	--	--	--	--	--	--	--
C119	--	--	--	--	--	--	--	--	--	--	--	--
C121	8	10	13	--	--	--	--	--	--	--	--	--
C123	--	--	--	--	--	--	--	--	--	--	--	--
C125	--	--	--	--	--	--	--	--	--	--	--	--
C126	--	--	--	--	--	--	--	--	--	--	--	--
C127	--	--	--	--	--	--	--	--	--	--	--	--
C129	--	--	--	7.5	4	5	--	--	--	--	--	--
C130	--	--	--	--	--	--	--	--	--	--	--	--
C133	--	--	--	--	--	--	--	--	--	--	--	--
C134	--	--	--	--	--	--	--	--	--	--	--	--
C136	--	--	--	--	--	--	--	--	--	--	--	--
C137	--	--	--	--	--	--	--	--	--	--	--	--
C138	--	--	--	--	--	--	--	--	--	--	--	--
C141	27.5	23.5	--	--	--	--	--	--	--	--	--	--
C142	--	--	--	28.5	17	26	--	--	--	22	36	28.5
C143	--	--	--	--	--	--	--	--	--	--	--	--
C145	--	--	--	--	--	--	--	--	--	--	--	--
C146	--	--	--	--	--	--	--	--	--	--	--	--
C148	--	--	--	--	--	--	--	--	--	--	--	--
C149	--	--	--	--	--	--	--	--	--	--	--	--
C150	--	--	--	--	--	--	--	--	--	--	--	--
C152	--	--	--	--	--	--	--	--	--	--	--	--
C153	27.5	6.5	--	5.5	--	--	34.5	8	--	12.5	22	--
C155	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C156	--	--	--	--	--	--	46.5	34.5	28	--	--	--
C159	--	--	--	--	--	--	10	9	9.5	5	4.5	7
C160	40	27	33	34	24	42	42	64	54	34	40	44
C161	--	--	--	--	--	--	--	--	--	--	--	--
C165	--	--	--	--	--	--	--	--	--	--	--	--
C30	--	--	--	--	--	--	--	--	--	--	--	--
C32	--	--	--	--	--	--	--	--	--	--	--	--
C33	--	--	--	--	--	--	--	--	--	--	--	--
C36	--	--	--	--	--	--	--	--	--	--	--	--
C38	--	--	--	--	--	--	--	--	--	--	--	--
C41	--	--	--	--	--	--	--	--	--	--	--	--
C43	--	--	--	--	--	--	--	--	--	--	--	--
C48	--	--	--	--	--	--	--	--	--	--	--	--
C52	--	--	--	--	--	--	--	--	--	--	--	--
C60	19	18.5	23	14	18.5	20.5	30	33.5	24	23	28	24.5
C64	--	--	--	--	--	--	42.5	27	--	--	--	--
C67	--	--	--	--	--	--	--	--	--	--	--	--
C68	--	--	--	--	--	--	23	22	30	--	--	--
C72	--	--	--	--	--	--	--	--	--	--	--	--
C76	--	--	--	--	--	--	--	--	--	--	--	--
C80	--	--	--	--	--	--	--	--	--	--	--	--
C81	--	--	--	--	--	--	--	--	--	--	--	--
C84	--	--	--	--	--	--	--	--	--	--	--	--
C85	--	--	--	--	--	--	--	--	--	--	--	--
C88	--	--	--	--	--	--	--	--	--	--	--	--
C89	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
C91	--	--	--	--	--	--	--	--	--	--	--	--
C92	--	--	--	--	--	--	--	--	--	--	--	--
C94	--	--	--	--	--	--	--	--	--	--	--	--
C96	--	--	--	--	--	--	--	--	--	--	--	--
C97	--	--	--	--	--	--	--	--	--	--	--	--
C98	--	--	--	--	--	--	--	--	--	--	--	--
C99	--	--	--	--	--	--	17	19	16	--	--	--
S201	--	--	--	--	--	--	--	--	--	--	--	--
S202	--	--	--	--	--	--	--	--	--	--	--	--
S203	--	--	--	--	--	--	--	--	--	--	--	--
S204	--	--	--	--	--	--	--	--	--	--	--	--
S205	--	--	--	--	--	--	--	--	--	--	--	--
S206	--	--	--	--	--	--	--	--	--	--	--	--
S207	--	--	--	--	--	--	--	--	--	--	--	--
