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

## ST BERNARD PARISH, LOUISIANA

**Prepared For:**

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

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## 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.

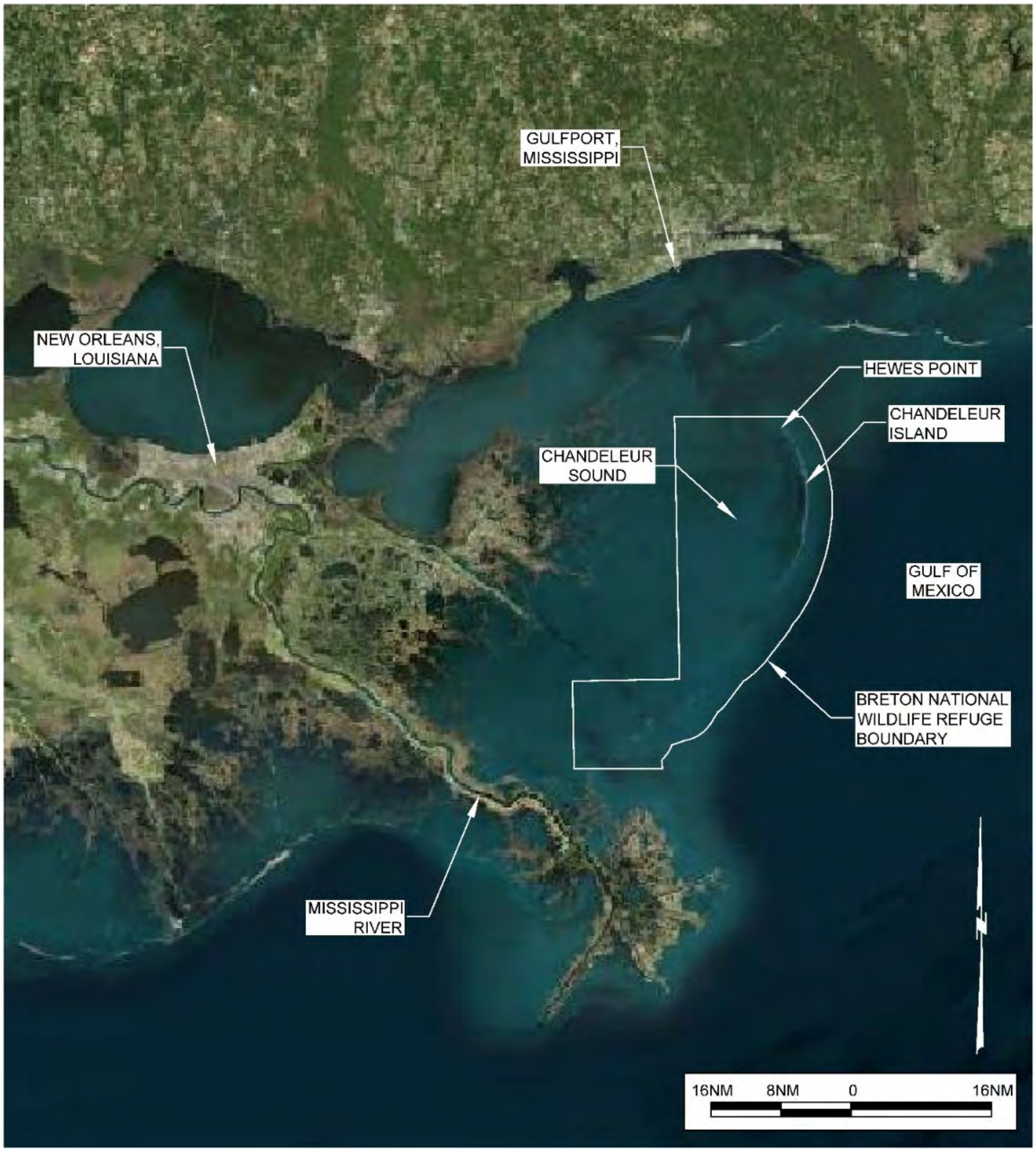


**Figure 1. Project Location Map**

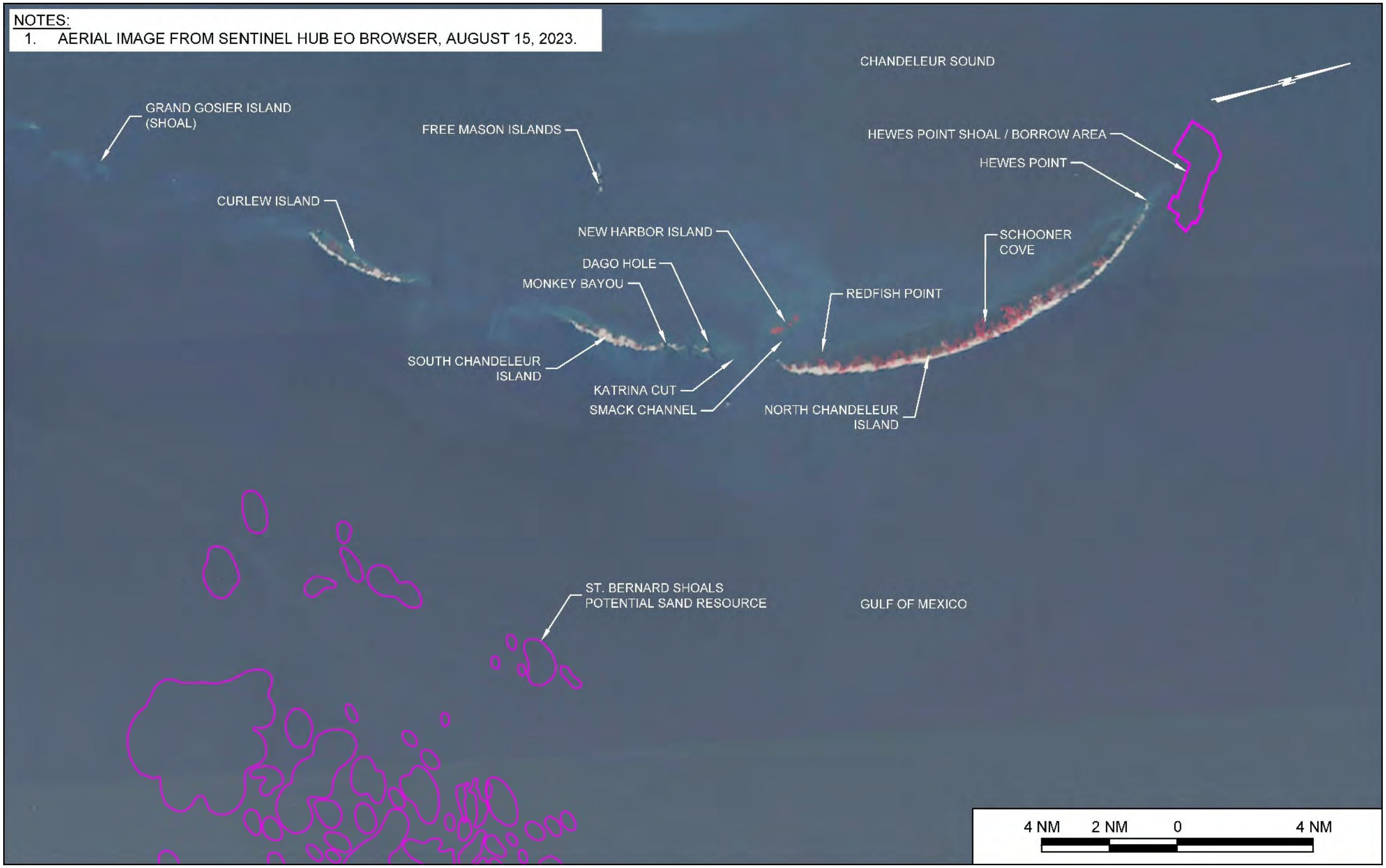


**Figure 2. Chandeleur Island and Potential Sand Resources**

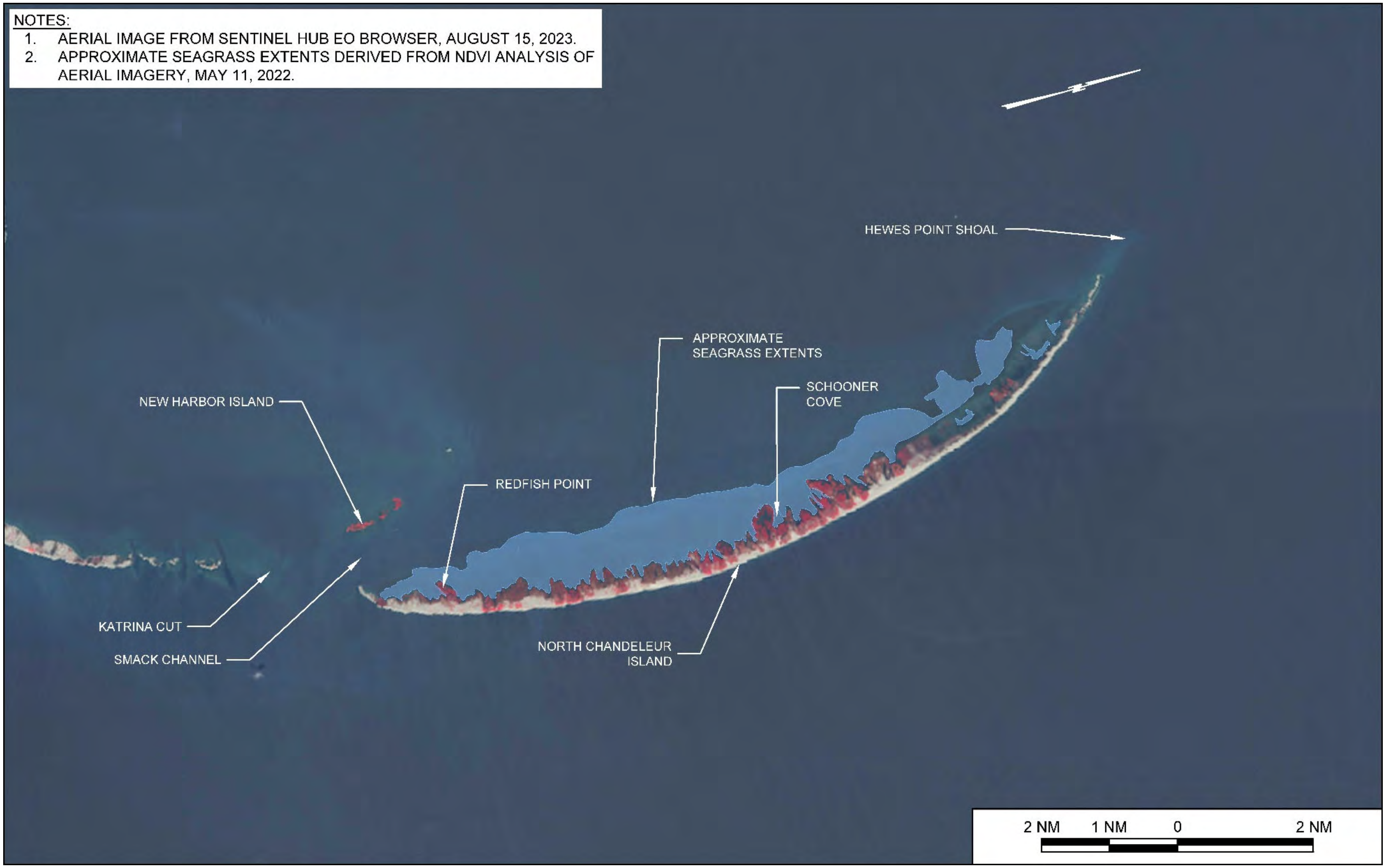


**Figure 3. Project Area and Approximate Seagrass Extents**

## 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.

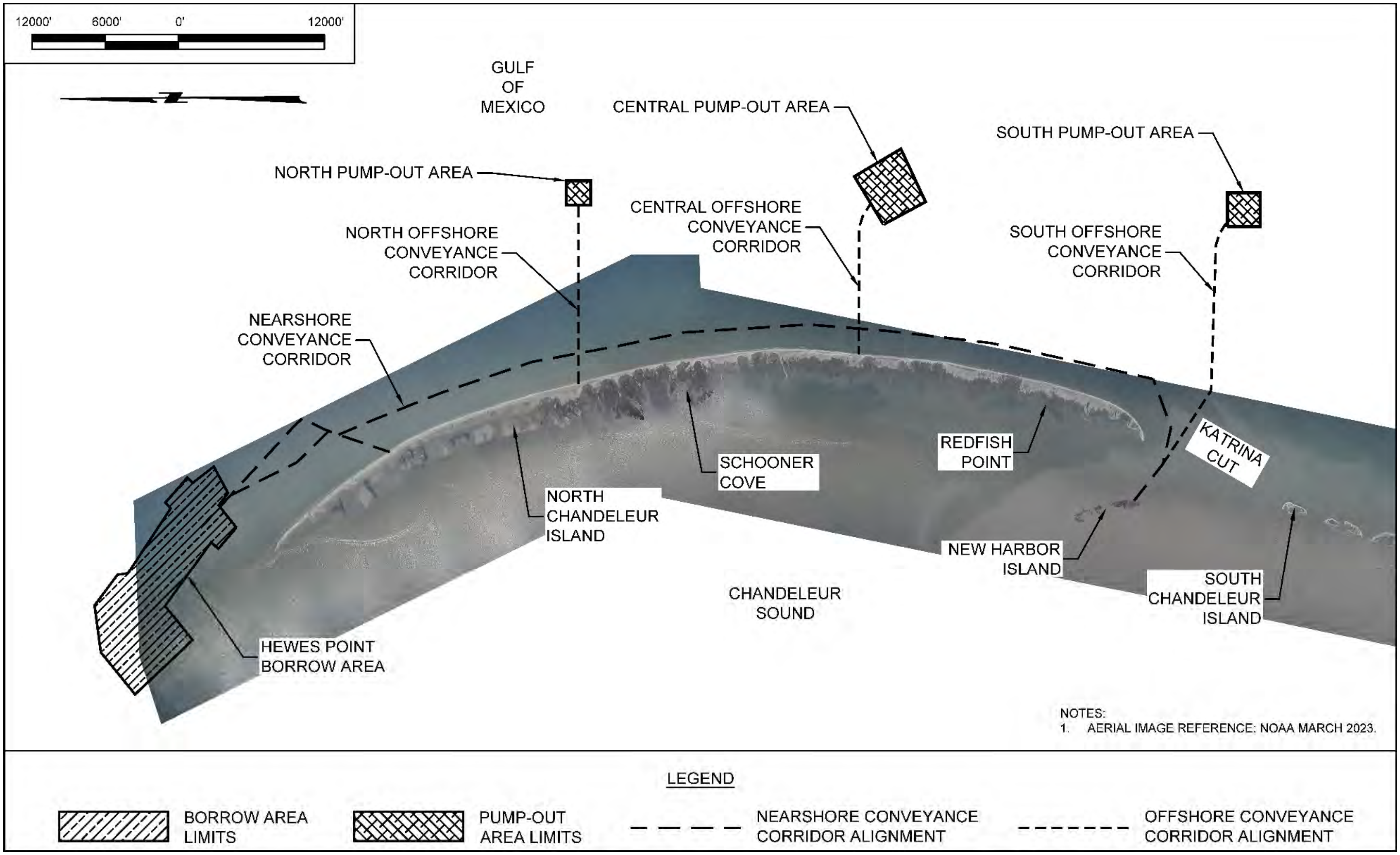


**Figure 4. Conveyance Corridors and Pump-Out Areas**

# 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.

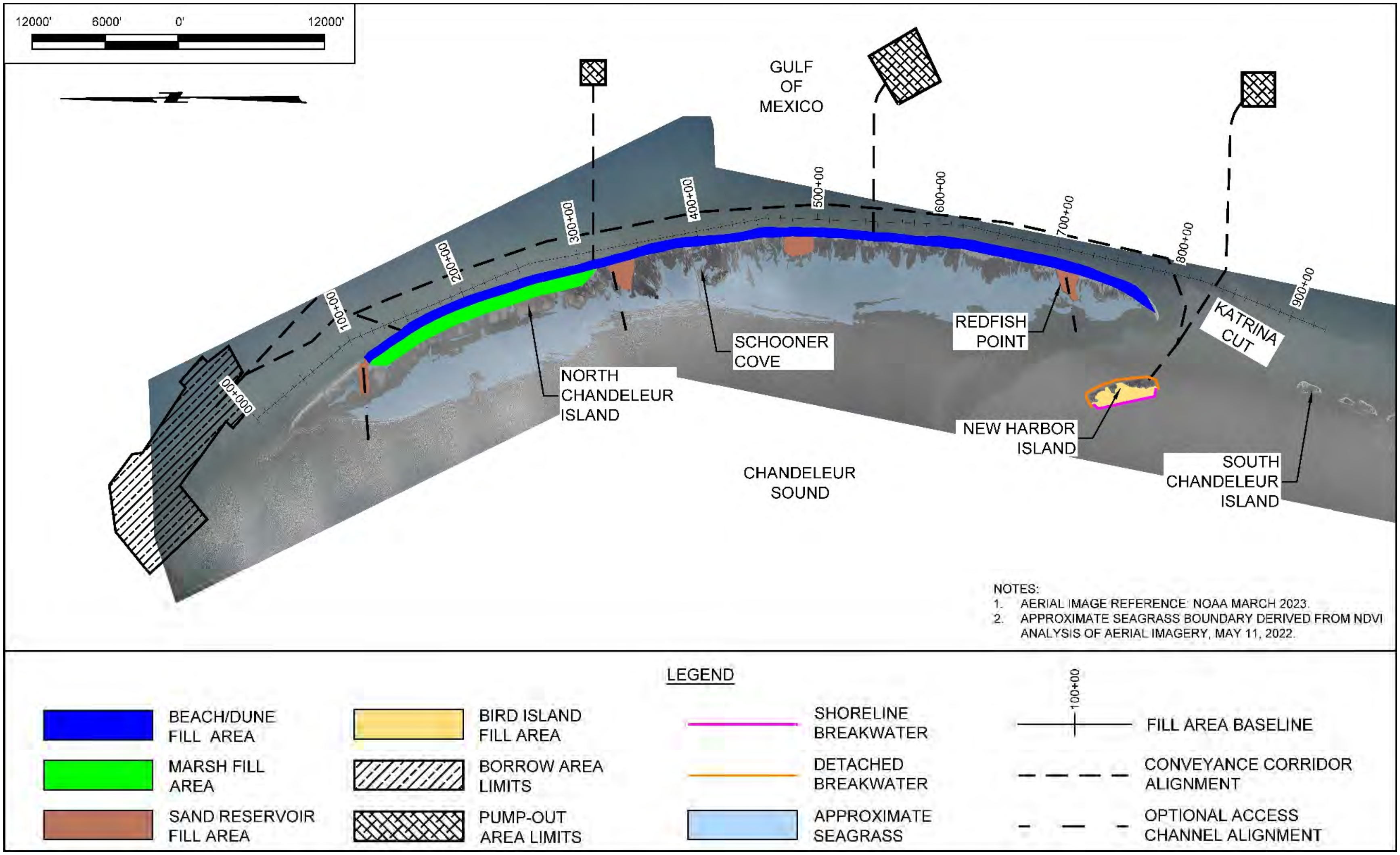


