PALMETTO BEACH LIVING COASTLINE AND COMMUNITY ENGAGEMENT

Project Report

CITY OF TAMPA
AUGUST, 2023

Funded By the National Fish and Wildlife Foundation - National Coastal Resilience Fund
For the City of Tampa

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Suggested Reference

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I-275
22ND ST.
YBOR CITY
DOWNTOWN
PALMETTO BEACH
MCKAY BAY

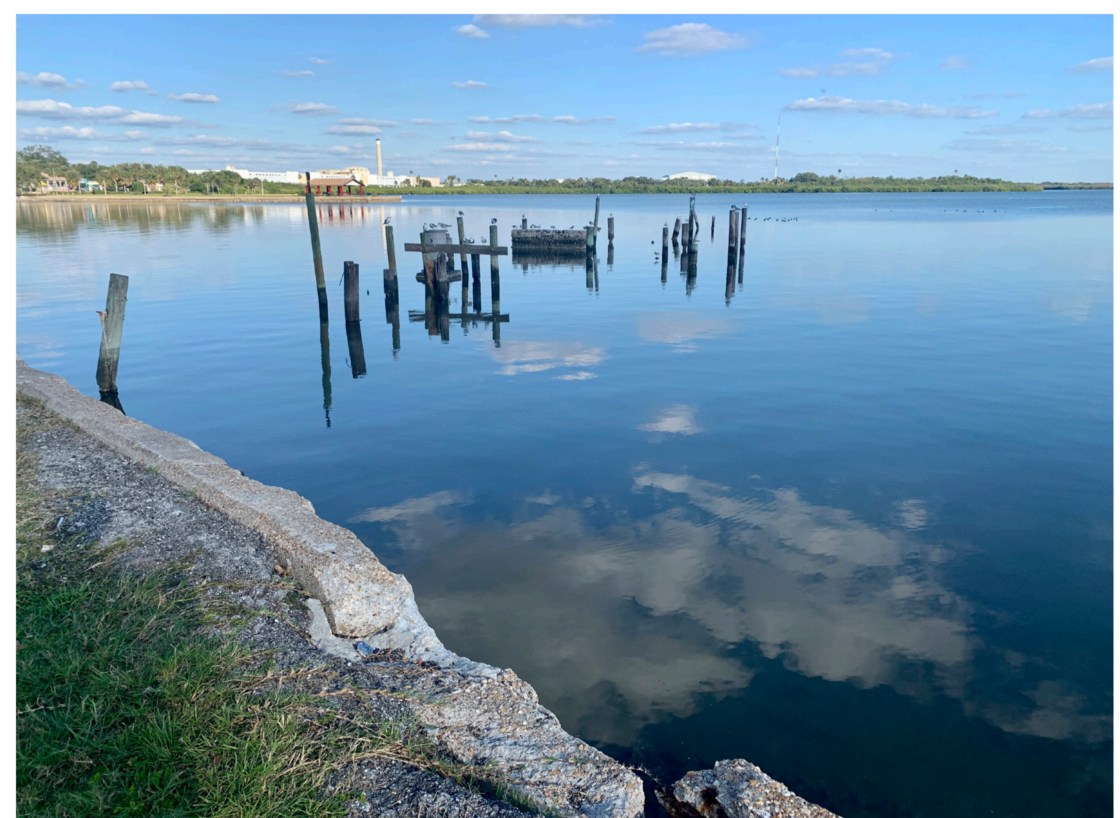
Introduction

The Palmetto Beach community resides at the western shoreline of McKay Bay, a significant estuary in the City of Tampa. It is an historic community, beginning as a working waterfront and capitalizing on the productive waters. Crab huts and shrimp boats were a common site in the area. As the ecosystem changed due to intense industrial development so did the community. Currently, there are no longer any functioning shops along the shore and the economic vitality has decreased.

McKay Bay is a sub-estuary located at the northern terminus of Tampa Bay. Over the past century, it has been heavily modified by various human efforts. Recent studies have commented on the deterioration of habitat in McKay Bay, such as the Tampa Bay Dredged Hole Habitat Assessment Project (2005), the Tampa Bay Estuary Program Habitat Master Plan Updates (2010 and 2020), and the Blue Carbon Report (2016). Dredging, urban runoff, and changes to water circulation patterns have all affected the quality of the bay environment. One report, in describing the soil conditions of the dredge hole in McKay Bay, says that, "The benthic community in the McKay Bay dredged hole showed the highest similarity between seasons of any of the dredge holes, probably because it was the most impoverished of the 11 holes during each sampling period." It also notes that soils are exceeding preferable quantities of Cadmium, Chromium, Copper, Nickel, Lead, Zinc, and pesticide Lindane.

The neighborhood has also been identified as vulnerable to both sea level rise and storm surge in projects such as the City of Tampa Land Regulatory Response to Sea Level Rise (ongoing) and the Hillsborough County Community Vulnerability Study (2020). Due to its proximity to the water and low-lying elevation, recent attention has been placed on Palmetto Beach to identify strategies to bring it health and resilience.