S208	--	--	--	--	--	--	--	--	--	--	--	--
S209	--	--	--	--	--	--	--	--	--	--	--	--
S210	--	--	--	--	--	--	--	--	--	--	--	--
S211	--	--	--	--	--	--	--	--	--	--	--	--
S212	--	--	--	--	--	--	--	--	--	--	--	--
S213	--	--	--	--	--	--	--	--	--	--	--	--
S214	--	--	--	--	--	--	--	--	--	--	--	--
S215	--	--	--	--	--	--	--	--	--	--	--	--
S216	--	--	--	--	--	--	--	--	--	--	--	--
S217	--	--	--	--	--	--	--	--	--	--	--	--
S218	--	--	--	--	--	--	--	--	--	--	--	--
S219	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
S220	--	--	--	--	--	--	--	--	--	--	--	--
S221	--	--	--	--	--	--	--	--	--	--	--	--
S222	--	--	--	--	--	--	--	--	--	--	--	--
S223	--	--	--	--	--	--	--	--	--	--	--	--
S224	--	--	--	--	--	--	--	--	--	--	--	--
S225	--	--	--	--	--	--	--	--	--	--	--	--
S226	--	--	--	--	--	--	--	--	--	--	--	--
S227	15.5	16	26	26	23.5	16	9.5	--	--	20	20	19.5
S228	--	--	--	--	--	--	--	--	--	--	--	--
S229	--	--	--	--	--	--	--	--	--	--	--	--
S230	--	--	--	--	--	--	--	--	--	--	--	--
S231	--	--	--	--	--	--	--	--	--	--	--	--
S232	--	--	--	--	--	--	--	--	--	--	--	--
S233	--	--	--	--	--	--	--	--	--	--	--	--
S234	--	--	--	--	--	--	--	--	--	--	--	--
S235	--	--	--	--	--	--	--	--	--	--	--	--
S236	--	--	--	--	--	--	--	--	--	--	--	--
S237	--	--	--	--	--	--	--	--	--	--	--	--
S238	--	--	--	--	--	--	--	--	--	--	--	--
S239	--	--	--	--	--	--	--	--	--	--	--	--
S240	--	--	--	--	--	--	--	--	--	--	--	--
S241	--	--	--	--	--	--	--	--	--	22	17.5	17
S242	--	--	--	--	--	--	--	--	--	--	--	--
S243	--	--	--	--	--	--	--	--	--	--	--	--
S244	--	--	--	--	--	--	--	--	--	--	--	--
S245	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
S246	--	--	--	--	--	--	--	--	--	--	--	--
S247	--	--	--	--	--	--	--	--	--	--	--	--
S248	--	--	--	--	--	--	--	--	--	--	--	--
S249	--	--	--	--	--	--	--	--	--	--	--	--
S250	--	--	--	--	--	--	--	--	--	--	--	--
S251	--	--	--	--	--	--	--	--	--	--	--	--
S252	--	--	--	--	--	--	--	--	--	--	--	--
S253	--	--	--	12	32	21	--	--	--	12	10	9.5
S254	--	--	--	--	--	--	--	--	--	--	--	--
S255	--	--	--	--	--	--	--	--	--	--	--	--
S256	--	--	--	--	--	--	--	--	--	--	--	--
S257	11.5	9.5	20	10.5	16	15	14	10	30	11.5	14	7.5
S258	22	--	--	--	--	--	29	20.5	--	--	--	--
S259	--	--	--	--	--	--	--	--	--	--	--	--
S260	12	17	19	17.5	8	12	11	--	--	--	--	--
S261	27	16.5	17	16	9.5	7.5	28	11	7.5	10.5	12	19
S262	19	--	--	40.5	48.5	39	21.5	43	22.5	--	--	--
S263	4	7	--	--	--	--	1.5	0.5	3	--	--	--
S264	--	--	--	--	--	--	--	--	--	--	--	--
S265	--	--	--	--	--	--	--	--	--	--	--	--
S266	--	--	--	--	--	--	17	--	--	--	--	--
S267	31	26	32	24	25	31	29	28	30.5	25	35	42
S268	--	--	--	--	--	--	--	--	--	--	--	--
S269	--	--	--	--	--	--	--	--	--	--	--	--
S270	--	--	--	--	--	--	--	--	--	--	--	--
S271	--	--	--	--	--	--	--	--	--	--	--	--