**Figure 5. Alternative 2 Plan View**

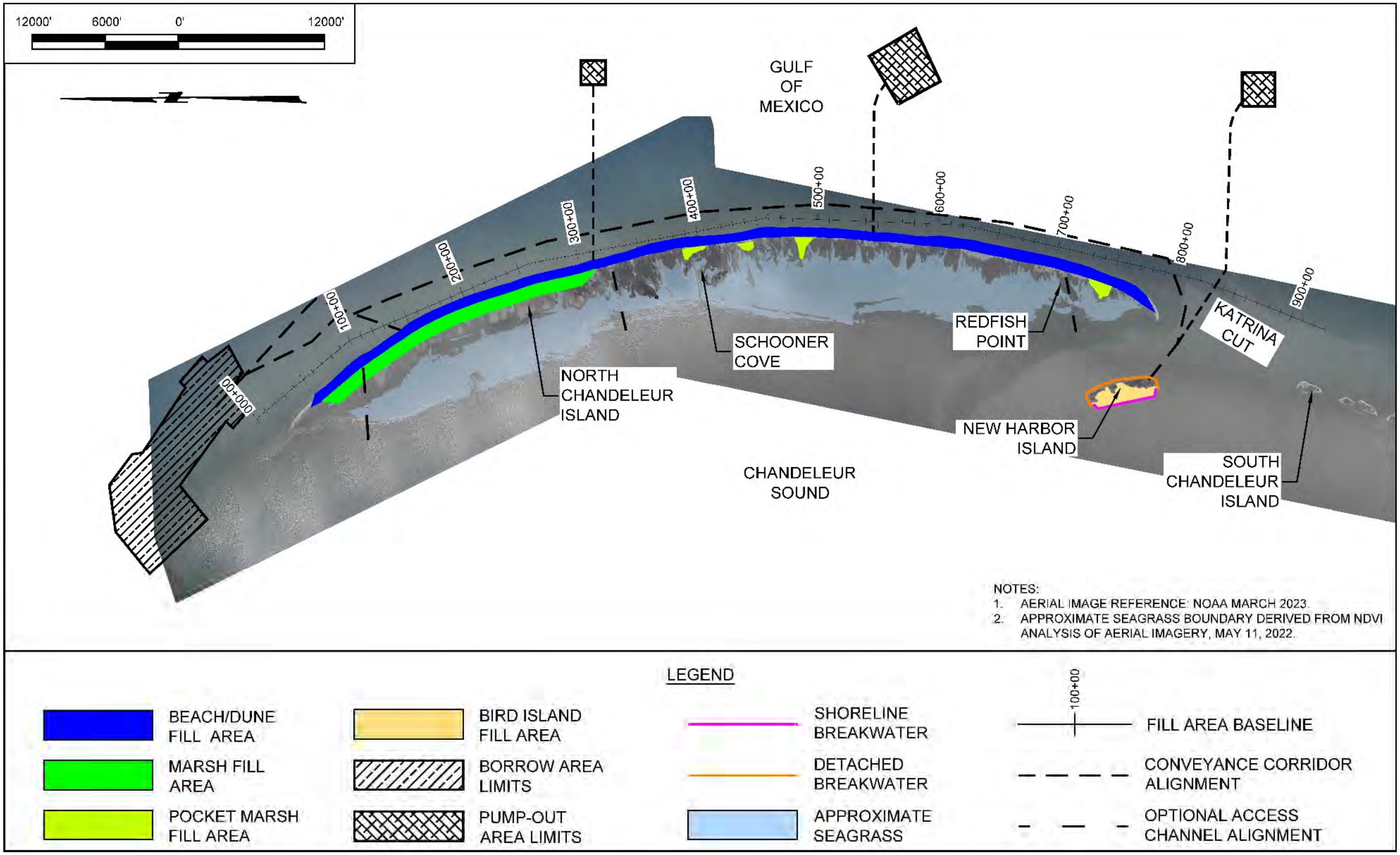


**Figure 6. Alternative 3 Plan View**

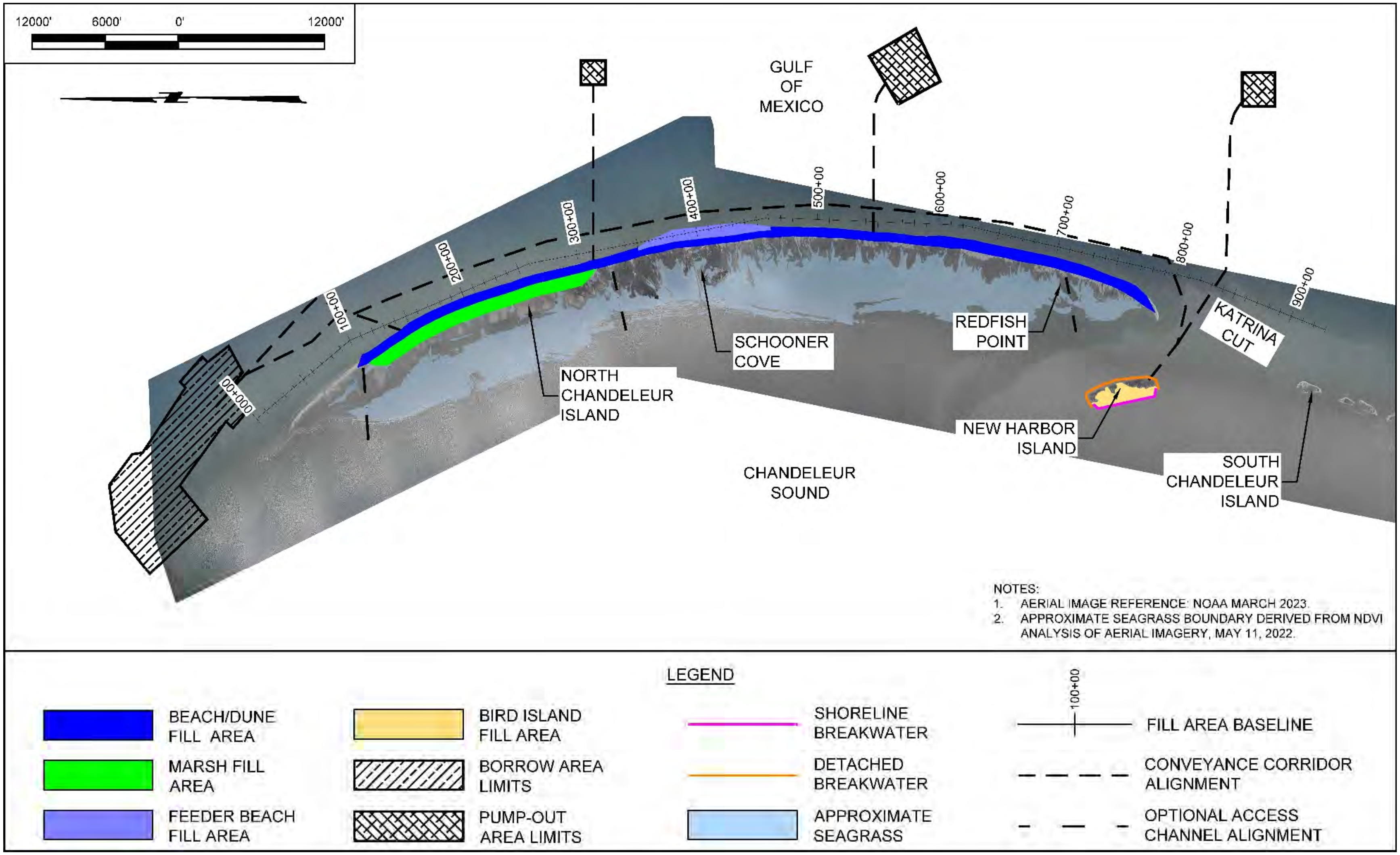


**Figure 7. Alternative 4 Plan View**

# 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).

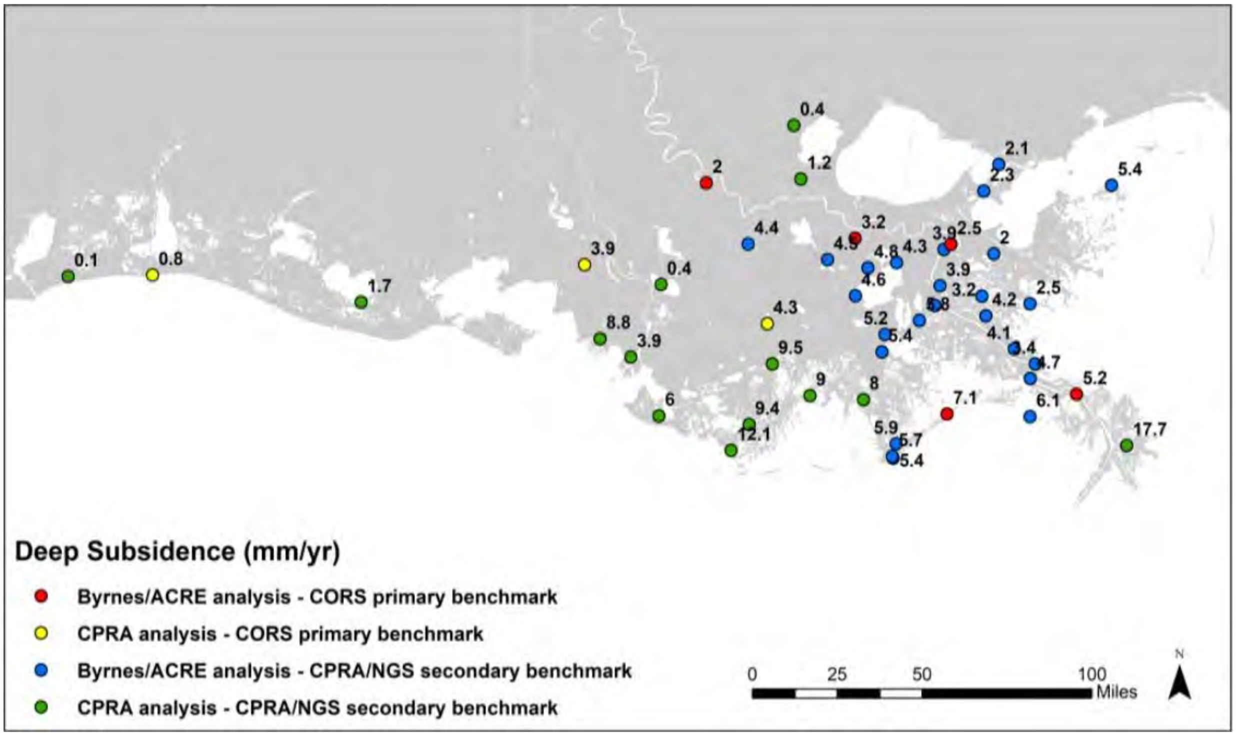


**Figure 8. Coastwide Map of Deep Subsidence Rates (Fitzpatrick et al., 2021)**

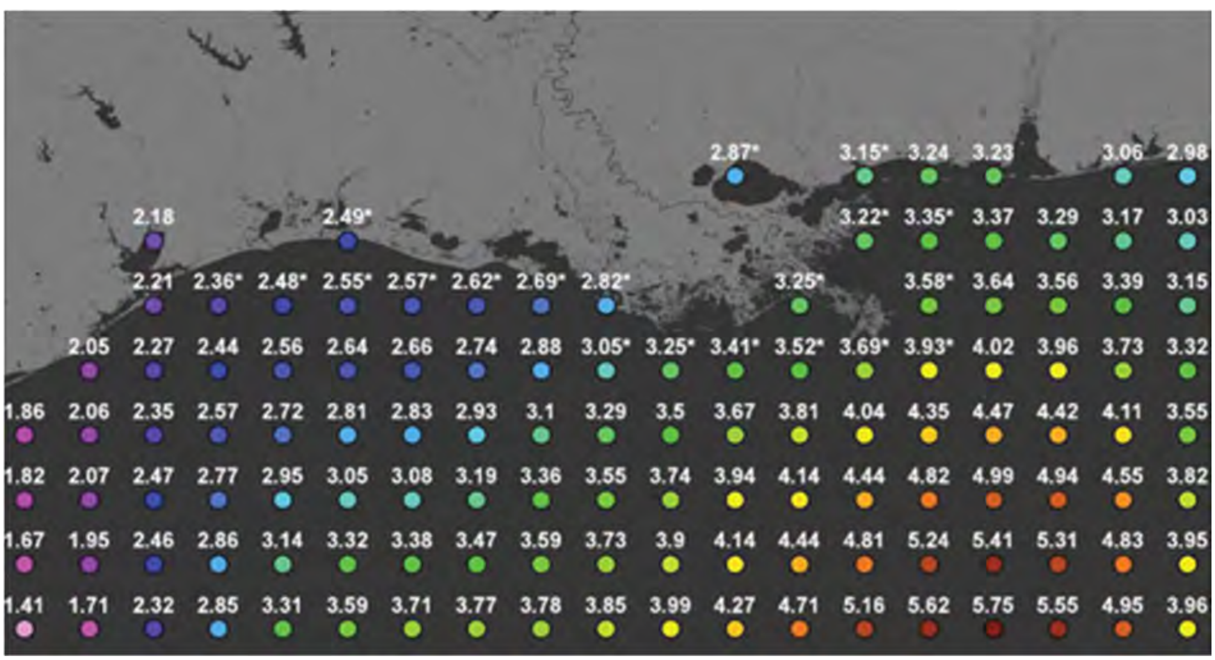


**Figure 9. Spatial Variability in Sea-Level Rise Trends Across Coastal Louisiana (CPRA, 2012)**

### 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).

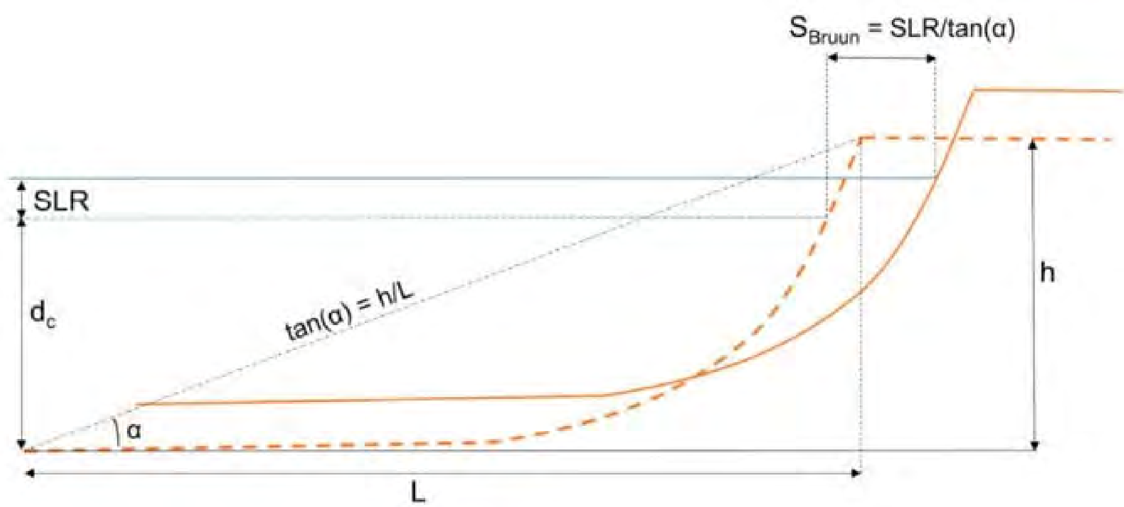


**Figure 10: Modified Bruun Rule**

(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.