This project, the Palmetto Beach Living Shoreline and Community Engagement study, funded by the City of Tampa and the National Fish and Wildlife Foundation, places emphasis on diagnosing the environmental systems in the area and providing project options to meet habitat and resilience goals. This was accomplished by an interdisciplinary team of scientists, engineers, urban designers, and graduate students. Projects were reviewed by the City and by the Tampa Bay Estuary Program to gauge internal capacity and feasibility for implementation.



Introduction

This pilot/catalyst project investigated the McKay Bay estuary to identify projects that can fulfill the two primary objectives of the National Coastal Resilience Fund (NCRF) grant program: Enhance coastal habitats; and increase resilience for the community. Research included scientific analysis of sediment and flow dynamics, field visits and site observation, interaction with the community, and a historic analysis. The Team also provided information based on previous work and research in the area. The work was broken down into 7 tasks, which are described on the following pages.

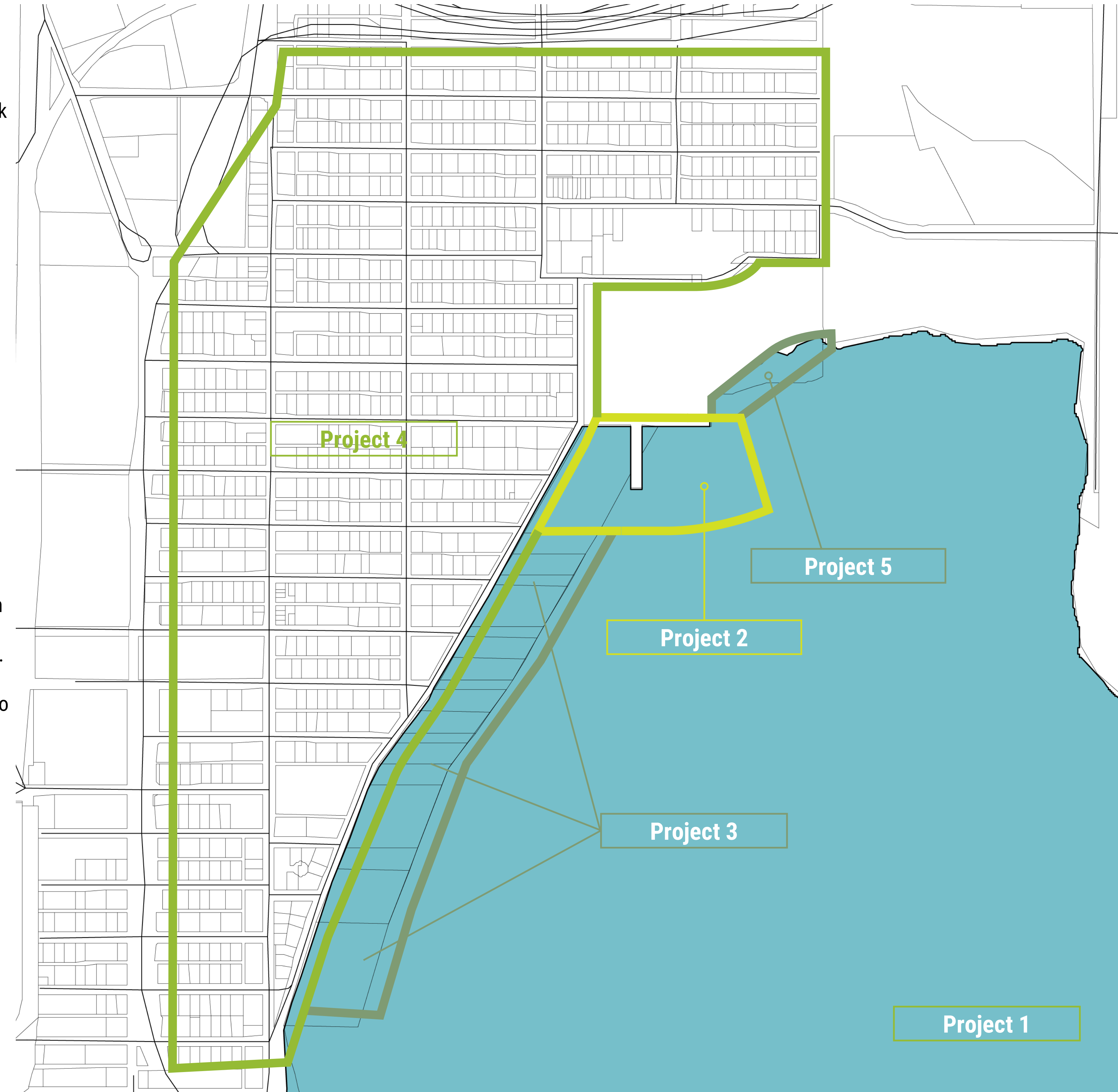
- Task 1: Sediment Morphological Assessment
- Task 2: Hydrodynamic Modeling and Characterization
- Task 3: Storm Surge Analysis
- Task 4: Biological Characterization and Migration Analysis
- Task 5: Community Engagement and Planning
- Task 6: Preliminary Design of Nature Based Solutions (NBS)
- Task 7: Economic Analysis

This pilot research identified five project opportunities. These are described in more detail in the Task 6 and 7 chapter reports.