Station ID	*R. maritima* Stem Height (cm)											
	FWD STB			AFT STB			AFT PRT			FWD PRT		
Replicate	1	2	3	1	2	3	1	2	3	1	2	3
S272	--	--	--	--	--	--	--	--	--	--	--	--
S273	--	--	--	--	--	--	--	--	--	--	--	--

Key: FWD STB = Forward Starboard; AFT STBD = Aft Starboard; AFT PRT = Aft Port; FWD PRT = Forward Port

Appendix D

Survey Station Coordinates

Table D-1. Station Coordinates

Station ID	Lat	Long	Station ID	Lat	Long
C101	29.90365	-88.83431	**S203**	29.83164	-88.84133
C102	29.90932	-88.84174	**S204**	29.83347	-88.86866
C103	29.90827	-88.83225	**S205**	29.83600	-88.84726
C105	29.91266	-88.83865	**S206**	29.84282	-88.87116
C106	29.91284	-88.84734	**S207**	29.84336	-88.85456
C107	29.91466	-88.83007	**S208**	29.84456	-88.86300
C109	29.91983	-88.83905	**S209**	29.84523	-88.85418
C110	29.92412	-88.84770	**S210**	29.84651	-88.88432
C111	29.92513	-88.83080	**S211**	29.84809	-88.85961
C113	29.92695	-88.83356	**S212**	29.84833	-88.87510
C114	29.93256	-88.84474	**S213**	29.85199	-88.88078
C115	29.93188	-88.83106	**S214**	29.85345	-88.87611
C117	29.93762	-88.83875	**S215**	29.85464	-88.85909
C119	29.94001	-88.83600	**S216**	29.85503	-88.84894
C121	29.94052	-88.84055	**S217**	29.85599	-88.86586
C123	29.94623	-88.83916	**S218**	29.85864	-88.88296
C125	29.95087	-88.84160	**S219**	29.85986	-88.83799
C126	29.95238	-88.84450	**S220**	29.85993	-88.86998
C127	29.95115	-88.83575	**S221**	29.86499	-88.85034
C129	29.95794	-88.84112	**S222**	29.86580	-88.87531
C130	29.96039	-88.84584	**S223**	29.87933	-88.84143
C133	29.96334	-88.84247	**S224**	29.88093	-88.83004
C134	29.96797	-88.84436	**S225**	29.88971	-88.82999
C136	29.97170	-88.85176	**S226**	29.89521	-88.82934
C137	29.97144	-88.84027	**S227**	29.90335	-88.82726
C138	29.97974	-88.84335	**S228**	29.90701	-88.84689
C141	29.97757	-88.84110	**S229**	29.90760	-88.84286
C142	29.98152	-88.84600	**S230**	29.90771	-88.82406
C143	29.98698	-88.85777	**S231**	29.91428	-88.85374
C145	29.99496	-88.84318	**S232**	29.91557	-88.82378
C146	29.99957	-88.85286	**S233**	29.92180	-88.83067
C148	29.99938	-88.85947	**S234**	29.92482	-88.82375
C149	30.00001	-88.84569	**S235**	29.92560	-88.86001
C150	30.00301	-88.85736	**S236**	29.92999	-88.84113
C152	30.00935	-88.86631	**S237**	29.93154	-88.85086
C153	30.01000	-88.84907	**S238**	29.93155	-88.82369
C155	30.01164	-88.85461	**S239**	29.93333	-88.83833
C156	30.01433	-88.86075	**S240**	29.93687	-88.85215