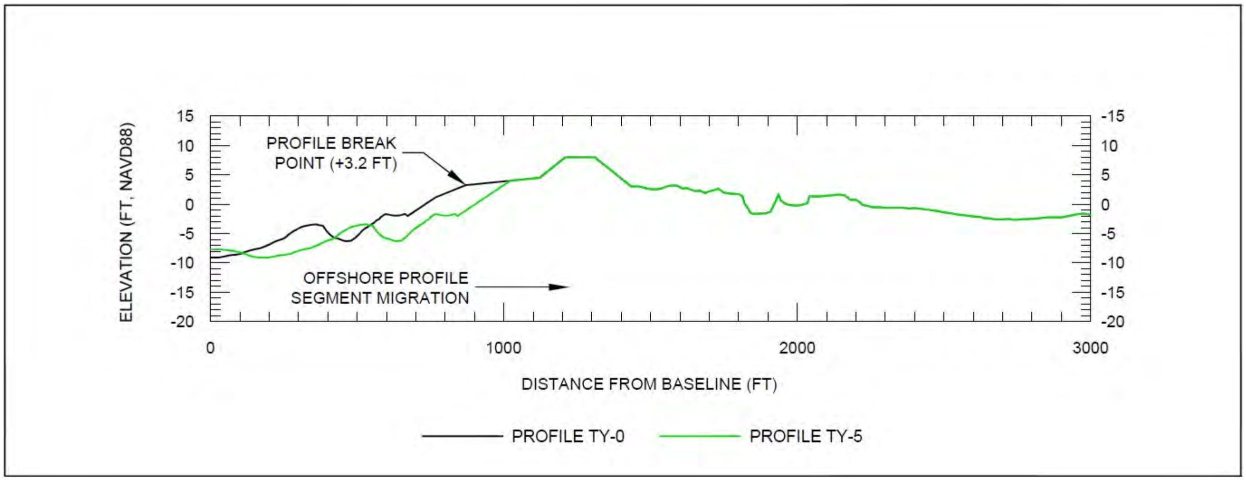


**Figure 11. Profile Modification for Shoreline Change.**

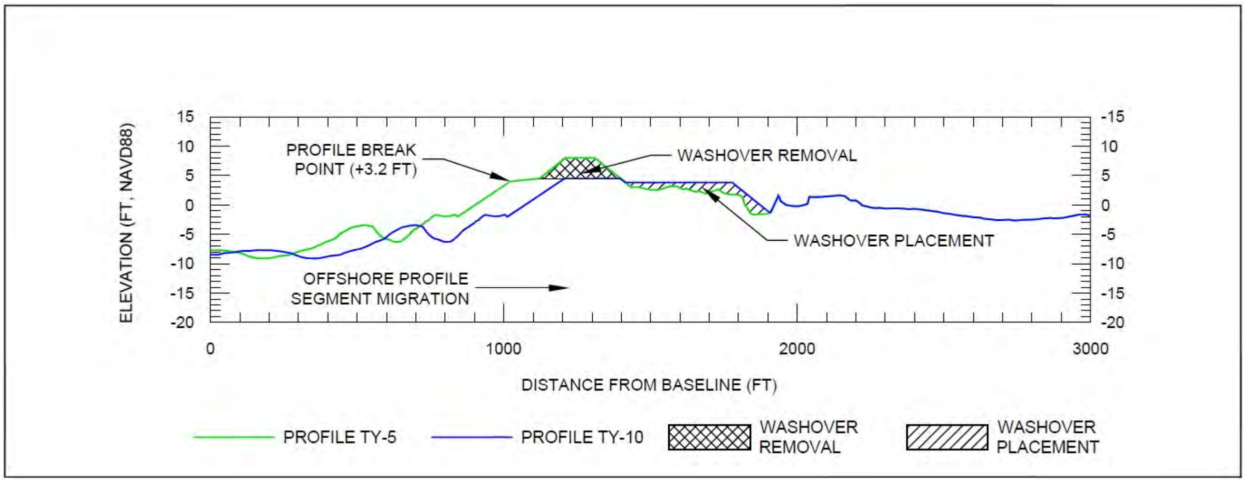


**Figure 12. Profile Modification due to Washover at TY-10.**

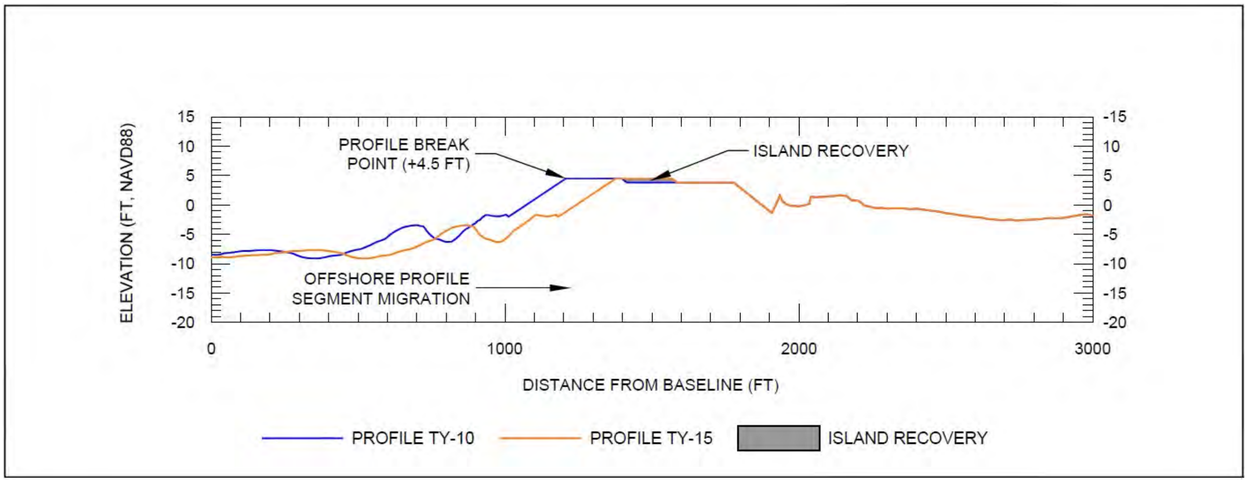


**Figure 13. Profile Modification for Island Recovery.**

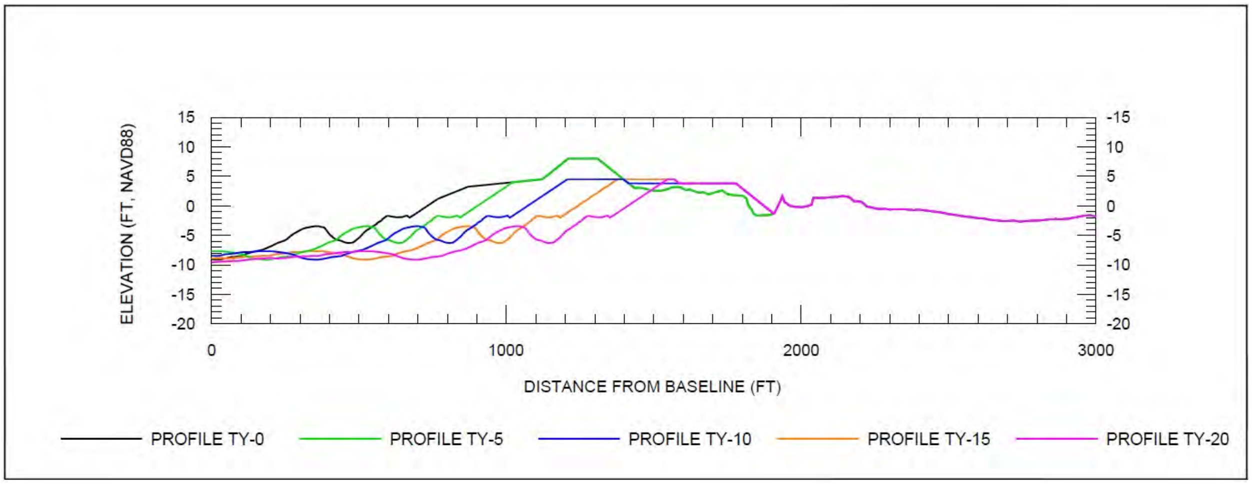


**Figure 14. Typical Profile Modeling over Time.**

## 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.

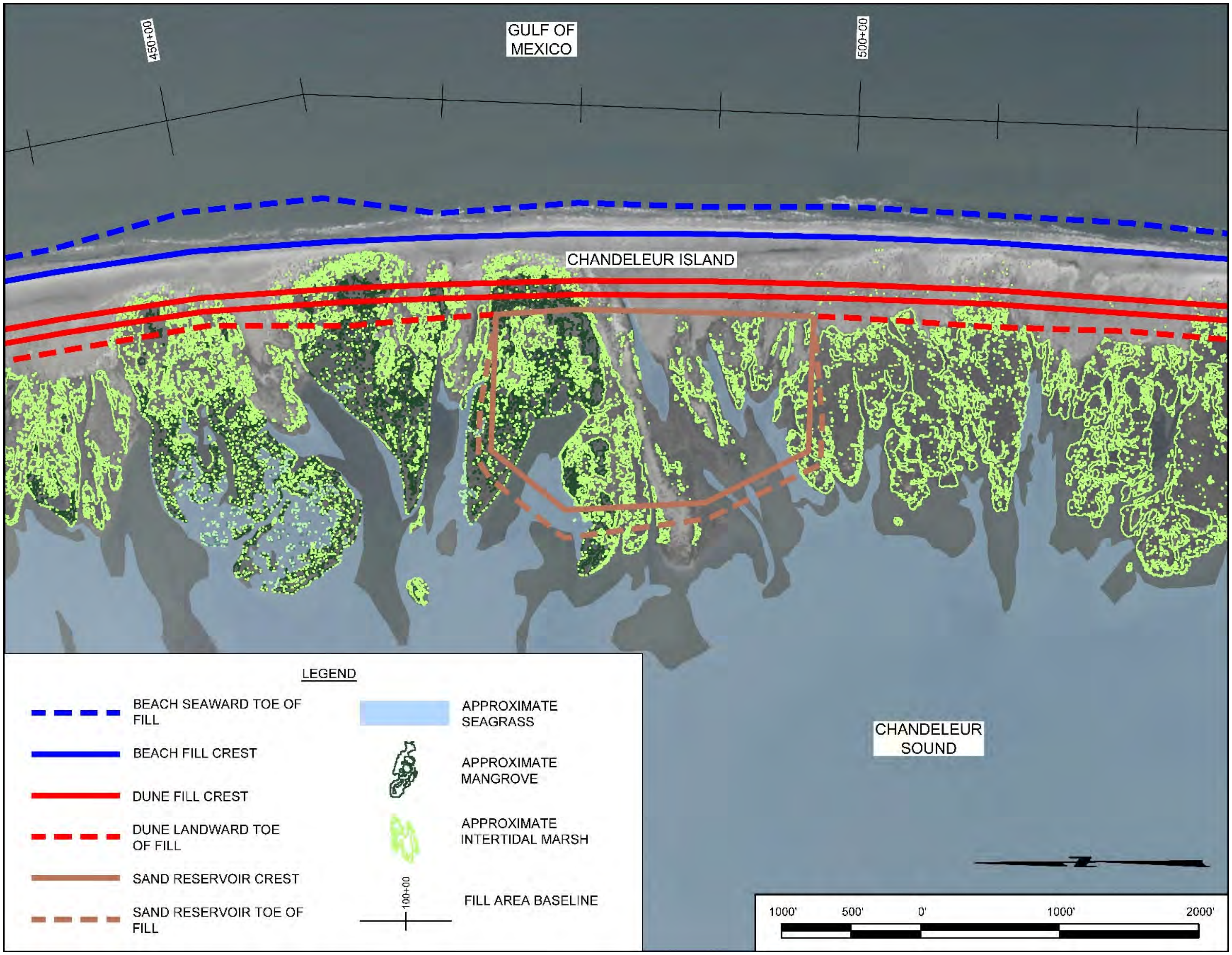


**Figure 15. Example Mangrove and Intertidal Vegetation Impacts in Relation to a Sand Reservoir**

## 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.

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

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.