Project 1 - Dredge and fill of the channel that crosses through McKay Bay
Significant historic dredging in McKay Bay has created a deep (~5 m) channel cut, which was shown to affect tidal flow and circulation. Intense dredging activities in the 1960s also removed a substantial delta at the mouth of the Six-Mile Creek (aka Palm River, now called the Bypass Canal). The removal of this bayhead delta, in addition to a deep channel directly to the mouth of McKay Bay, has substantially changed the bay-wise circulation pattern, resulting in a much weaker flow along the Palmetto Beach shoreline. This has contributed to the decline of habitat and water quality, particularly along the northern coast where Palmetto Beach the community is located. Filling the un-naturally deep channel can restore natural flow patterns that were historically much stronger along the coast than under present conditions. Additionally, re-directing flow with a breakwater structure or fill could increase positive benefits for the bay, especially at the Palmetto Beach coastline. This flow is especially important with recent increases to water temperature. Water exchange during tidal flux can help to regulate water quality conditions.

Project 1 aims at restoring the pre-engineering flow conditions, strengthening it along the Palmetto Beach coast.

Project 2 - Desoto Park Shoreline
The coastal edge of Desoto Park is contained by a seawall. This erosion prevention structure has deteriorated, providing the opportunity to replace it with a 'living' feature, and to create multiple layers of habitat and vegetation to support coastline stability. This could include a simple rip rap edge or more complex options that incorporate mangroves, marshes, oysters, and constructed reef structures. Some strategies are shown that extend the shoreline seaward. These design options create a shallow gradient edge with layers of plantings, walls, and waters' edge access. Reconfiguring the coastline offers an opportunity to cover, or cap, existing toxic soils (Morrison & Sherwood, 2014) while adding living erosion control features and a designed waterfront experience for the community.



Project 3 - Bermuda Boulevard Coastline and Piers
The City owns a number of submerged properties just off the coast of Bermuda Boulevard. These properties offer an opportunity to construct living shorelines and piers. Reef or rip rap structures would decrease erosive wave energy along the shoreline and create habitat. Piers, reminiscent of the historic Palmetto Beach coastline, would provide public access over the water.

Project 4 - Storm Drains and Outfalls
Low areas within Palmetto Beach drain into a series of inlets with water flowing directly to twelve (12) outfalls along the Bermuda Boulevard seawall. This stormwater system could be simplified by manifolding multiple trunk lines into one, concentrated the flow and running it through sediment traps and sub-surface water quality treatment infrastructure, prior to being released into the bay. Reducing the number of outfalls would also decrease the number of tidal gate valves required to safeguard the community from future sea level rise.

Project 5 - Brazilian Pepper Removal at Desoto Park
This invasive aquatic species has taken over parts of the McKay Bay shoreline. Removal and replacement with marsh and mangrove habitats will help native wetland species to thrive, increasing habitat and water quality.

TASK 1

SEDIMENT MORPHOLOGICAL ASSESSMENT

Bathymetry Survey

The natural bathymetry can be characterized as a shallow estuarine environment, historically known for its blue crab, fish, and other coastal habitat. The east side of the bay is especially shallow, near the mouth of the existing Tampa Bay Bypass Canal. The Canal, which was constructed by the Army Corp. of Engineers in the 1960's and 1970's, replaced the historic Palm River and Six Mile Creek to alleviate inland flooding and provide potable water storage. As it enters the bay, the canal extends through it, cutting a channel in its middle to the 22nd Street Causeway and to the south. This channel is a major feature, as are the dredge holes from previous excavations to create new industrial lands.

To accurately compute the tidal circulation within McKay Bay, accurate and up-to-date bathymetry is necessary. A detailed bathymetry survey was conducted by this study using a synchronized precision echo sounder and a RTK GPS. Essential features, including the shallow water along the eastern coast, the un-naturally deep dredged channel through the middle, the limited partial fill of the dredged hole in 2014-2015, were well captured.