Station ID	Lat	Long	Station ID	Lat	Long
C159	30.01739	-88.85904	**S241**	29.94035	-88.82539
C160	30.02240	-88.86615	**S242**	29.94111	-88.84800
C161	30.02605	-88.86812	**S243**	29.94523	-88.85544
C165	30.03624	-88.86672	**S244**	29.94618	-88.82434
C30	29.82349	-88.86035	**S245**	29.94171	-88.82933
C32	29.82602	-88.86887	**S246**	29.95335	-88.83160
C33	29.82769	-88.85345	**S247**	29.95671	-88.85070
C36	29.83539	-88.88362	**S248**	29.95772	-88.83058
C38	29.82950	-88.85211	**S249**	29.96047	-88.83877
C41	29.84350	-88.84459	**S250**	29.96422	-88.85111
C43	29.83674	-88.86860	**S251**	29.96495	-88.83034
C48	29.84350	-88.84459	**S252**	29.97042	-88.84745
C52	29.85086	-88.84111	**S253**	29.97408	-88.83349
C60	29.85568	-88.84199	**S254**	29.97891	-88.85710
C64	29.86087	-88.84192	**S255**	29.98190	-88.83287
C67	29.86316	-88.84942	**S256**	29.98719	-88.85440
C68	29.86134	-88.84003	**S257**	29.98748	-88.84232
C72	29.86971	-88.84065	**S258**	29.98936	-88.84520
C76	29.87077	-88.83676	**S259**	29.98977	-88.85351
C80	29.87509	-88.84184	**S260**	29.99069	-88.84025
C81	29.87721	-88.83492	**S261**	30.00076	-88.84275
C84	29.87710	-88.85499	**S262**	30.00510	-88.84806
C85	29.87626	-88.83876	**S263**	30.01294	-88.84837
C88	29.88597	-88.84649	**S264**	30.01376	-88.85625
C89	29.88228	-88.83631	**S265**	30.01846	-88.87288
C91	29.88662	-88.85232	**S266**	30.02324	-88.85458
C92	29.88939	-88.83623	**S267**	30.02733	-88.85997
C94	29.89297	-88.84791	**S268**	30.03582	-88.88091
C96	29.89138	-88.85224	**S269**	30.03912	-88.86392
C97	29.89728	-88.84057	**S270**	30.04133	-88.87354
C98	29.89847	-88.84699	**S271**	30.04424	-88.87565
C99	29.90053	-88.83626	**S272**	30.04266	-88.86486
S201	29.82791	-88.86383	**S273**	30.04610	-88.86592
S202	29.82993	-88.86030			

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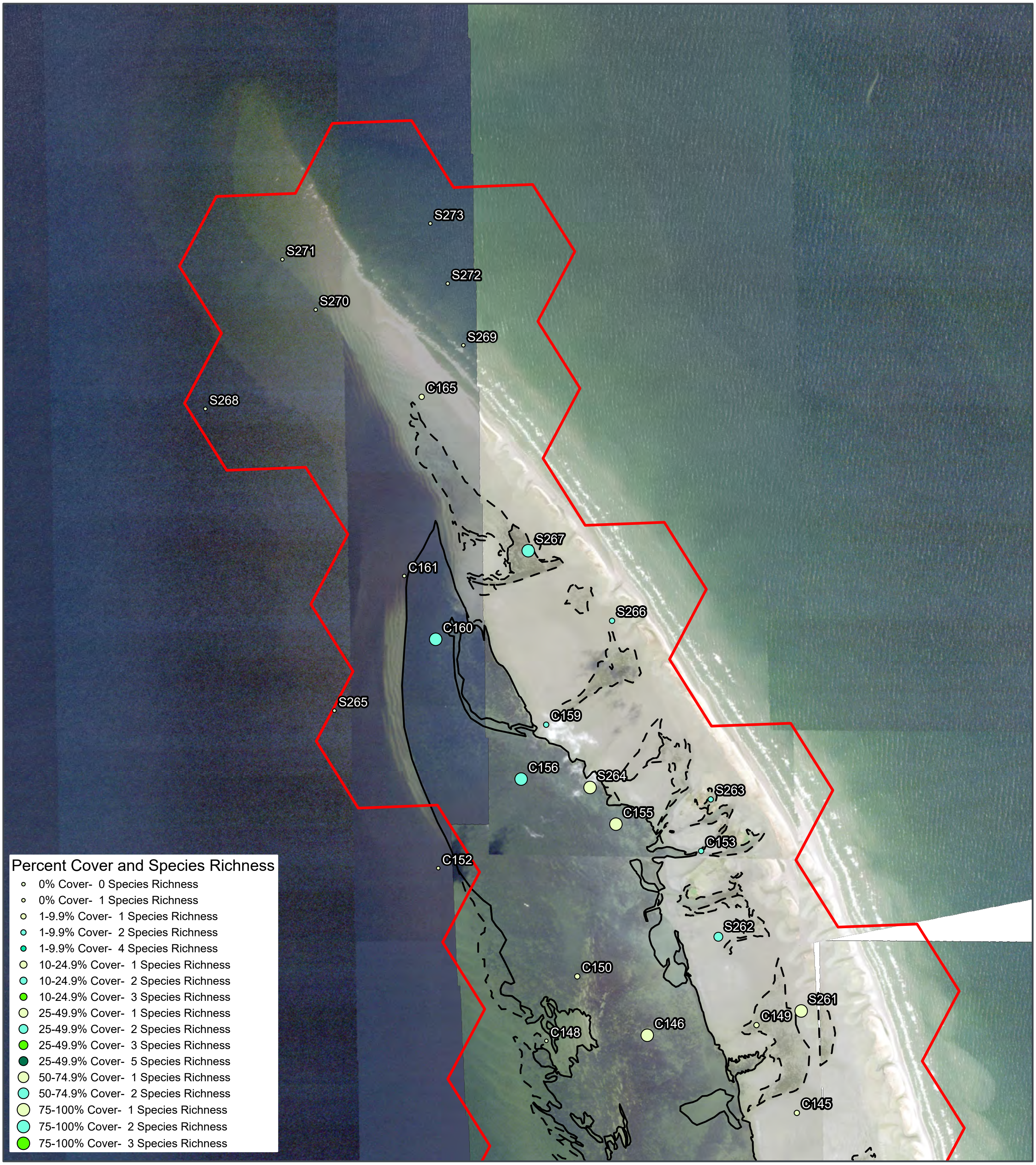
Appendix E