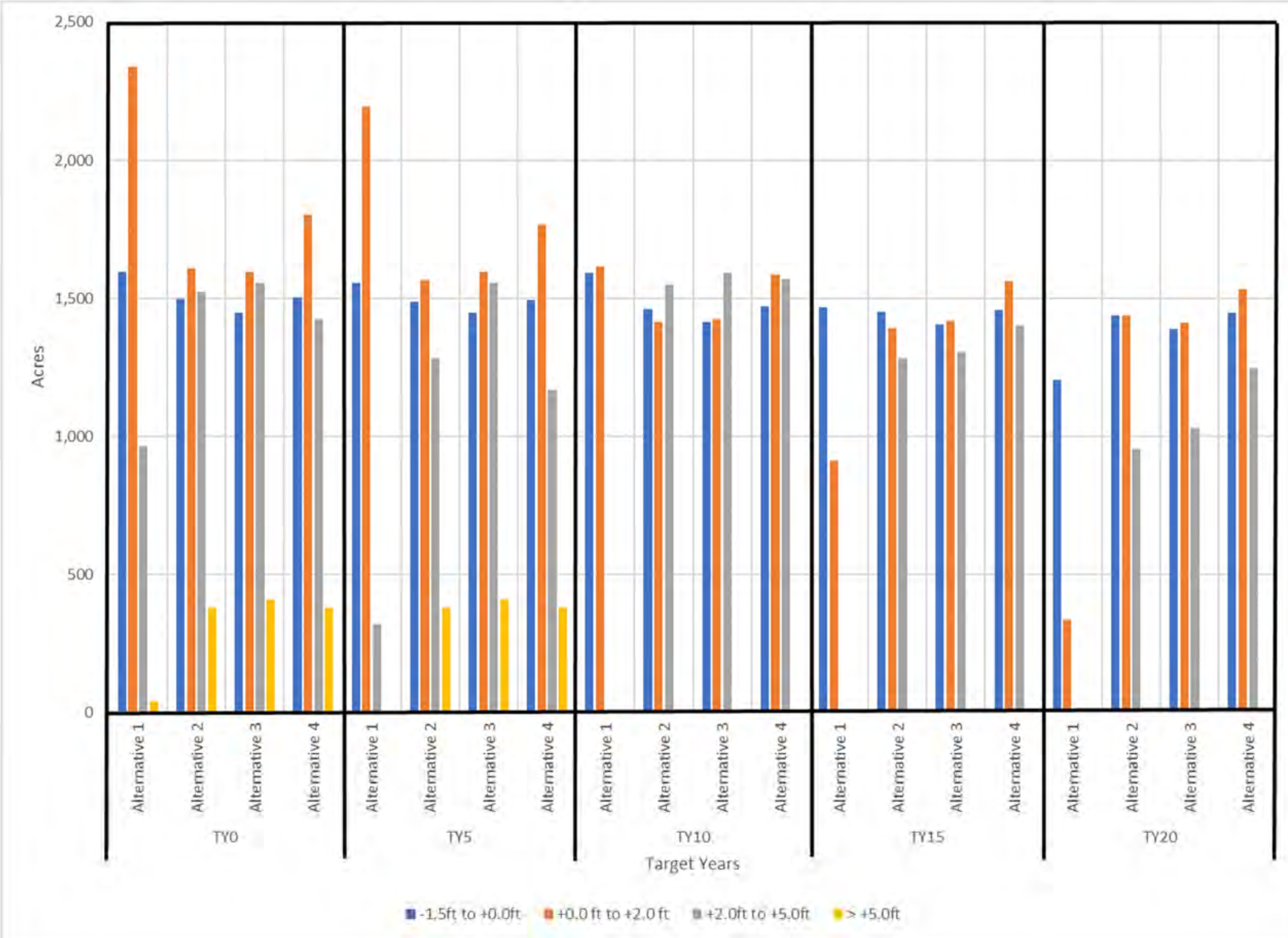


**Figure 16. Histogram of Habitat Acres over Time**

## 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.

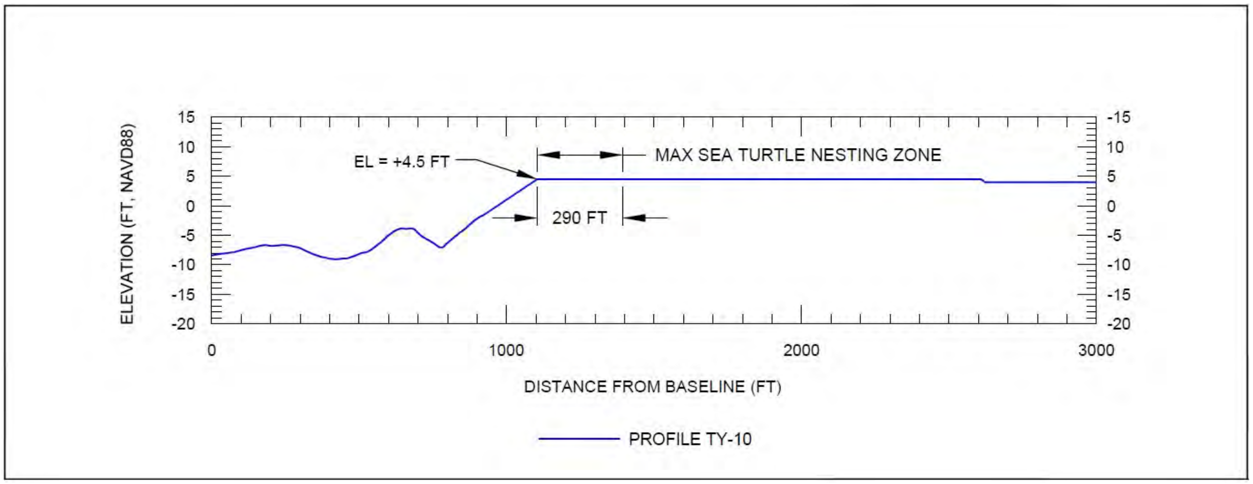


**Figure 17. Maximum Sea Turtle Nesting Zone for Calculations Where Dune is Not Present**

## 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.

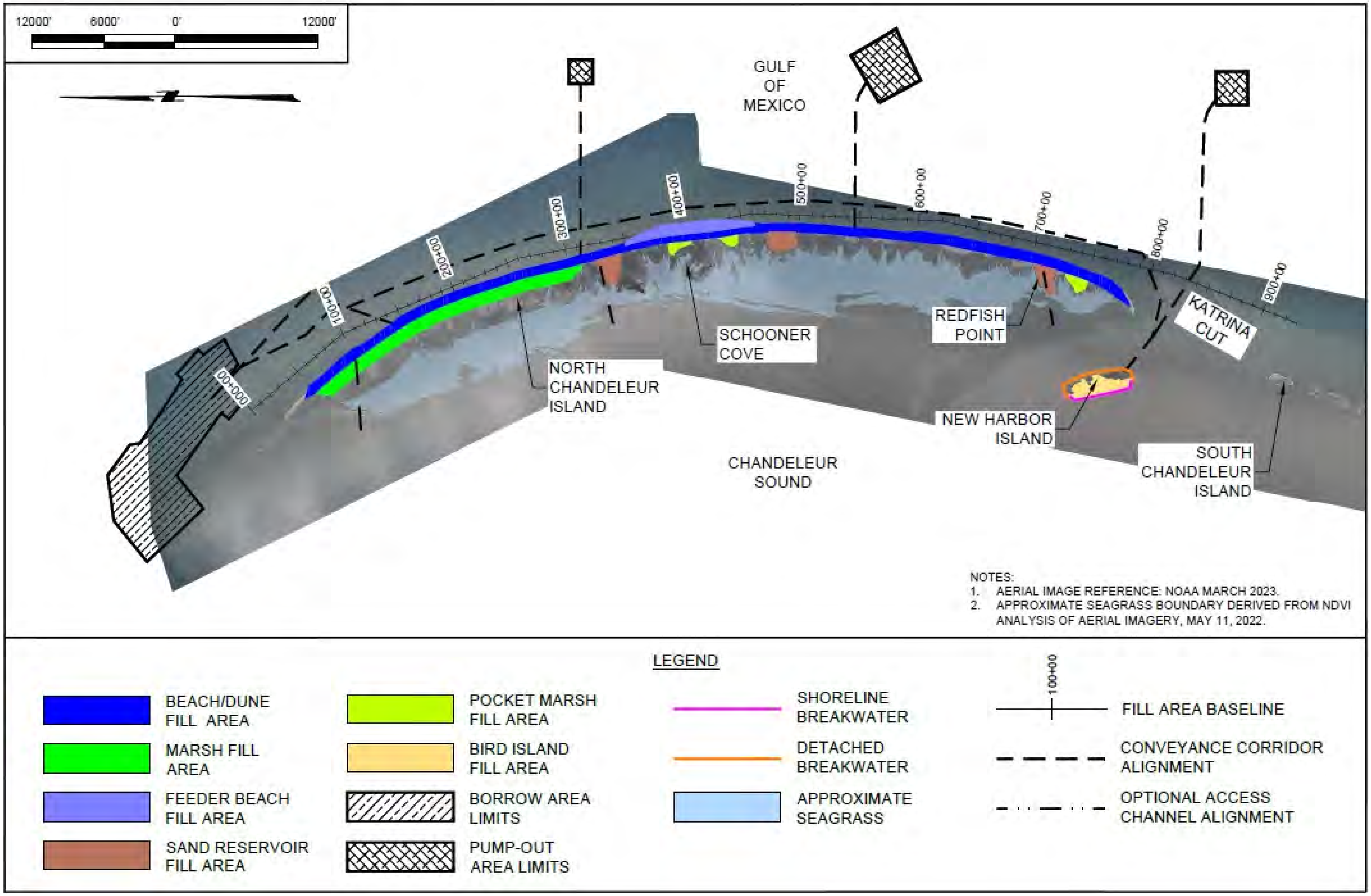


**Figure 18. Recommended Alternative Plan View (Alternative 5)**

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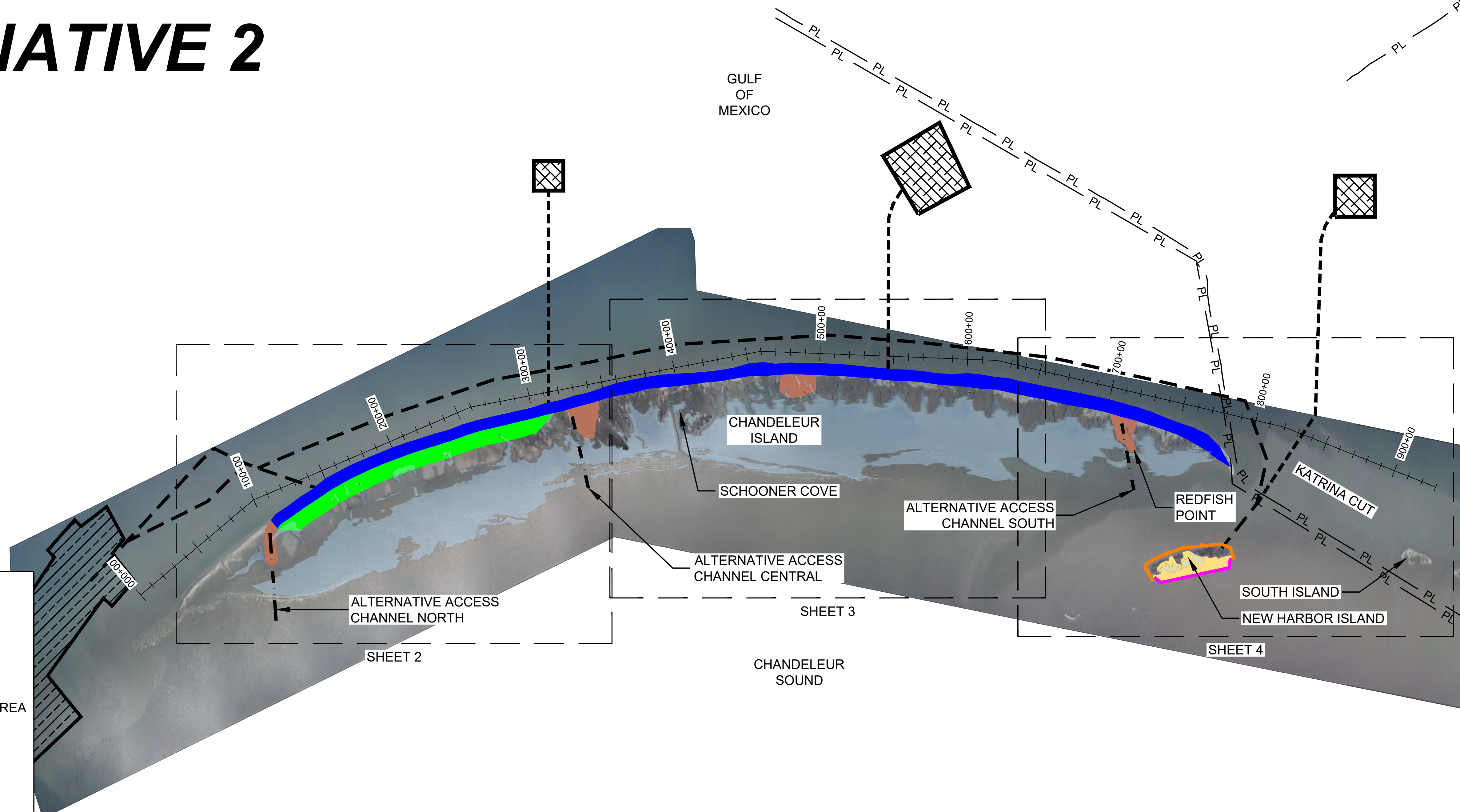
# Appendix A: Alternative Design Drawings

# 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 |

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150 TERRACE AVENUE
BATON ROUGE, LOUISIANA 70802

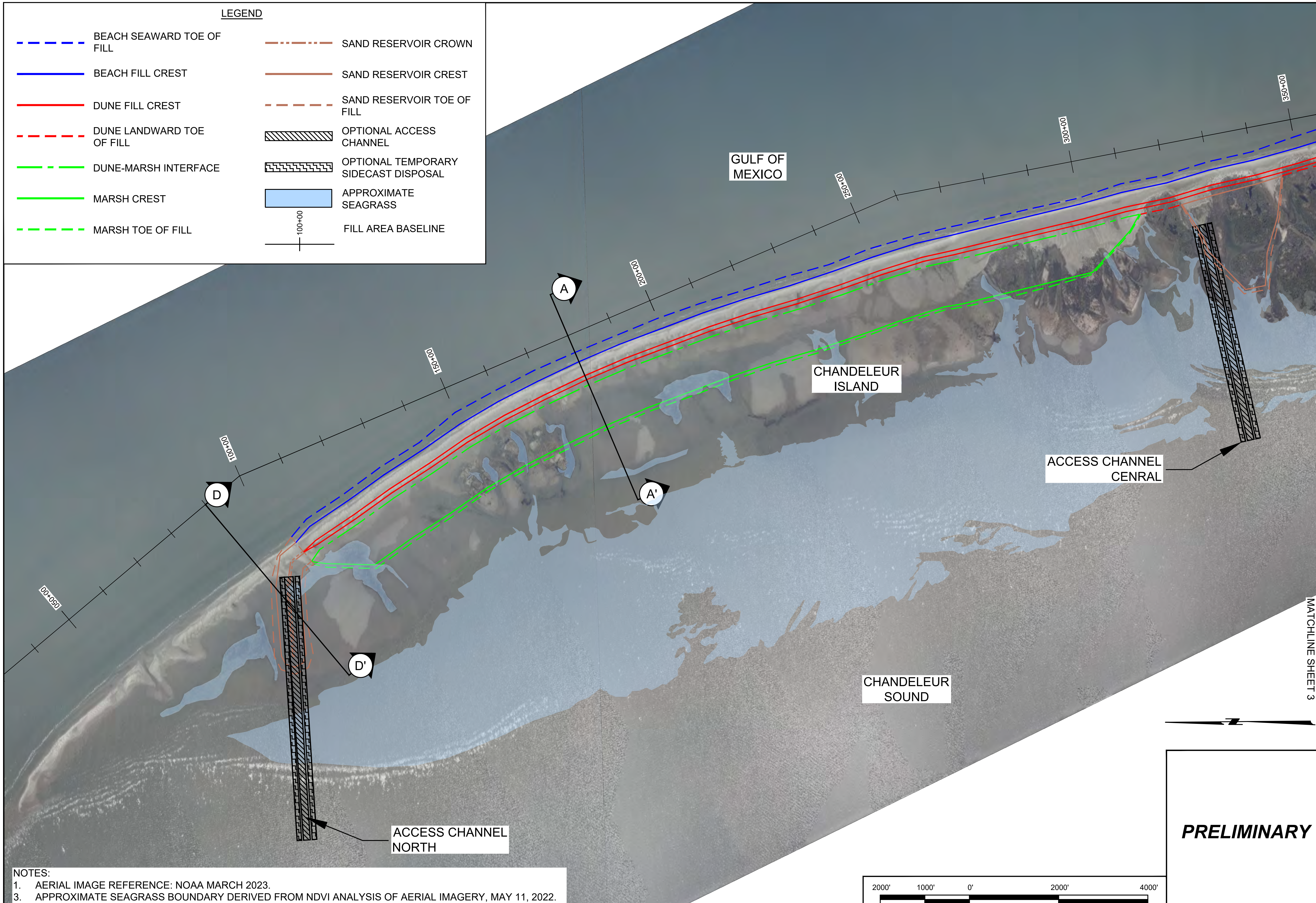
CHANDELEUR ISLAND RESTORATION

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

RESTORATION ALTERNATIVE 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.

**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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CHANDELEUR ISLAND RESTORATION

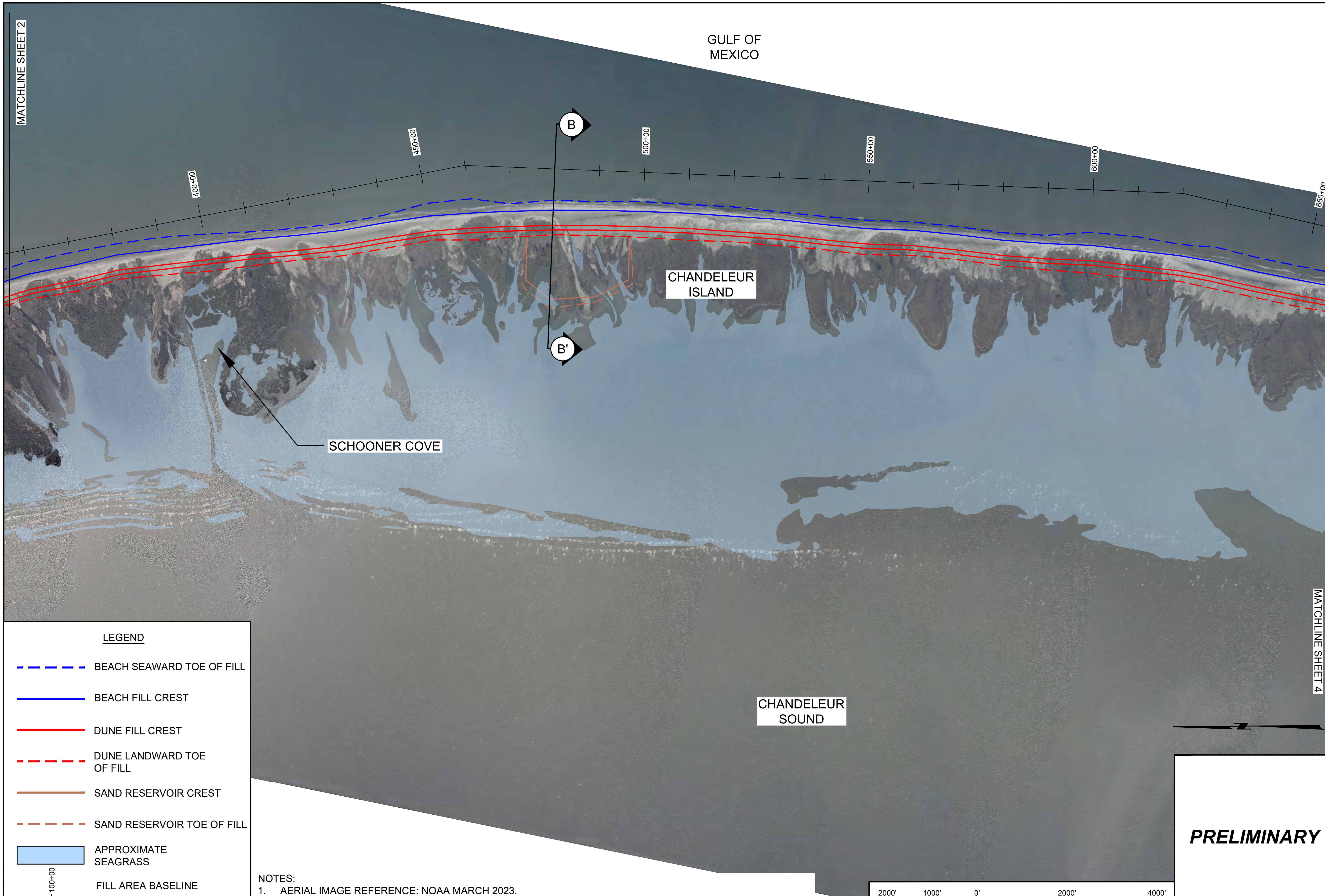
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

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.

**PRELIMINARY**

| 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

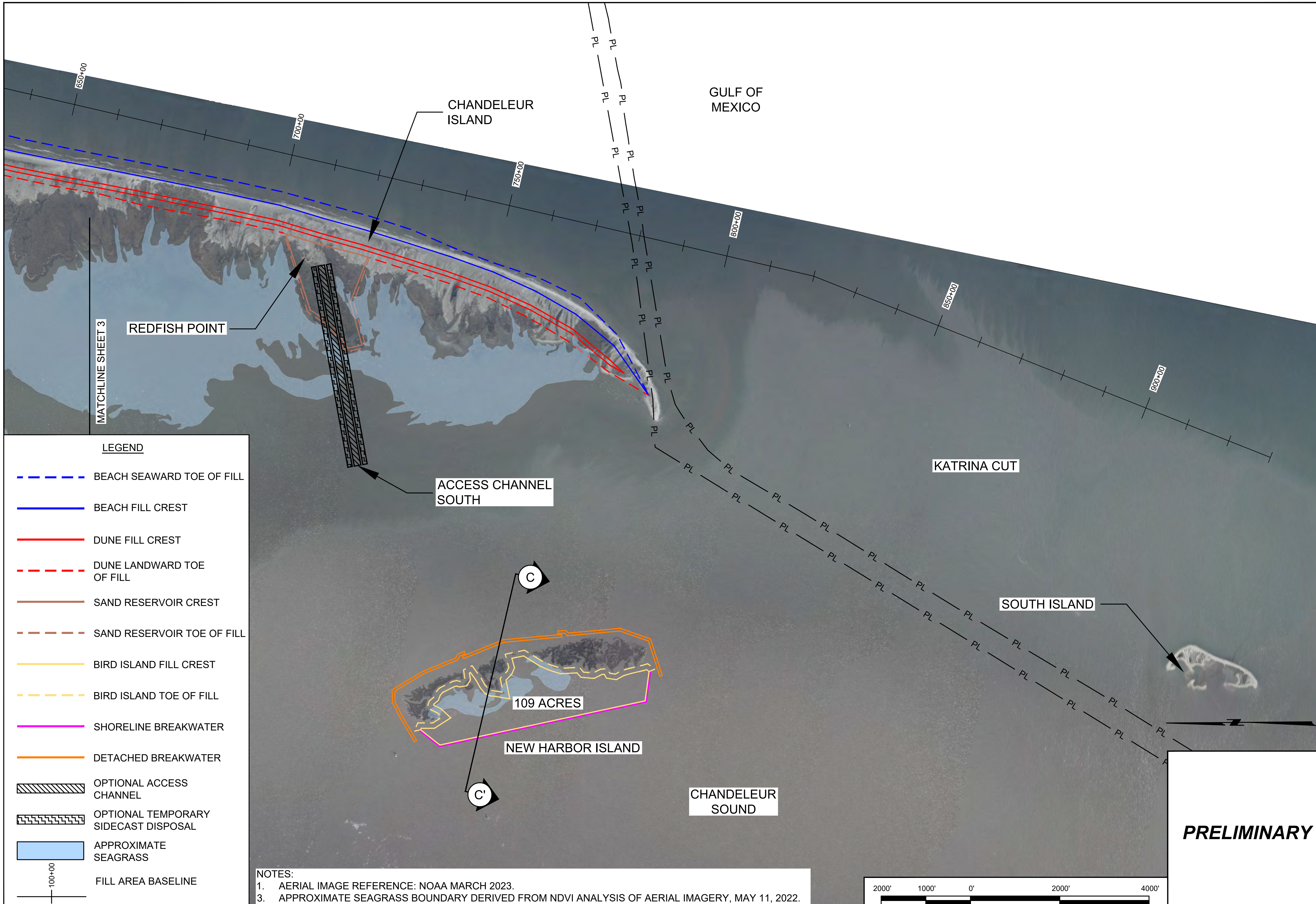
CHANDELEUR ISLAND RESTORATION

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

DATE: FEBRUARY 2024




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.