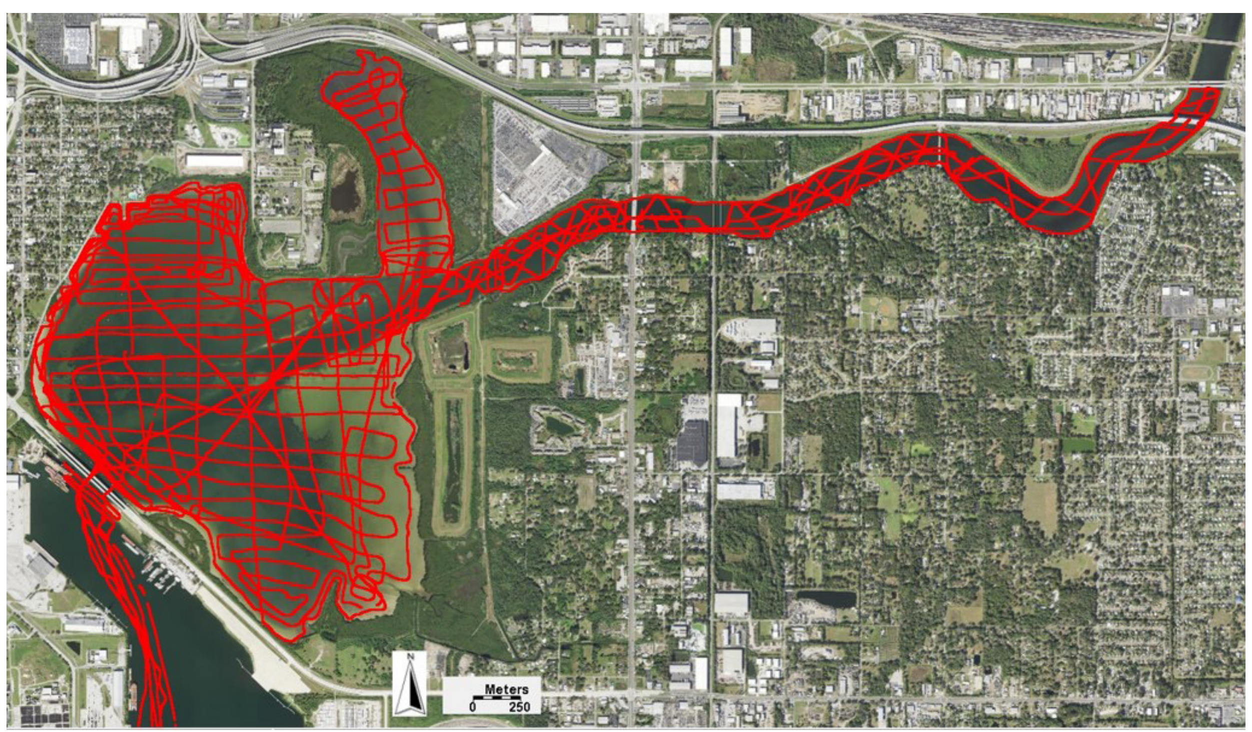


Image: Map of the route taken to record bathymetry data