Seagrass Study Results Map Book



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 1 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
30.0255°N 88.8607°W

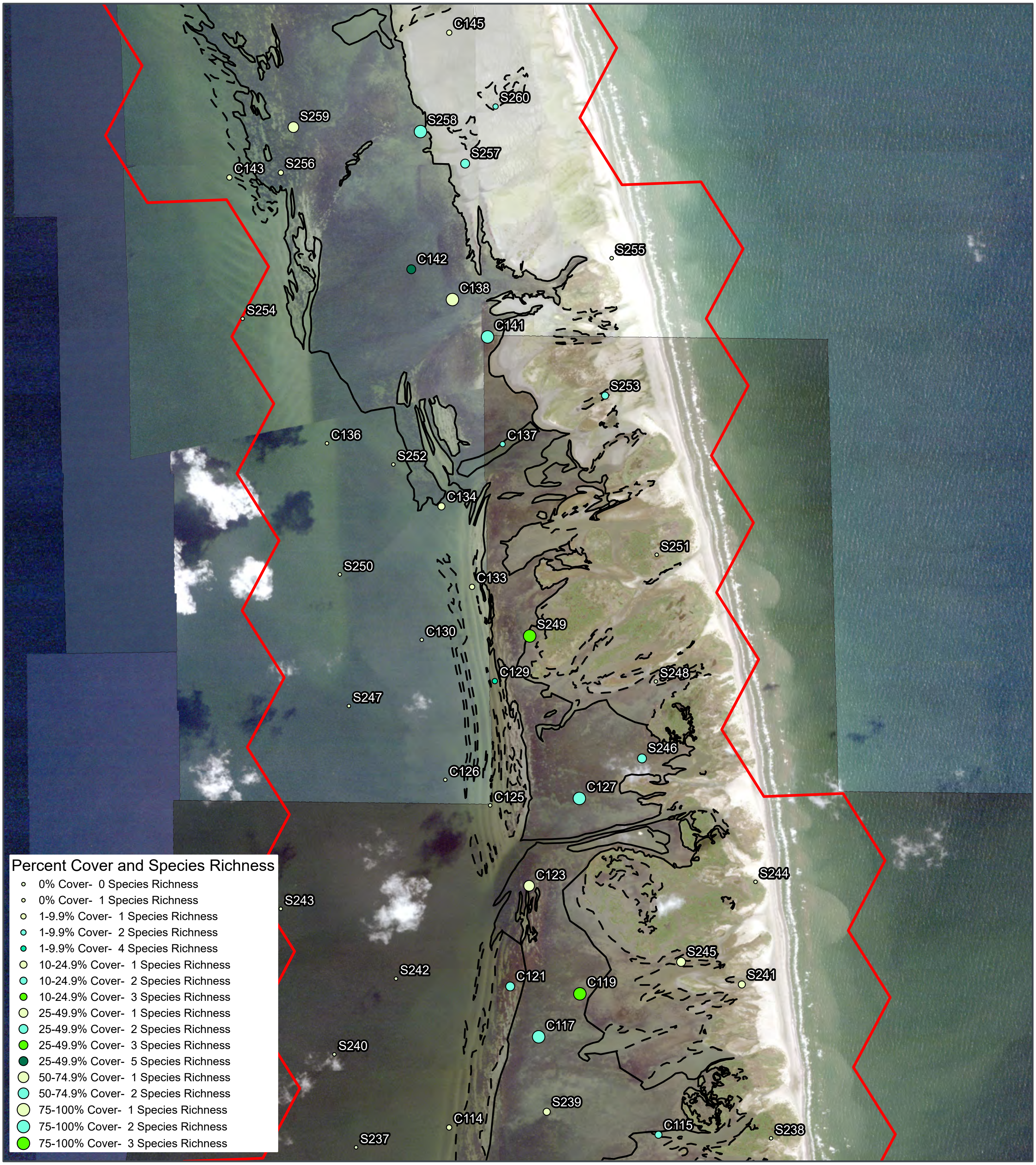
0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results Appendix