**PRELIMINARY**

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


CHANDELEUR ISLAND RESTORATION

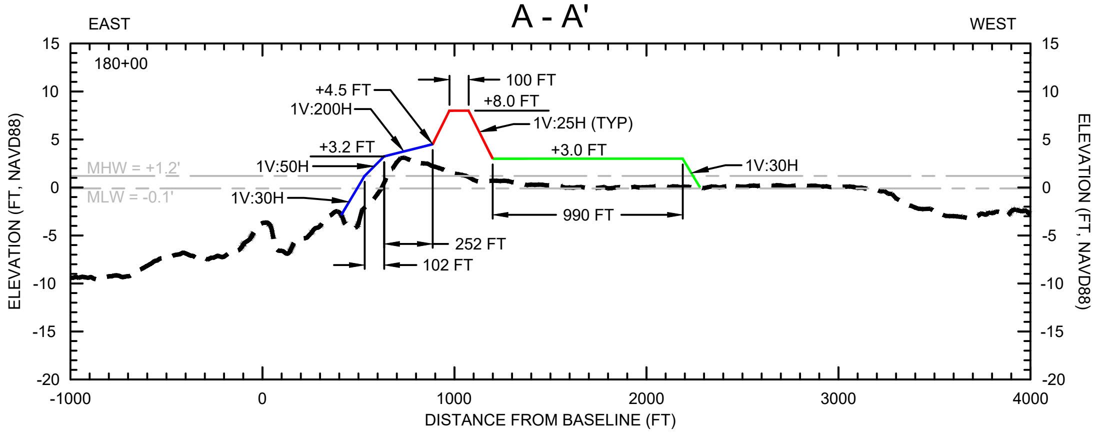
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 2 PLAN VIEW

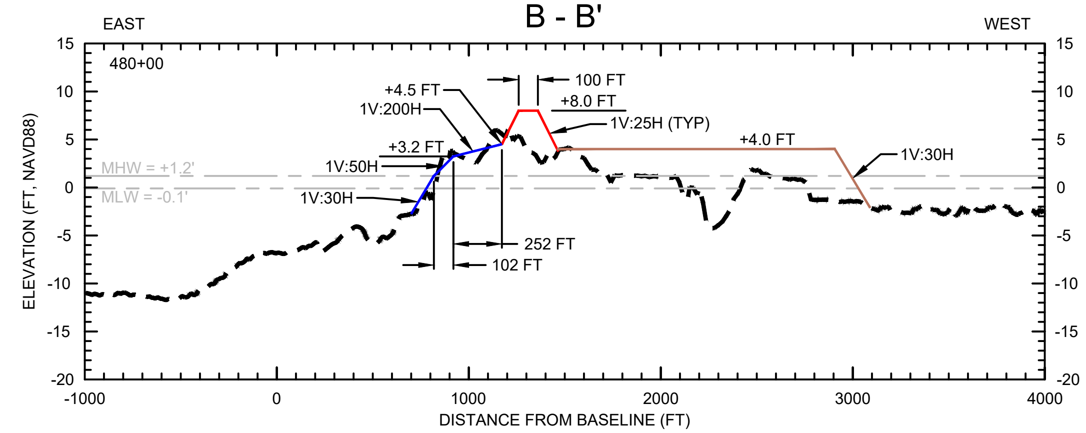
STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

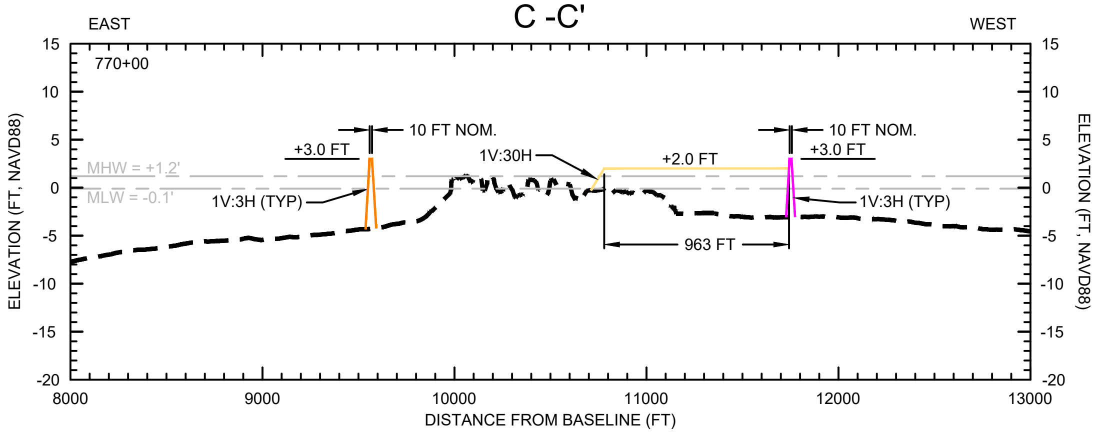
A - A'



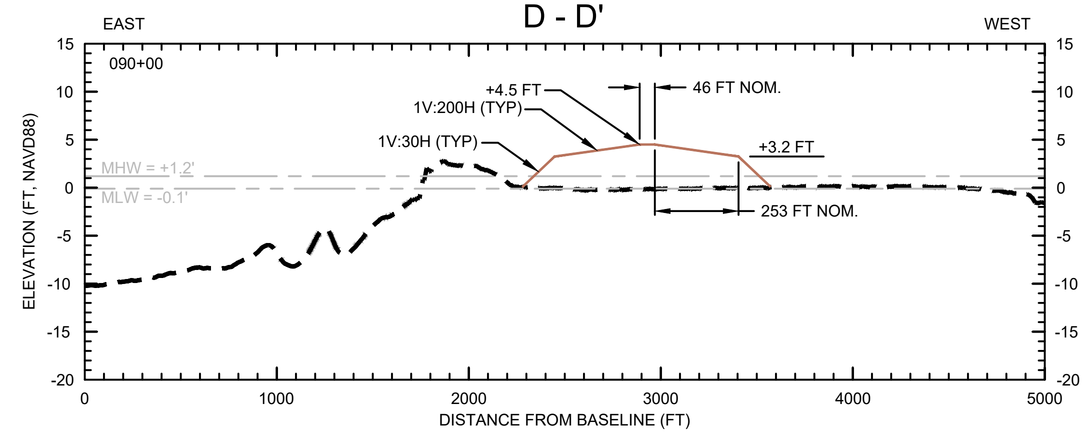

B - B'




C -C'




D - D'




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
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.

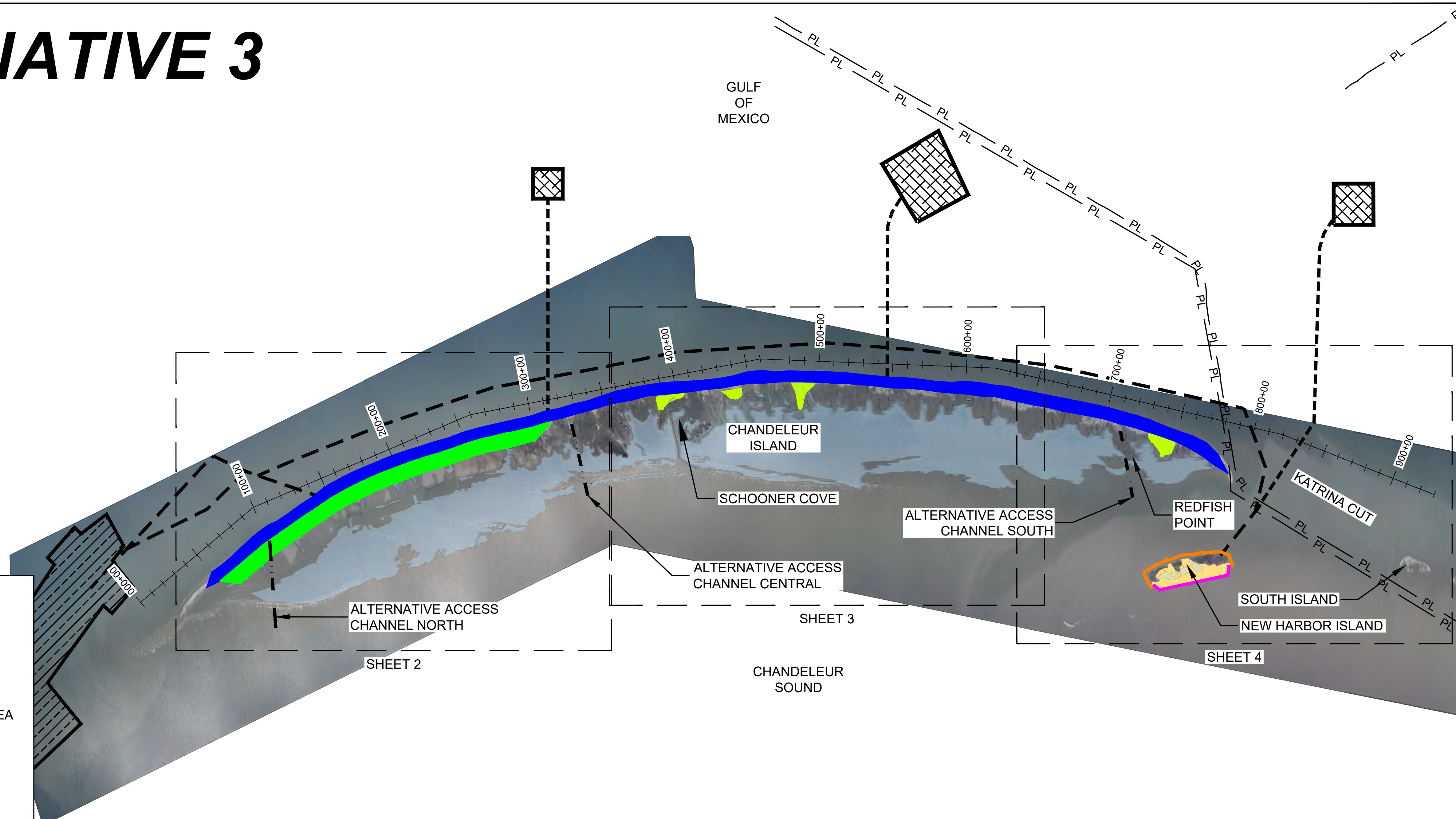
RESTORATION ALTERNATIVE 2 TYPICAL SECTIONS

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.

***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.
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DENHAM SPRINGS, LA
70726



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

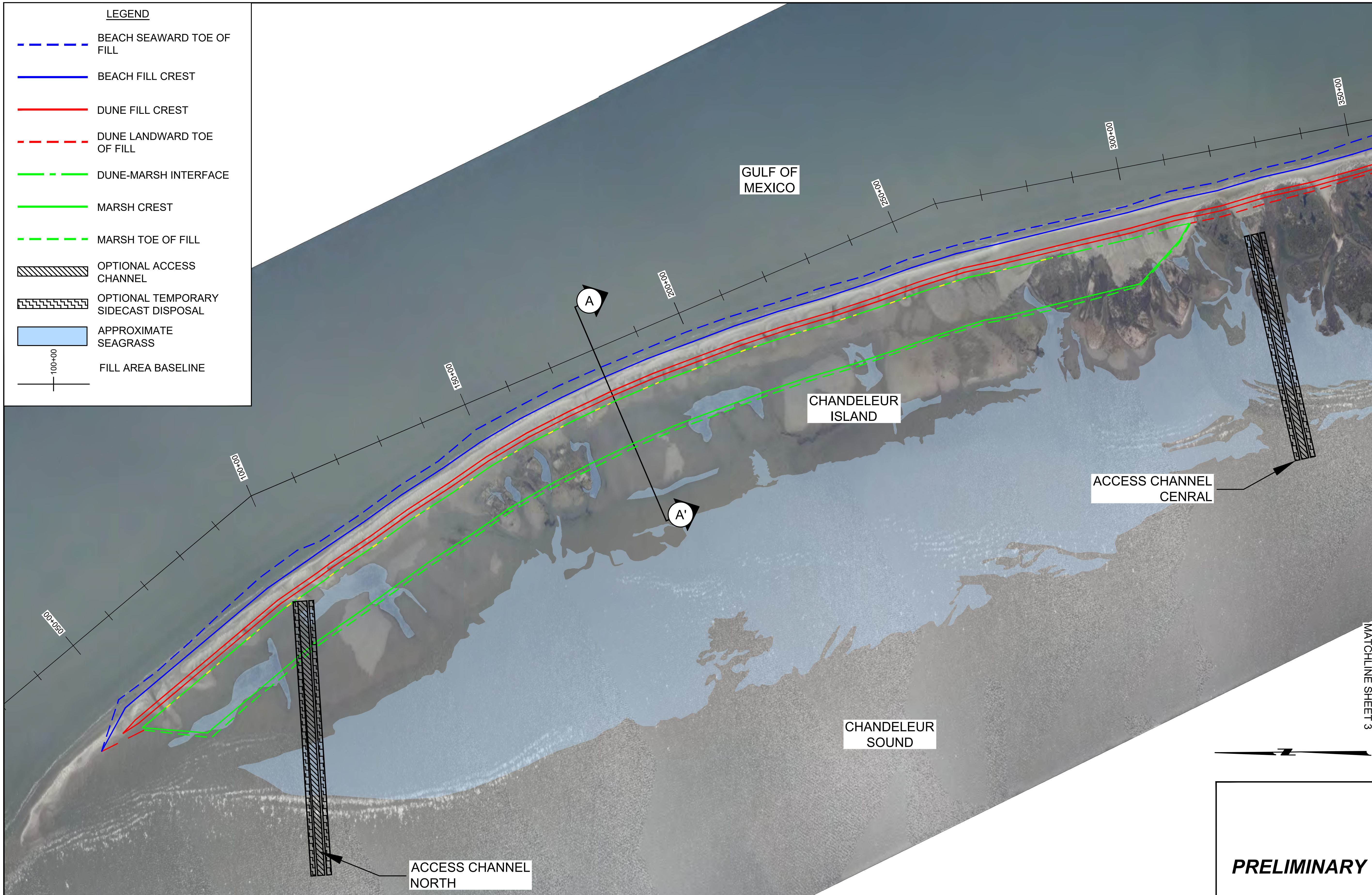

CHANDELEUR ISLAND RESTORATION

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

RESTORATION ALTERNATIVE 3 OVERVIEW

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

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 |

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

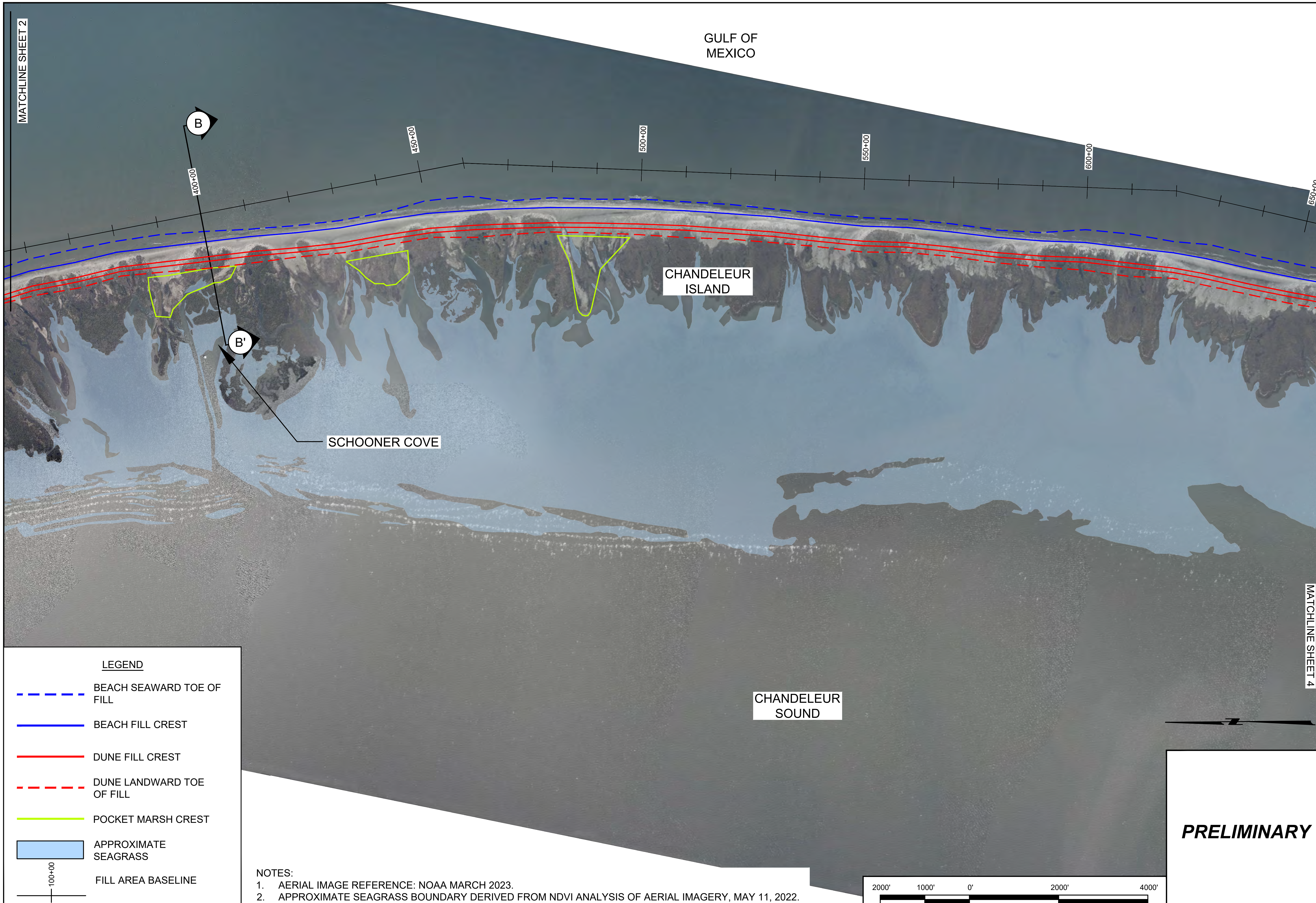
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 3 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
- 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.