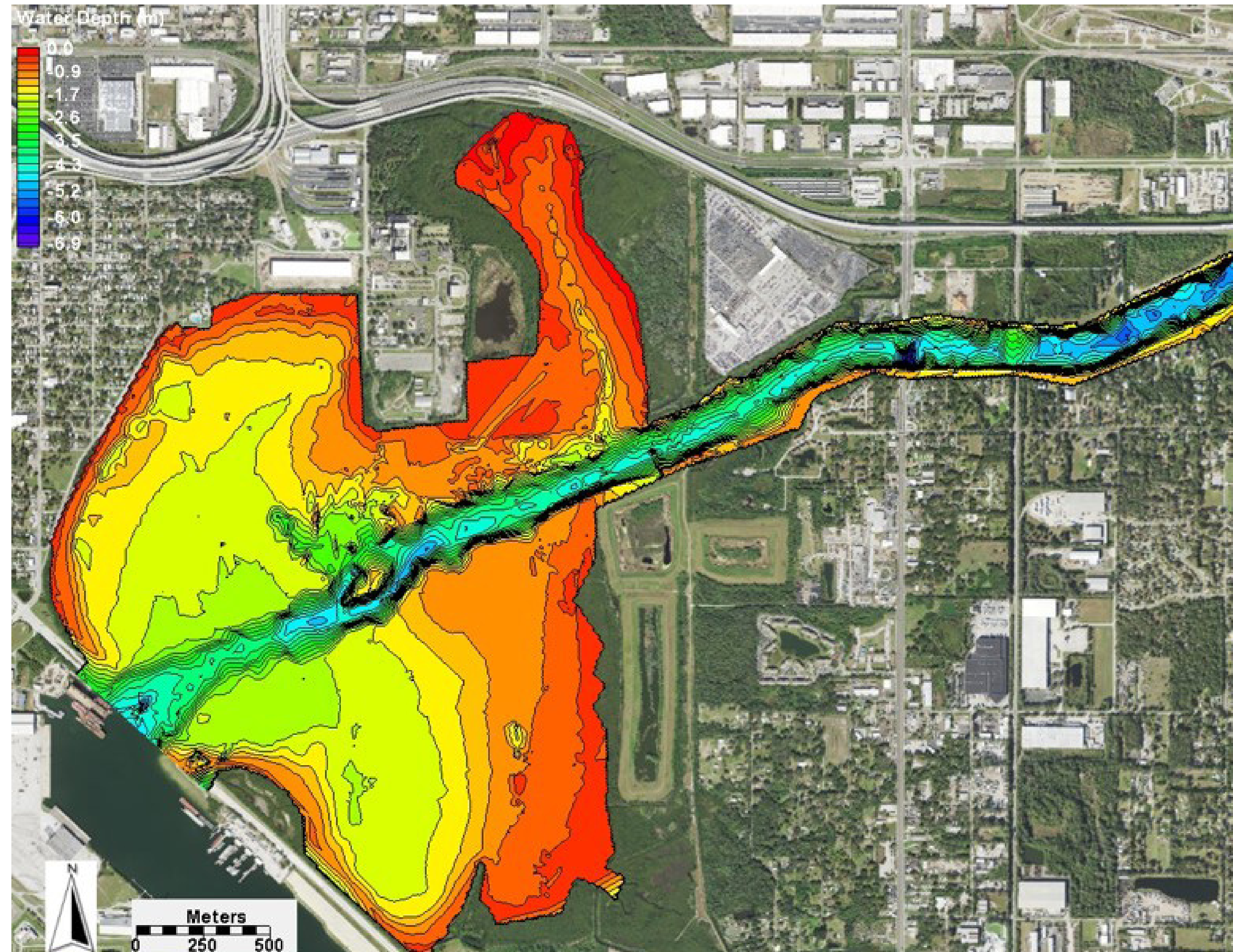
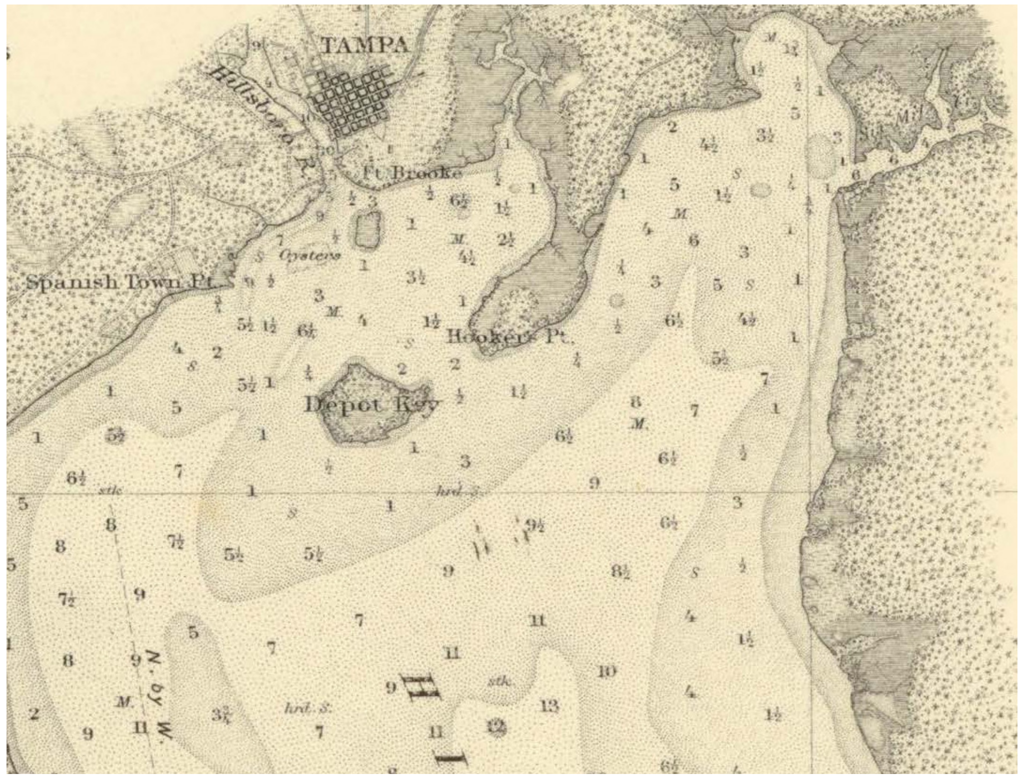