SWCA ENVIRONMENTAL CONSULTANTS



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 2 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
29.9635°N 88.8395°W

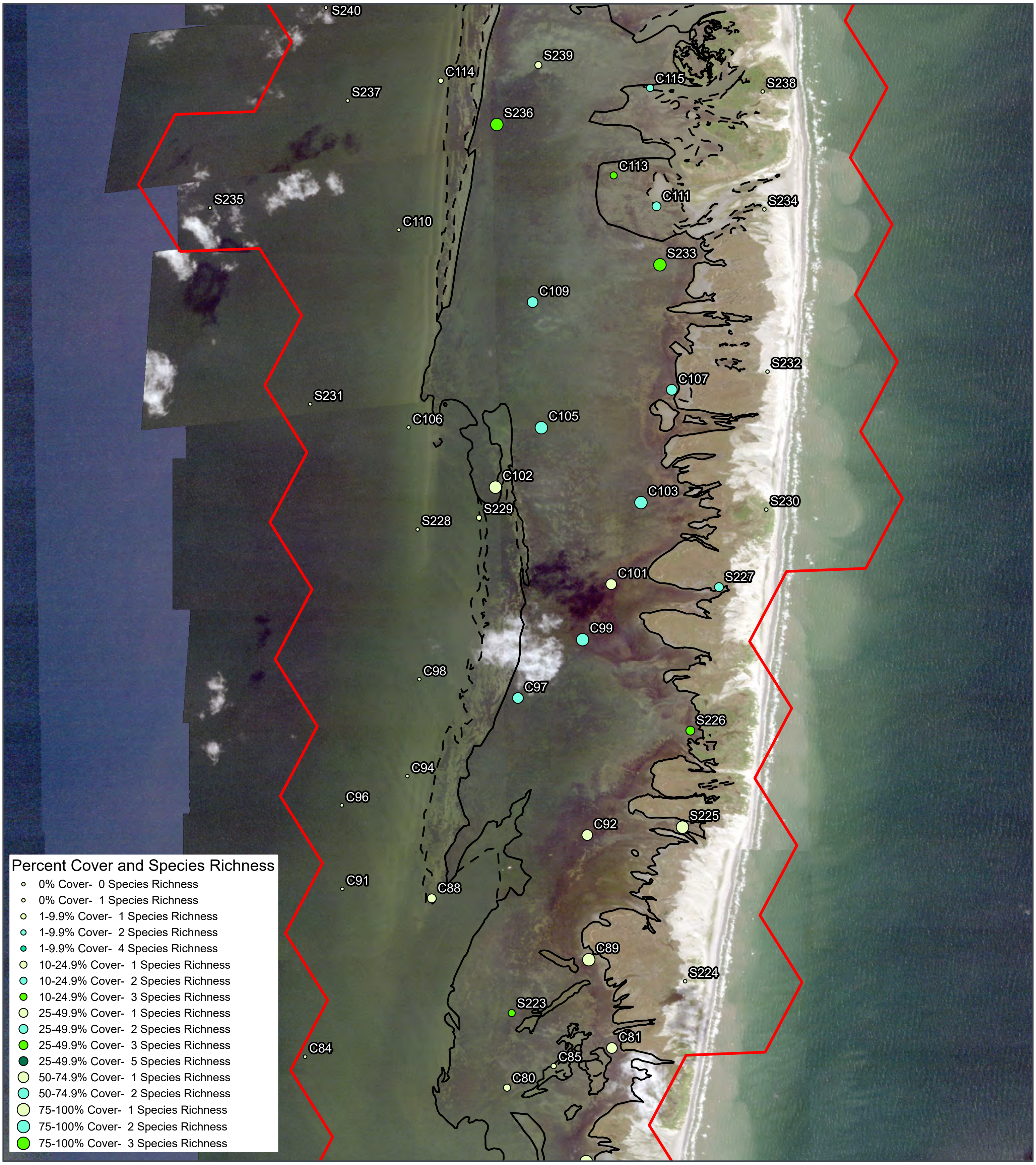
0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