**PRELIMINARY**

| REV. | DATE | DESCRIPTION | BY |
|---|---|---|---|
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CHANDELEUR ISLAND RESTORATION

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STATE PROJECT NUMBER: PO-0199
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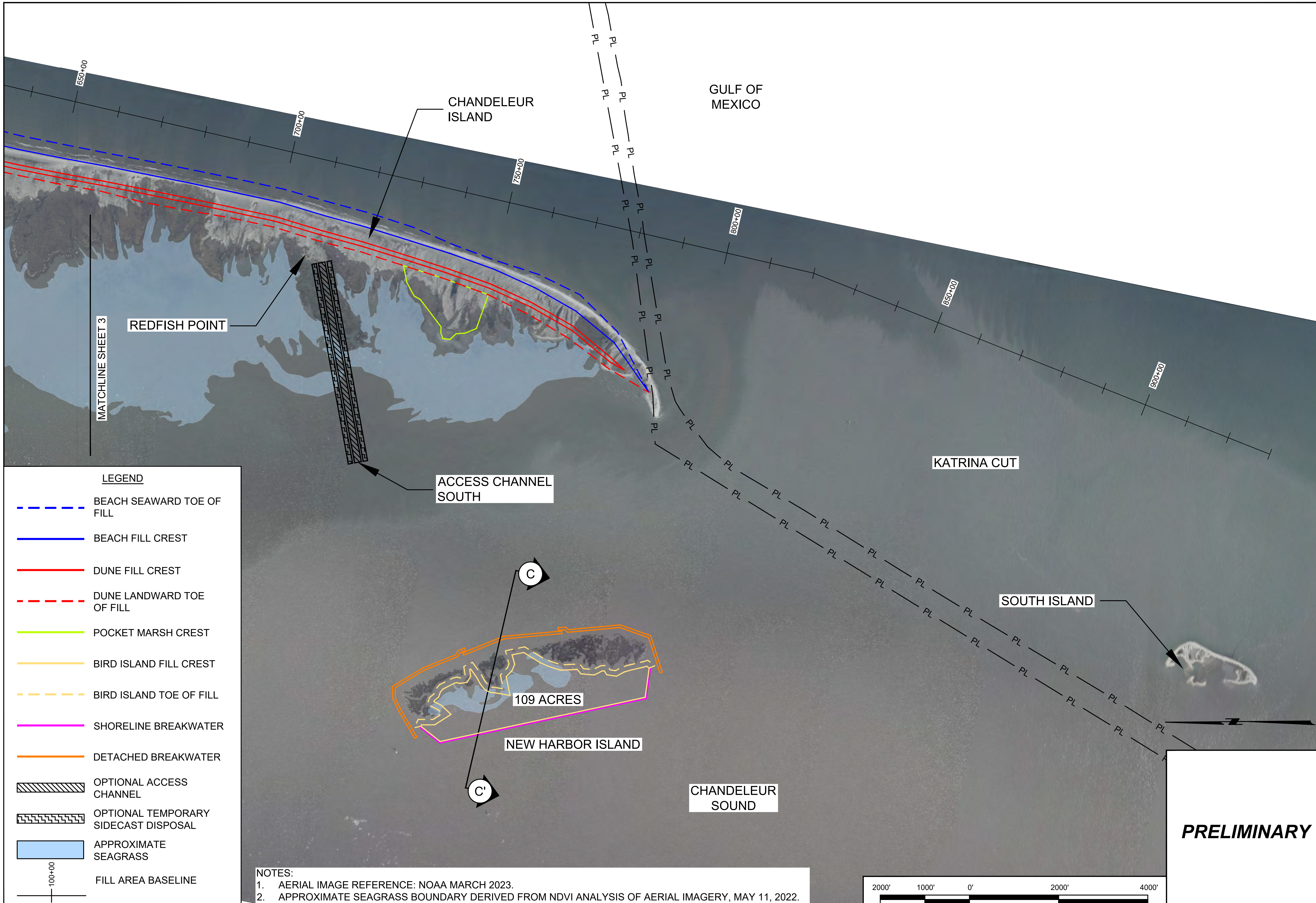


LEGEND

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

CHANDELEUR ISLAND RESTORATION

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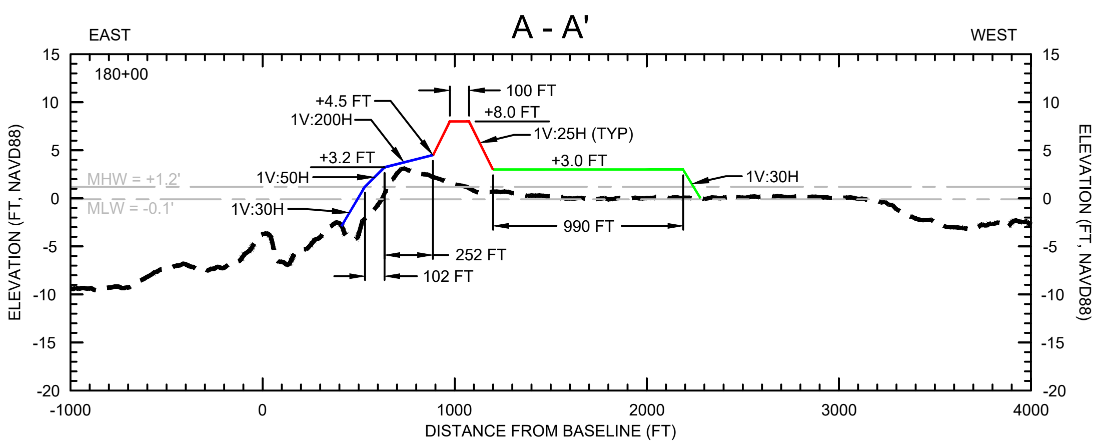
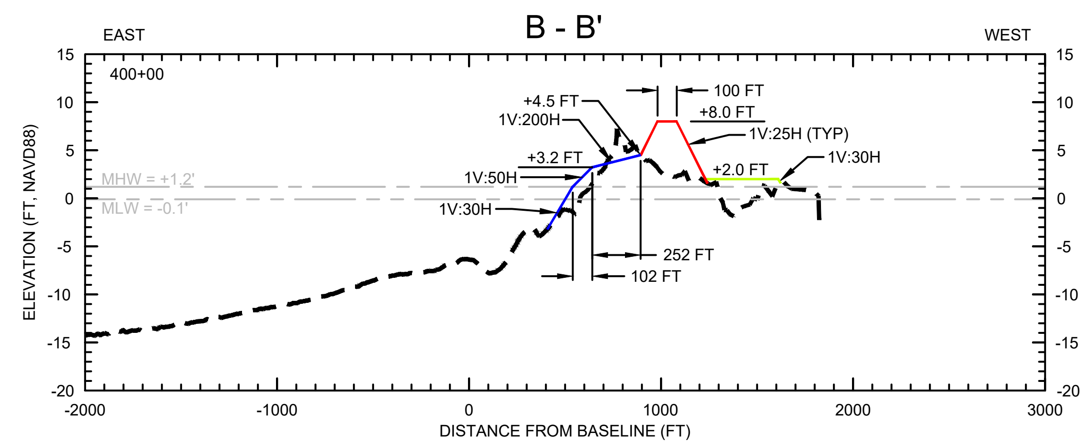
RESTORATION ALTERNATIVE 3 PLAN VIEW

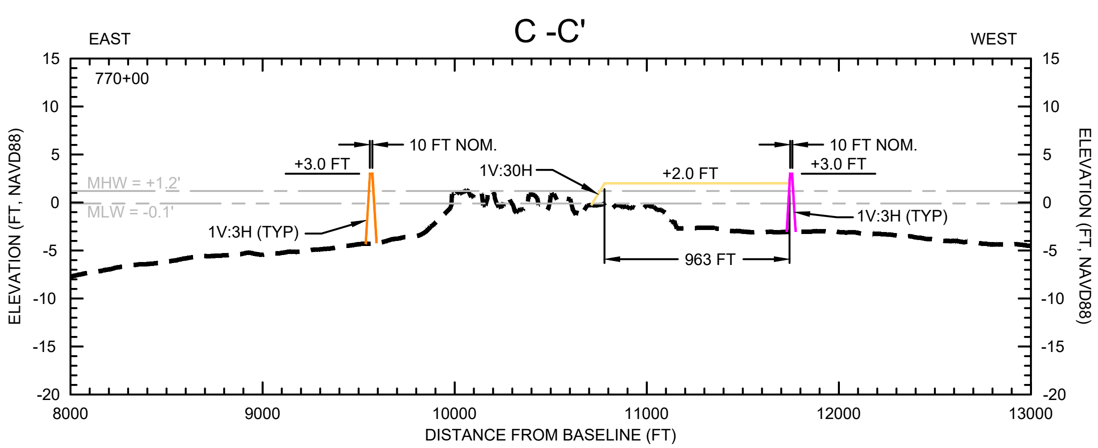
STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 4 OF 5




LEGEND

- BEACH FILL
- DUNE FILL
- MARSH FILL
- 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.

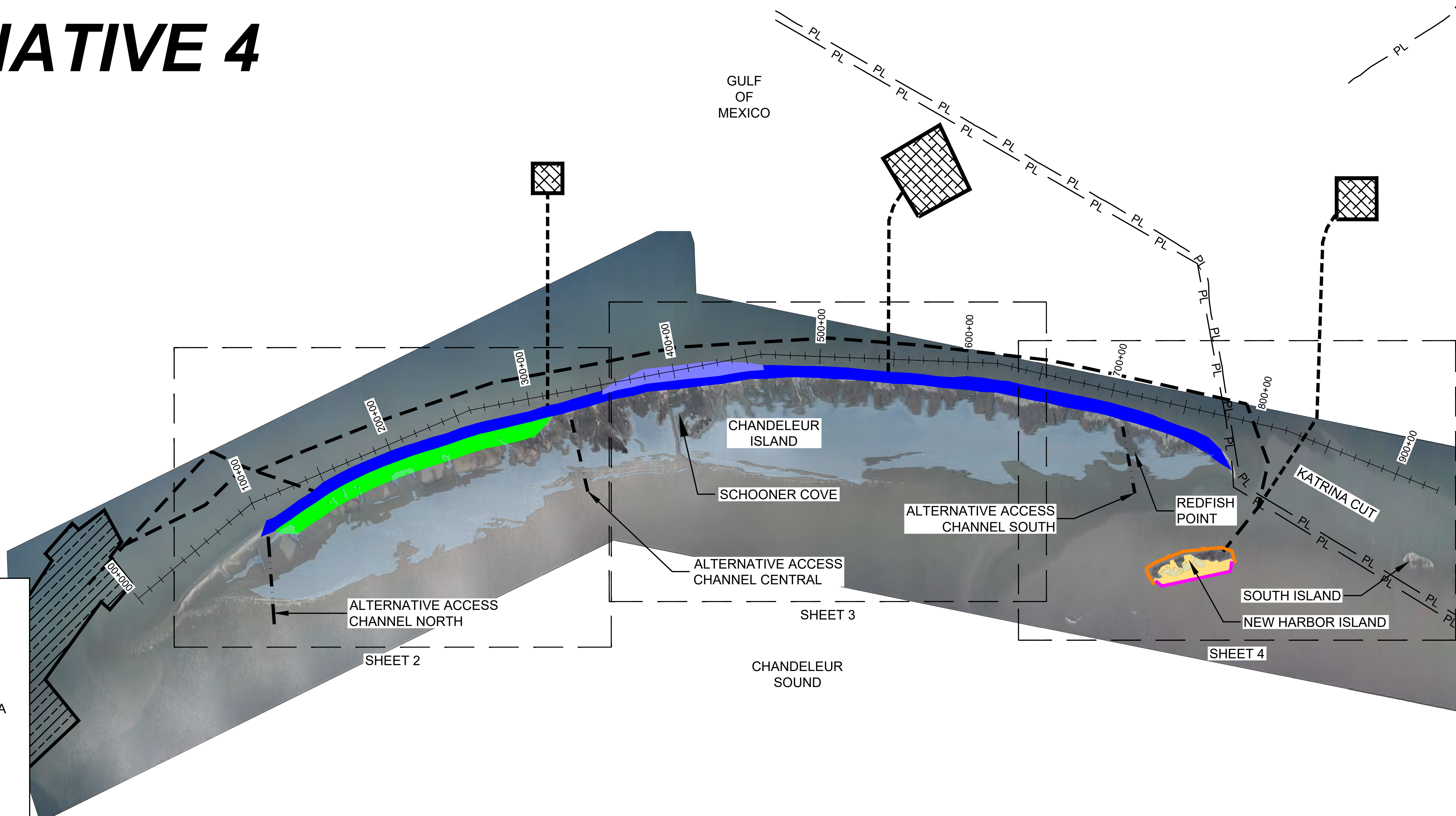
RESTORATION ALTERNATIVE 3 TYPICAL SECTIONS

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 |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DENHAM SPRINGS, LA 70726


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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 OVERVIEW

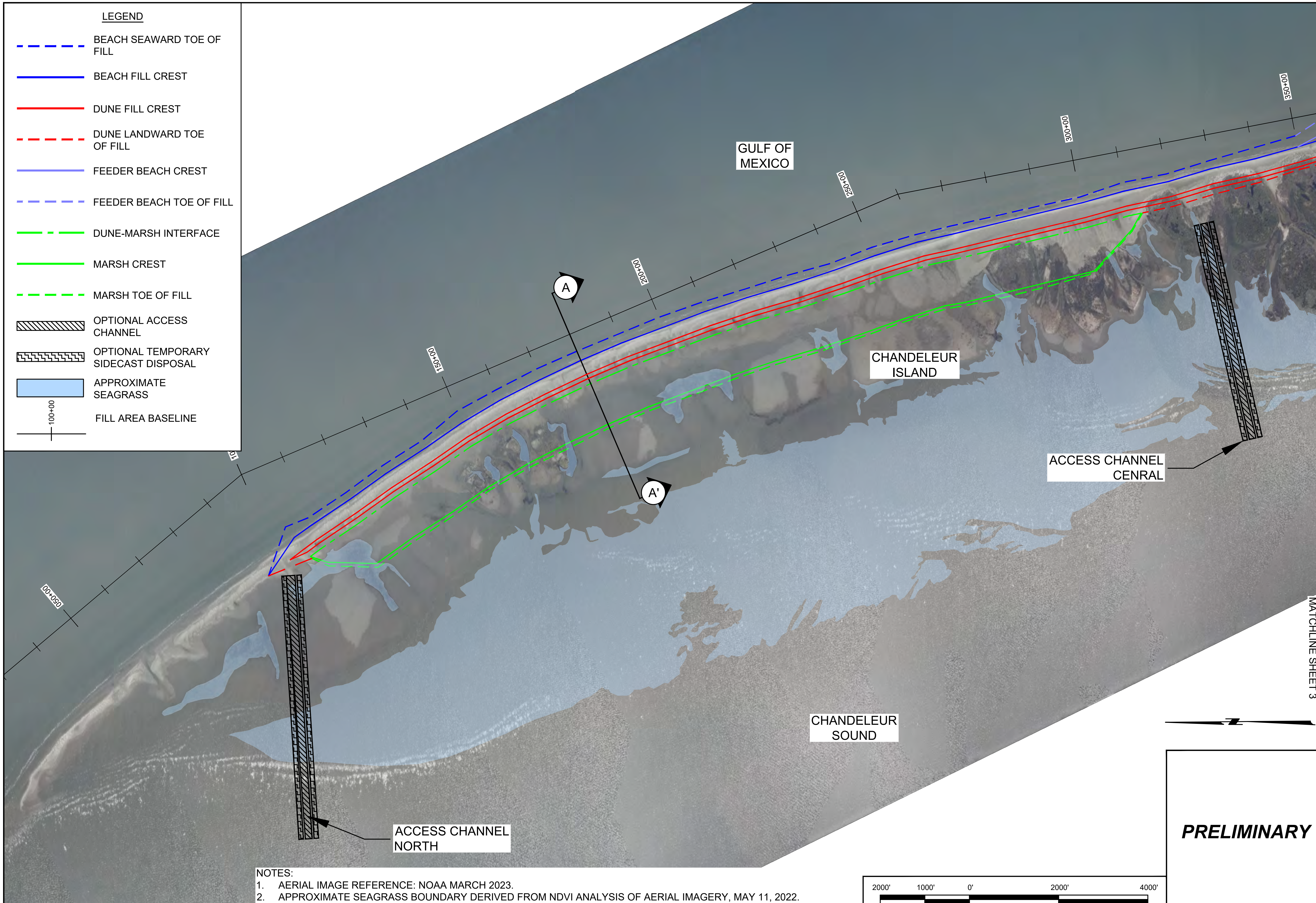
STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