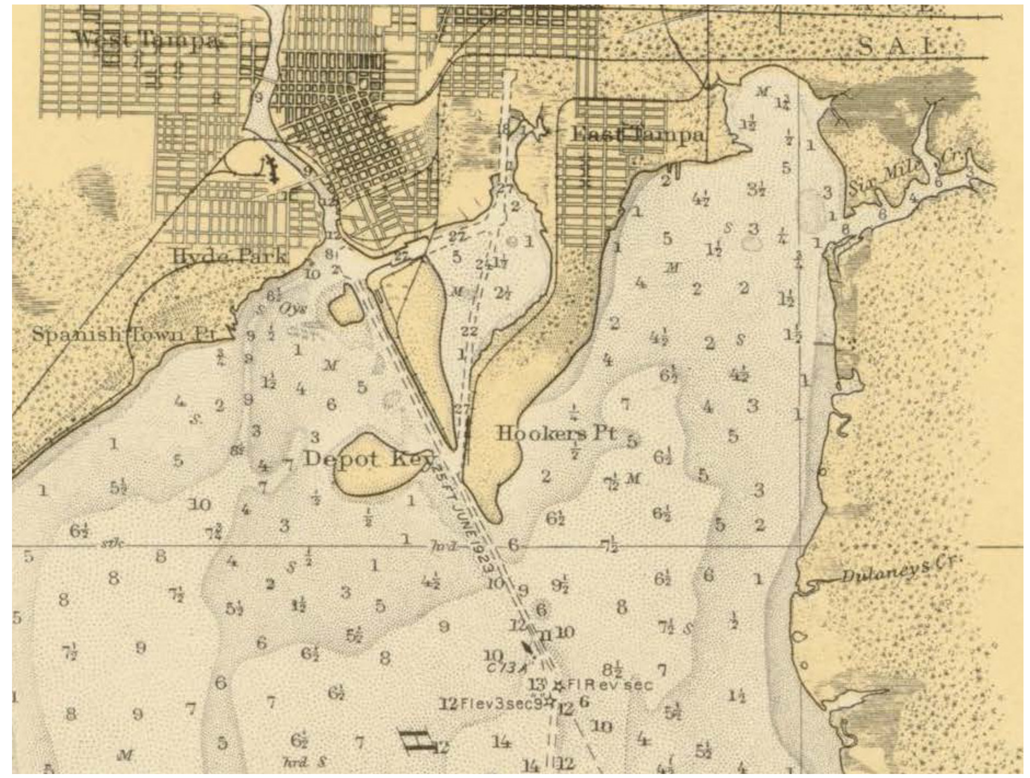
Image: Recorded Bathymetry

Historic Analysis

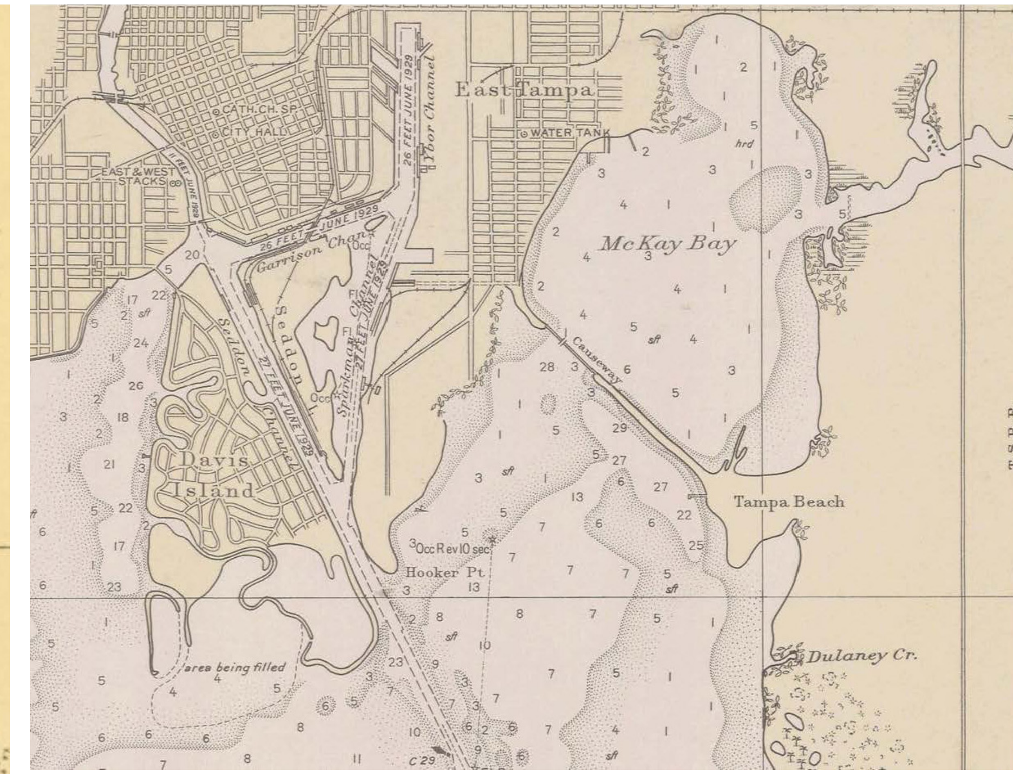
Historical bathymetry maps and aerial photos were collected and analyzed. The pre-engineering conditions is illustrated by the 1885 map. The significant human modification is apparent. Changes directly relevant to the tidal circulation include: The construction of a causeway and a bridge at the wide entrance to the bay in the 1930s and the dredging of the Six-Mile River and the creation of the Bypass Canal in the 1940s.