SWCA ENVIRONMENTAL CONSULTANTS



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 3 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
29.9039°N 88.8404°W

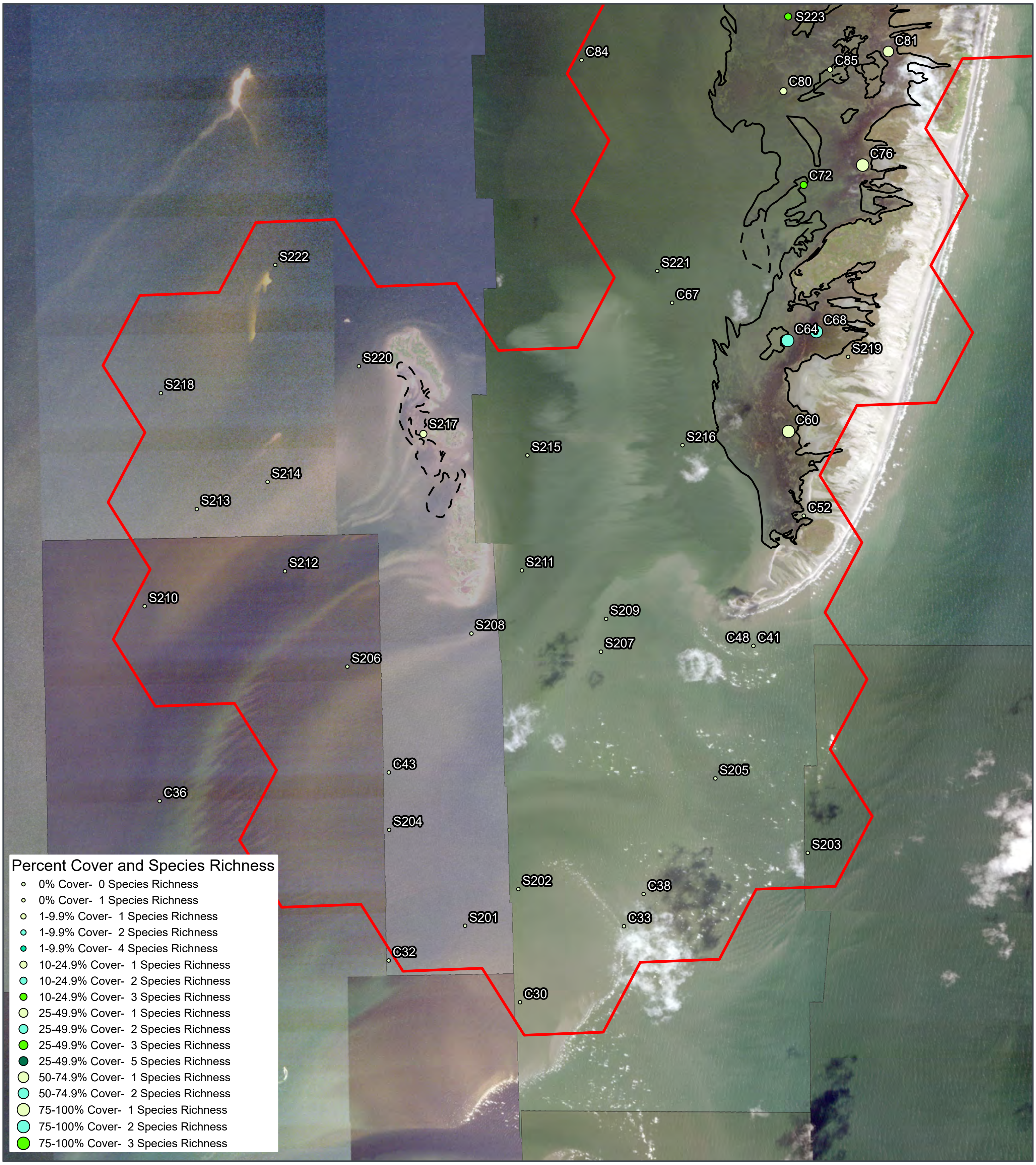
0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results
Appendix