SHEET 1 OF 5

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




NOTES:
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**PRELIMINARY**

| 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

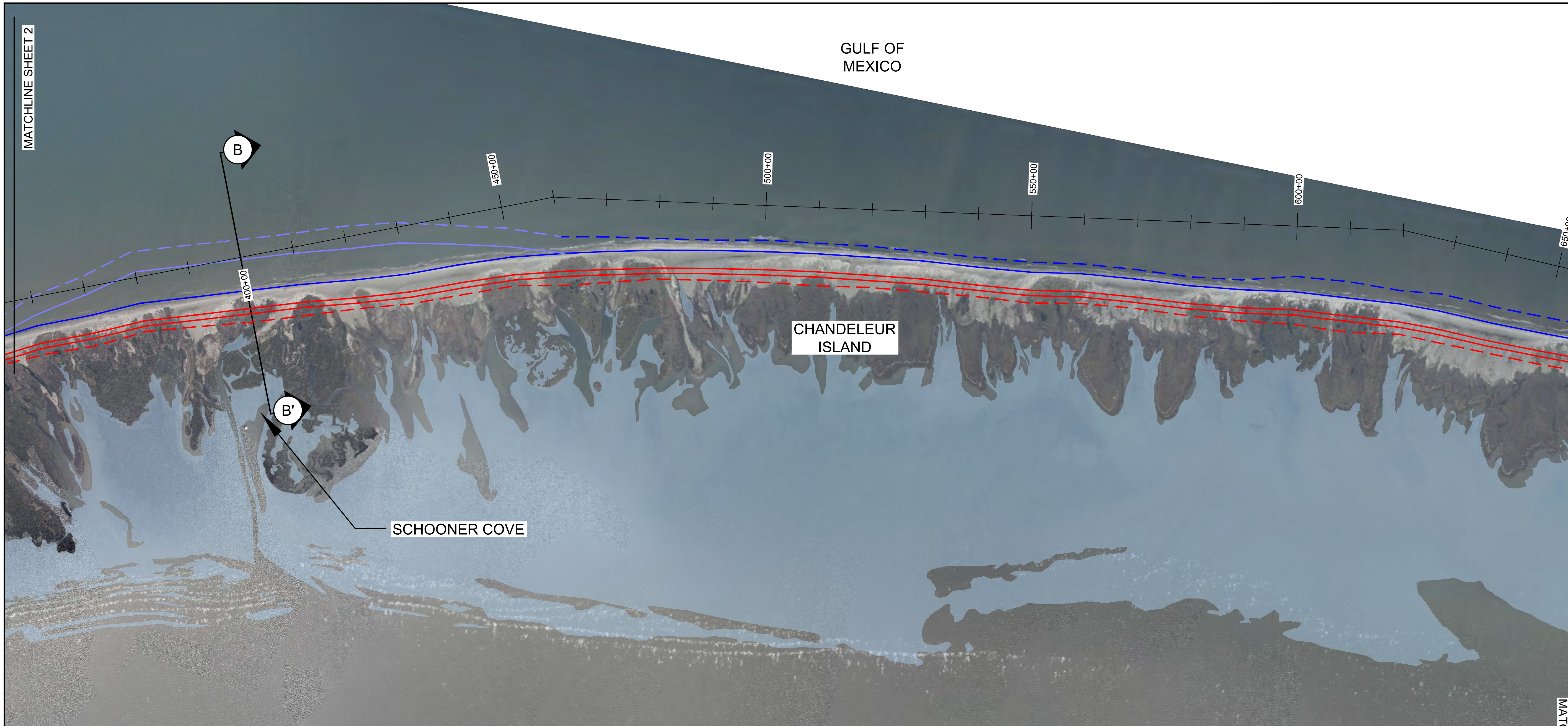
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 4 PLAN VIEW

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

DATE: FEBRUARY 2024

SHEET 2 OF 5




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:
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 |
| 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.

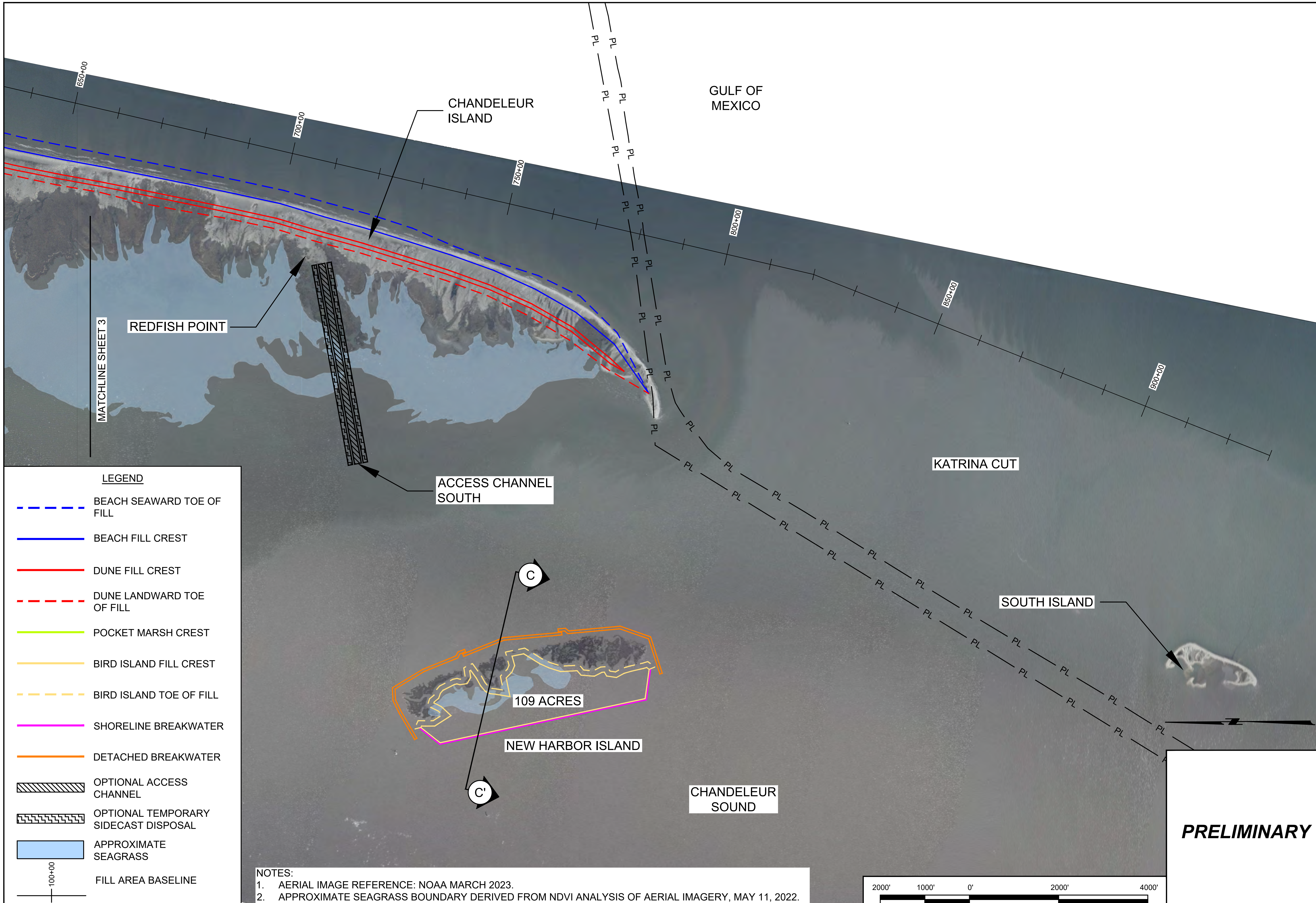
**PRELIMINARY**

RESTORATION ALTERNATIVE 4 PLAN VIEW

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

DATE: FEBRUARY 2024

SHEET 3 OF 5




NOTES:

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**PRELIMINARY**

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

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CHANDELEUR ISLAND RESTORATION

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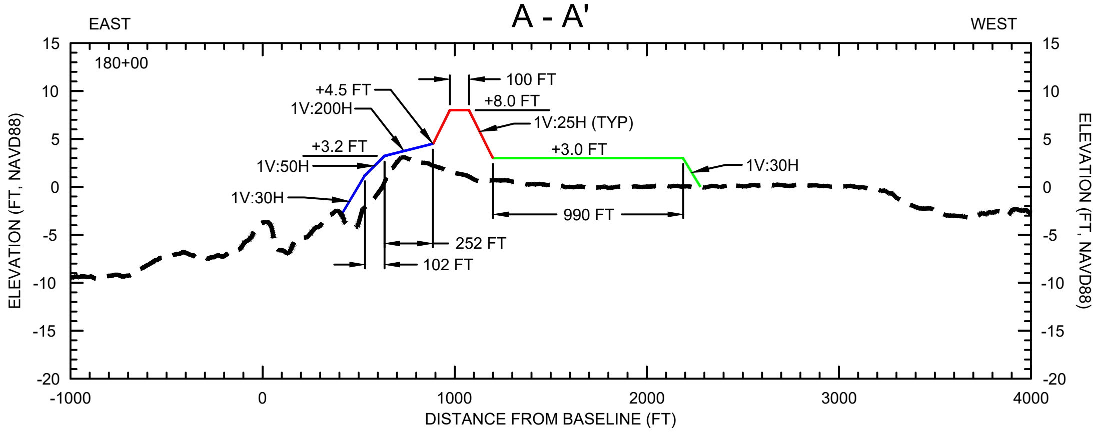
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 4 PLAN VIEW

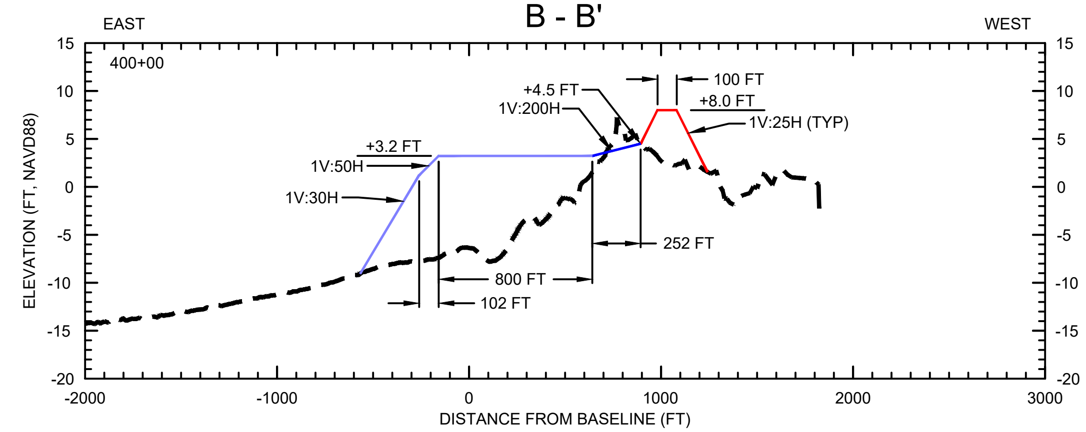
STATE PROJECT NUMBER: PO-0199
DRAWN BY: STEVE DARTEZ

DATE: FEBRUARY 2024

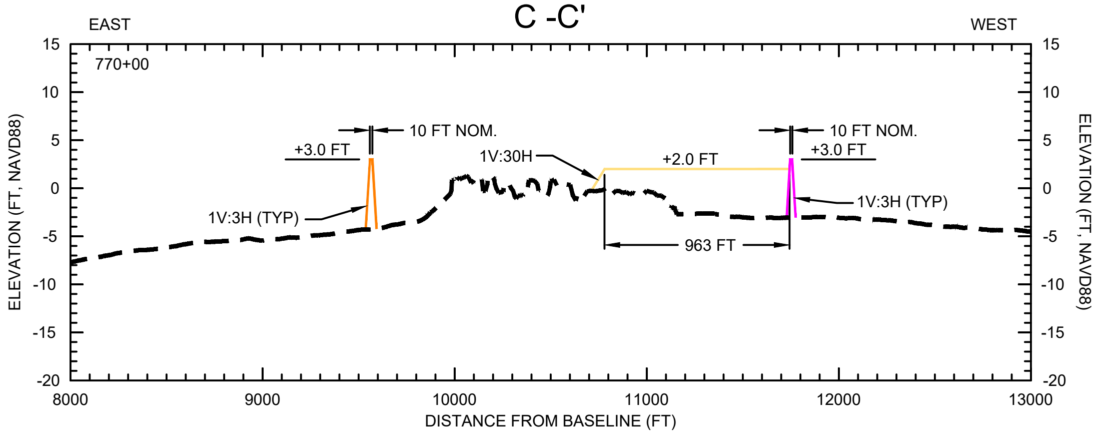
## A - A'




## B - B'




## C -C'




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 |


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


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.

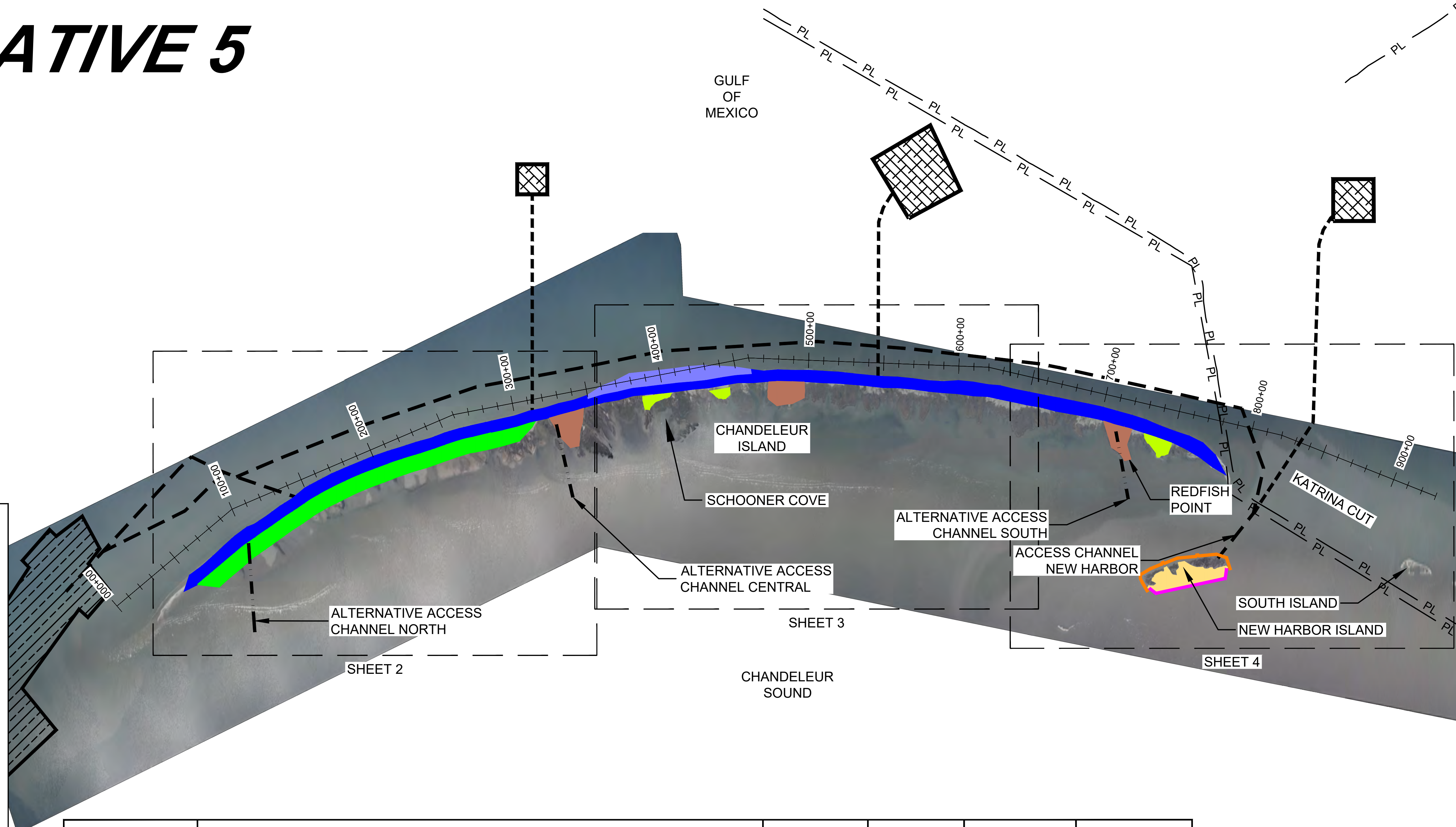
RESTORATION ALTERNATIVE 4 TYPICAL SECTIONS

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

DATE: FEBRUARY 2024

SHEET 5 OF 5

# 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 |
|---|---|---|---|
| 01 | 01/15/2024 | UPDATED TABLE | SD |
| 02 | 02/19/2024 | MODIFICATIONS TO ACCESS CHANNELS | SD |
| 02 | 02/19/2024 | REFINED FILL VOLUME CALCULATION | SD |