1885



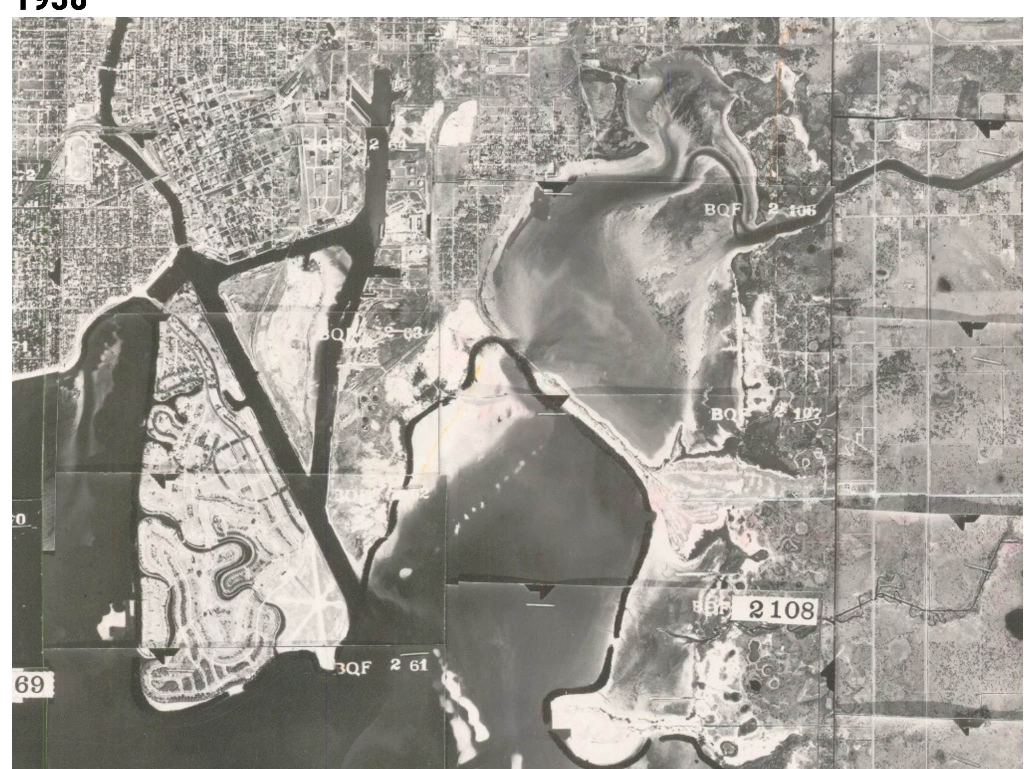
1924



1930

1938

1938



1948

Historic Analysis

Additional changes to McKay Bay included the removal of the shallow shoal at the mouth of the Six-Mile River and the land fill at the northern end of the bay in the 1950s and continued dredging of the deep channel extending to the causeway bridge in the 1960s and continued landfill.

1957

1965

1965

1968

1969

1973

Historic Analysis

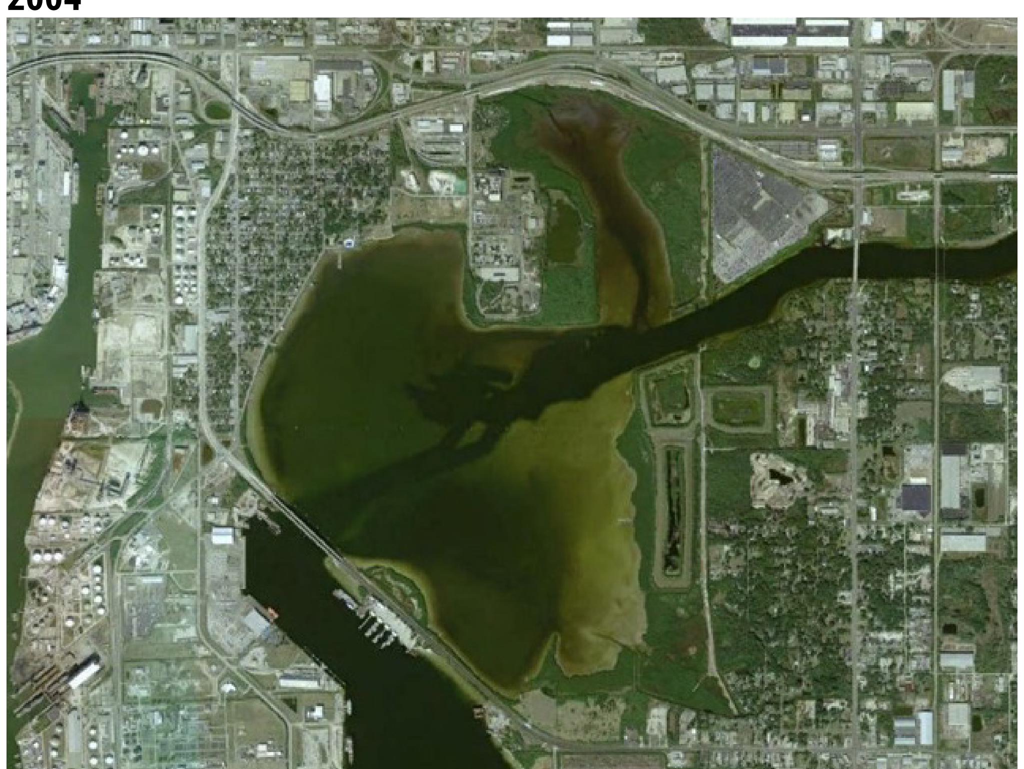
From 1980 to 2014, the Selmon Expressway was constructed and expanded at the northern edge of the bay. Dredged areas are highly visible from aerials. A small dredge fill project took place by 2014. The above dredge and fill of McKay Bay have reduced the surface area of the bay by about 18%. Presently, the bay size is ~3.7 km2. The fill area along the north shore is ~ 0.68 km2. However, the water area reduction by the land fill was more than compensated by the Bypass Canal, which has a surface area of ~ 1.0 km2, a significant increase from the Six-Mile River. Overall, the anthropogenic activities have likely increased the tidal prism of McKay Bay, slightly by increasing the water area.