SWCA ENVIRONMENTAL CONSULTANTS



CHANDELEUR ISLAND RESTORATION PROJECT

Seagrass Study Results

Sheet 4 of 4

Survey Area

Seagrass Coverage – September 2022 Aerial Imagery

Dense

Patchy

St. Bernard Parish, Louisiana
NAD 1983 StatePlane Louisiana
South FIPS 1702 Feet
29.8474°N 88.8599°W

0 1,000 2,000 Feet
0 330 660 Meters

N

1:32,000

SkySat Aerial Imagery September 2022
accessed September 2023</ITA>
Updated: 9/14/2023
Project No. XXXXX
Layout: Seagrass Study Results Appendix

SWCA ENVIRONMENTAL CONSULTANTS

Attachment E

Impact Pile-Driving Acoustic Output – Multi-species Tool

IMPACT PILE DRIVING REPORT

PRINT IN LANDSCAPE TO CAPTURE ENTIRE SCREEN

PROJECT INFORMATION	PEAK	SELss	RMS
Single strike level (dB)			

OTHER INFO: The estimated number of timber piles for roc

Number of strikes per p

Attenuation: 0

RESULTANT ISOPLETHS (Range to Effects)

FISHES

	ONSET OF PHYSICAL INJURY			BEHAVIOR
	Peak Isopleth	SEL_{cum} Isopleth Fish ≥ 2 g	SEL_{cum} Isopleth Fish < 2 g	RMS Isopleth
ISOPLETHS (meters)	0.3	29.3	29.3	135.9
Isopleth (feet)	0.8	96.1	96.1	446.0

SEA TURTLES

	PTS ONSET		BEHAVIOR
	Peak Isopleth	SEL_{cum} Isopleth	RMS Isopleth
ISOPLETHS (meters)	0.0	2.3	2.9
Isopleth (feet)	0.0	7.4	9.6

Sea Turtles present

MARINE MAMMALS

	LF Cetacean	MF Cetaceans	HF Cetaceans	PW Pinniped	OW Pinnipeds
AUD INJ ONSET (Peak isopleth, meters)	0.0	0.0	0.5	0.0	0.0
AUD INJ ONSET (Peak isopleth, feet)	0.1	0.0	1.5	0.1	0.0
AUD INJ ONSET (SEL_{cum} isopleth, meters)	56.6	7.2	87.6	50.3	18.7
AUD INJ ONSET (SEL_{cum} isopleth, feet)	185.7	23.7	287.3	164.9	61.5
	ALL MM	MF Cet. present	NO HF CET.	NO PHOCIDS	NO OTARIIDS
Behavior (RMS isopleth, meters)	29.3	LF Cet. present			
Behavior (RMS isopleth, feet)	96.1				

Other Info: The estimated number of timber piles for rock breakwater warning signs is 30 piles spaced at a maximum of 500 ft intervals. A conservative estimate of 360 strikes per pile was estimated, although the specific number of strikes per pile or duration of pile-driving is not known.

Notes: Number of strikes per pile is the maximum of the three seabed elevations (form PO-0199 Typical Pile Driving). Pile-driving is not expected to take more than 30 days, if 1 pile were driven per day. However, as a conservative measure, 15 piles per day are used to estimate maximum impacts.