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

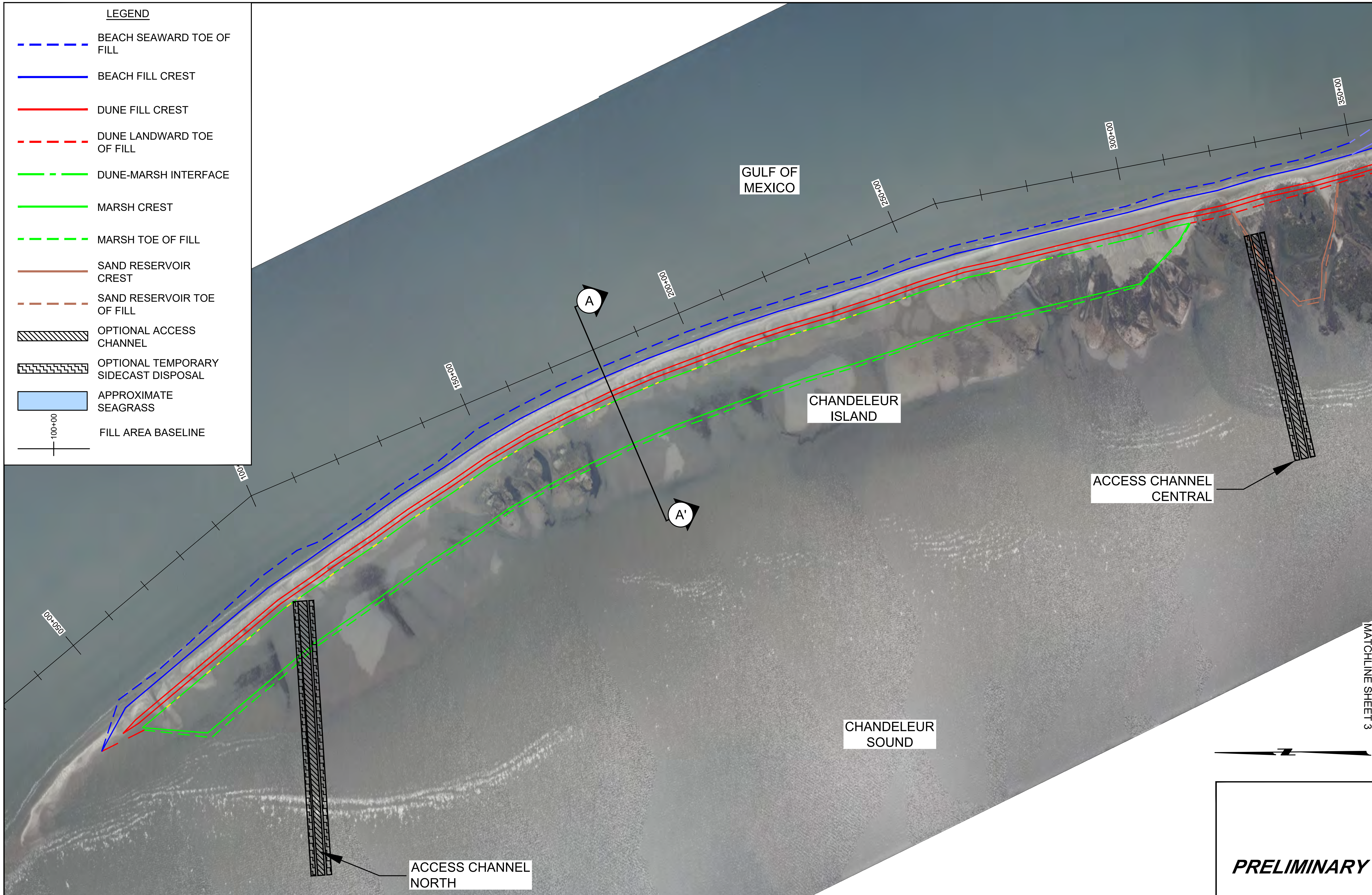
CHANDELEUR ISLAND RESTORATION

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

RESTORATION ALTERNATIVE 5 OVERVIEW

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

DATE: OCTOBER 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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COASTAL PROTECTION AND RESTORATION AUTHORITY
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CHANDELEUR ISLAND RESTORATION

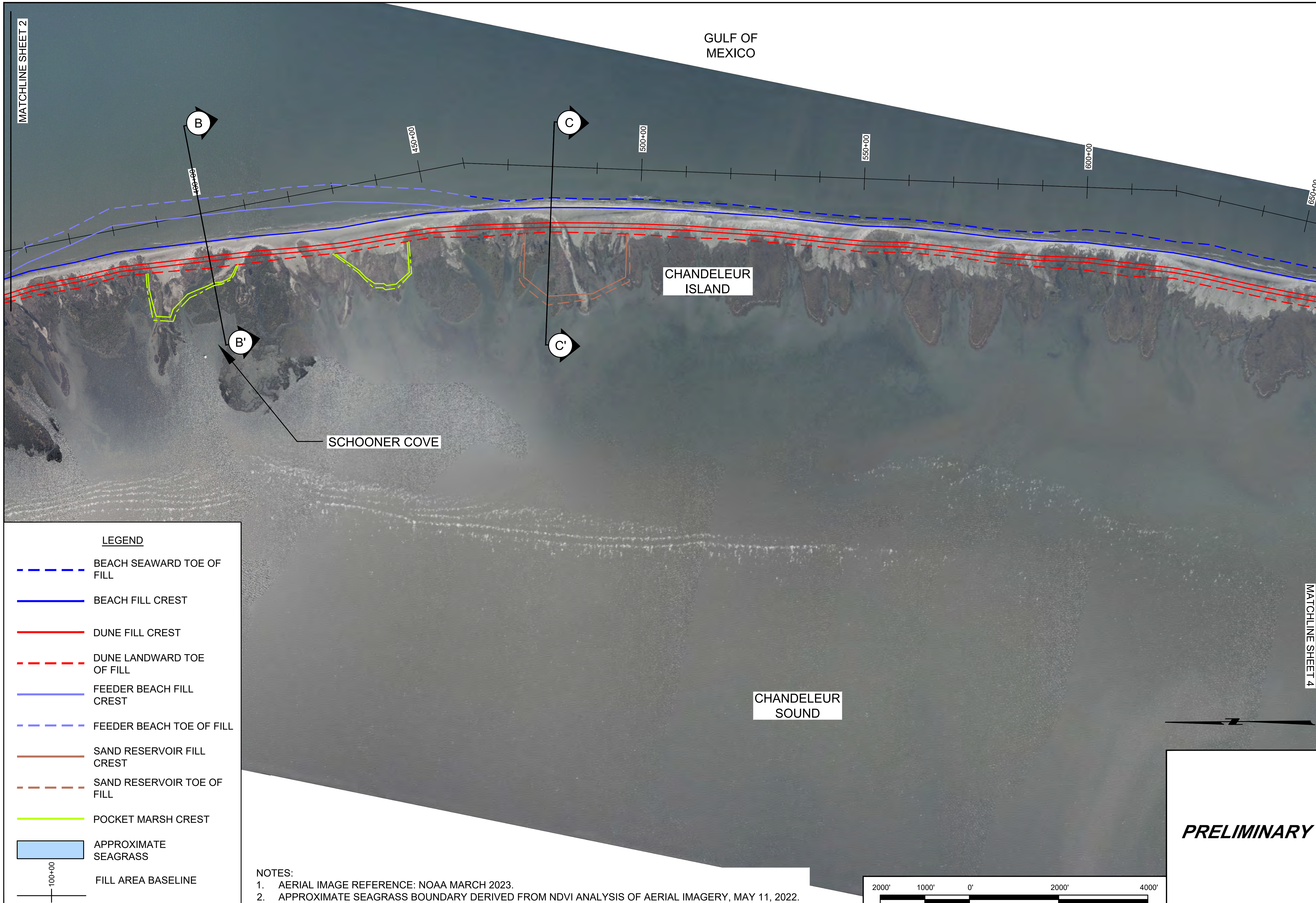
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 5
NORTH ZONE
PLAN VIEW

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

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


CHANDELEUR ISLAND RESTORATION

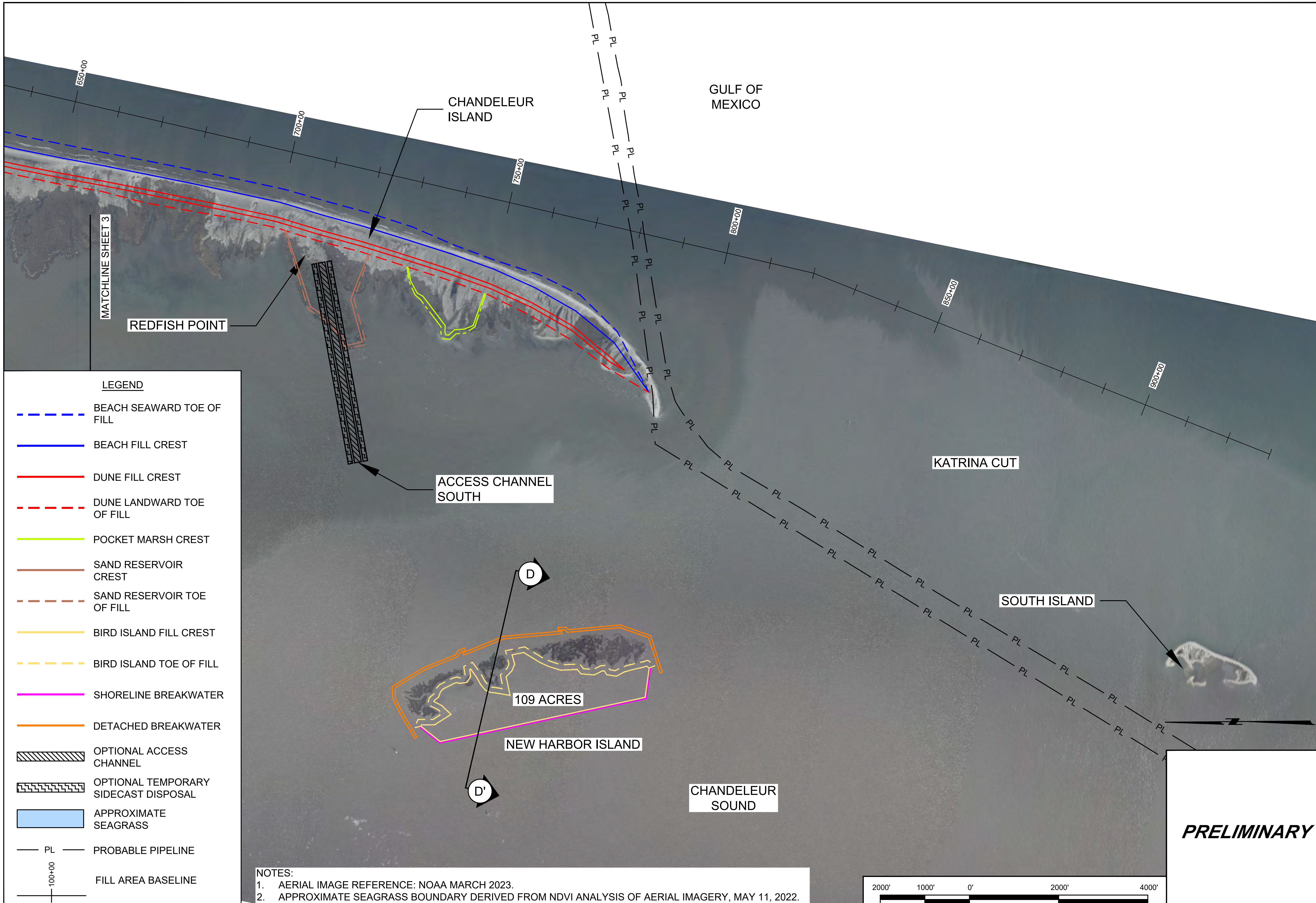
DESIGNED BY: BRETT BORNE, P.E.
APPROVED BY: MICHAEL POFF, P.E.

RESTORATION ALTERNATIVE 5
CENTRAL ZONE
PLAN VIEW

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

DATE: OCTOBER 2024

SHEET 3 OF 5




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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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.

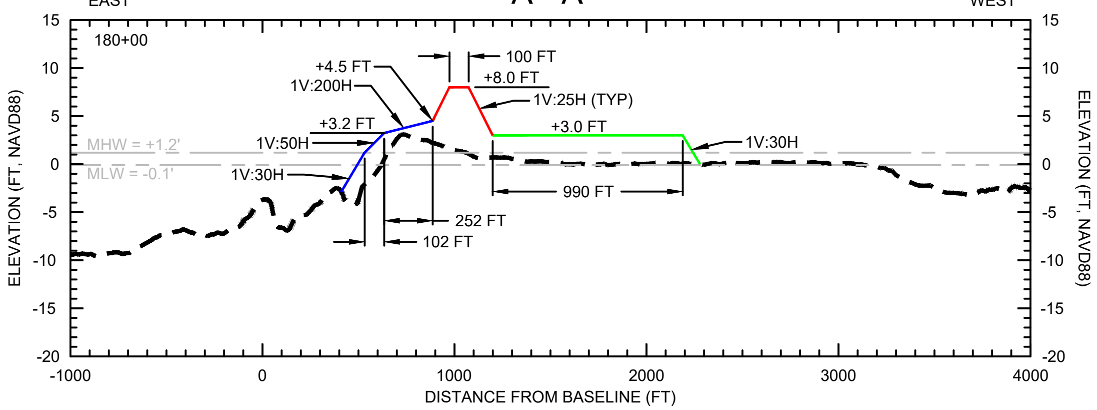
RESTORATION ALTERNATIVE 5
SOUTH ZONE
PLAN VIEW

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

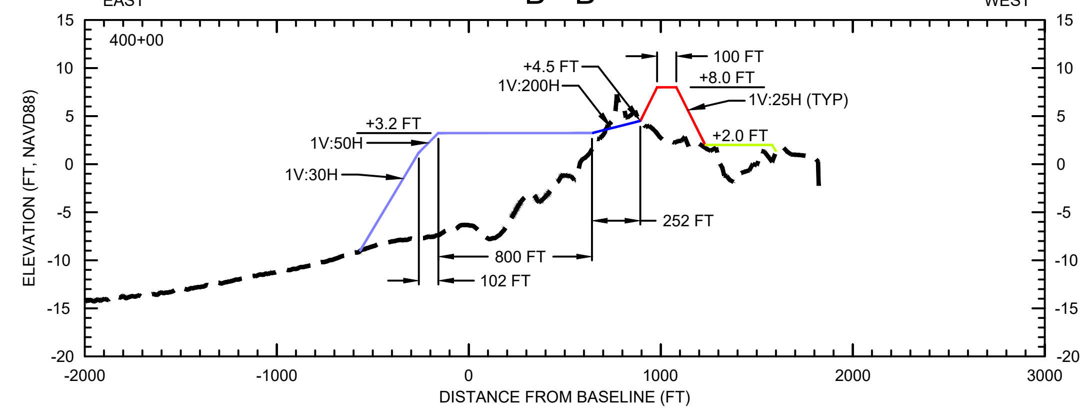
DATE: OCTOBER 2024

SHEET 4 OF 5

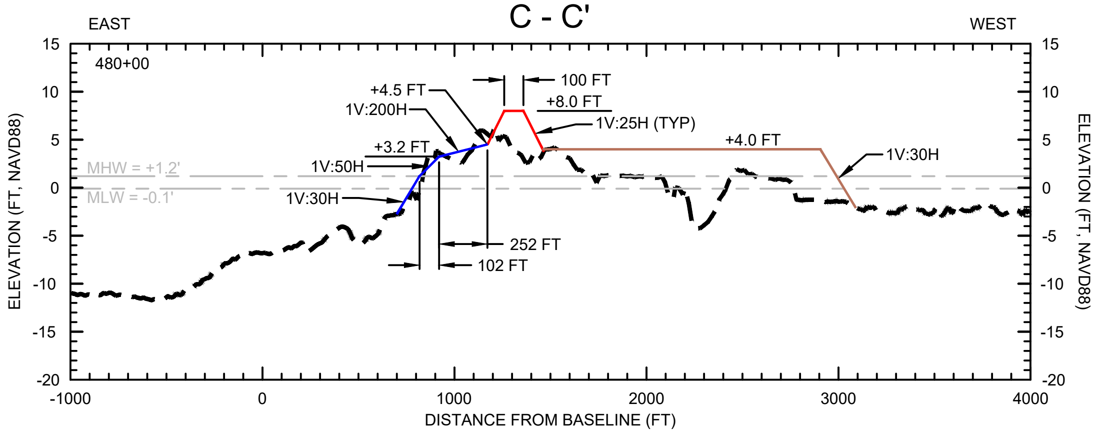
## A - A'



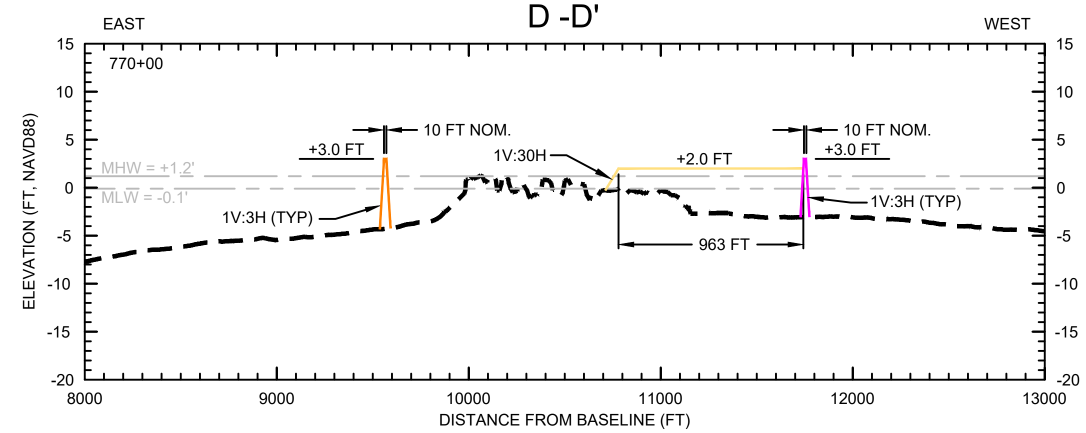

## B - B'




## C - C'




## D -D'




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 |
|---|---|---|---|
| | | | |

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RESTORATION ALTERNATIVE 5 TYPICAL SECTIONS

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DATE: OCTOBER 2024