1980

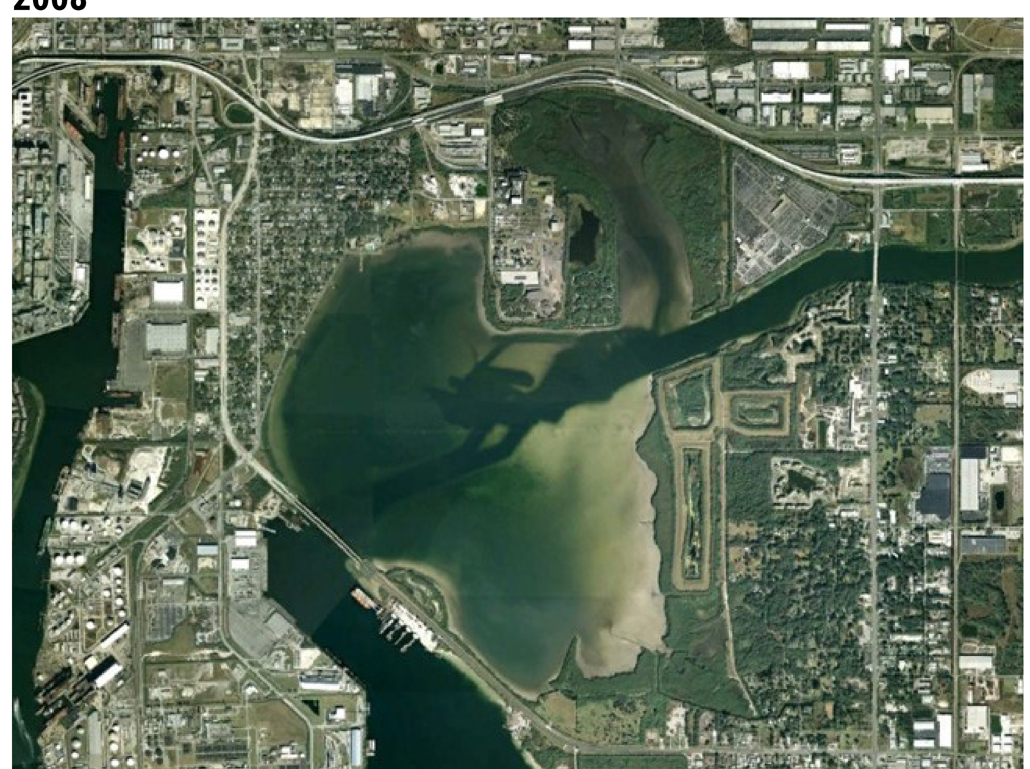
1984

1995

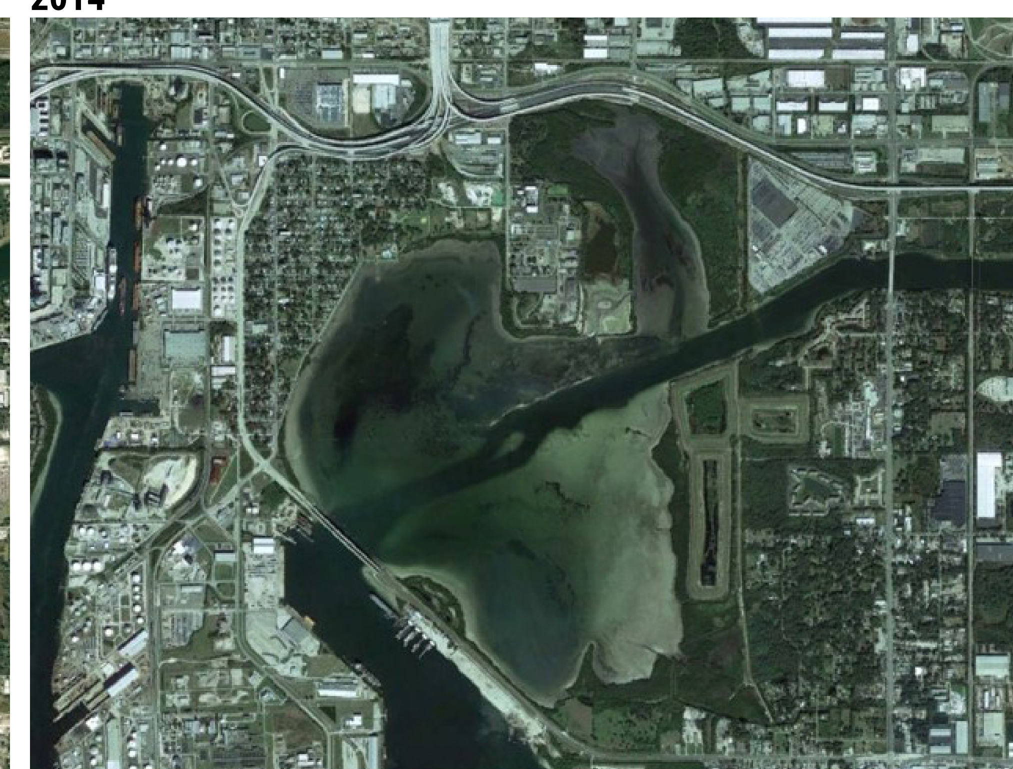
2004



2008



2014



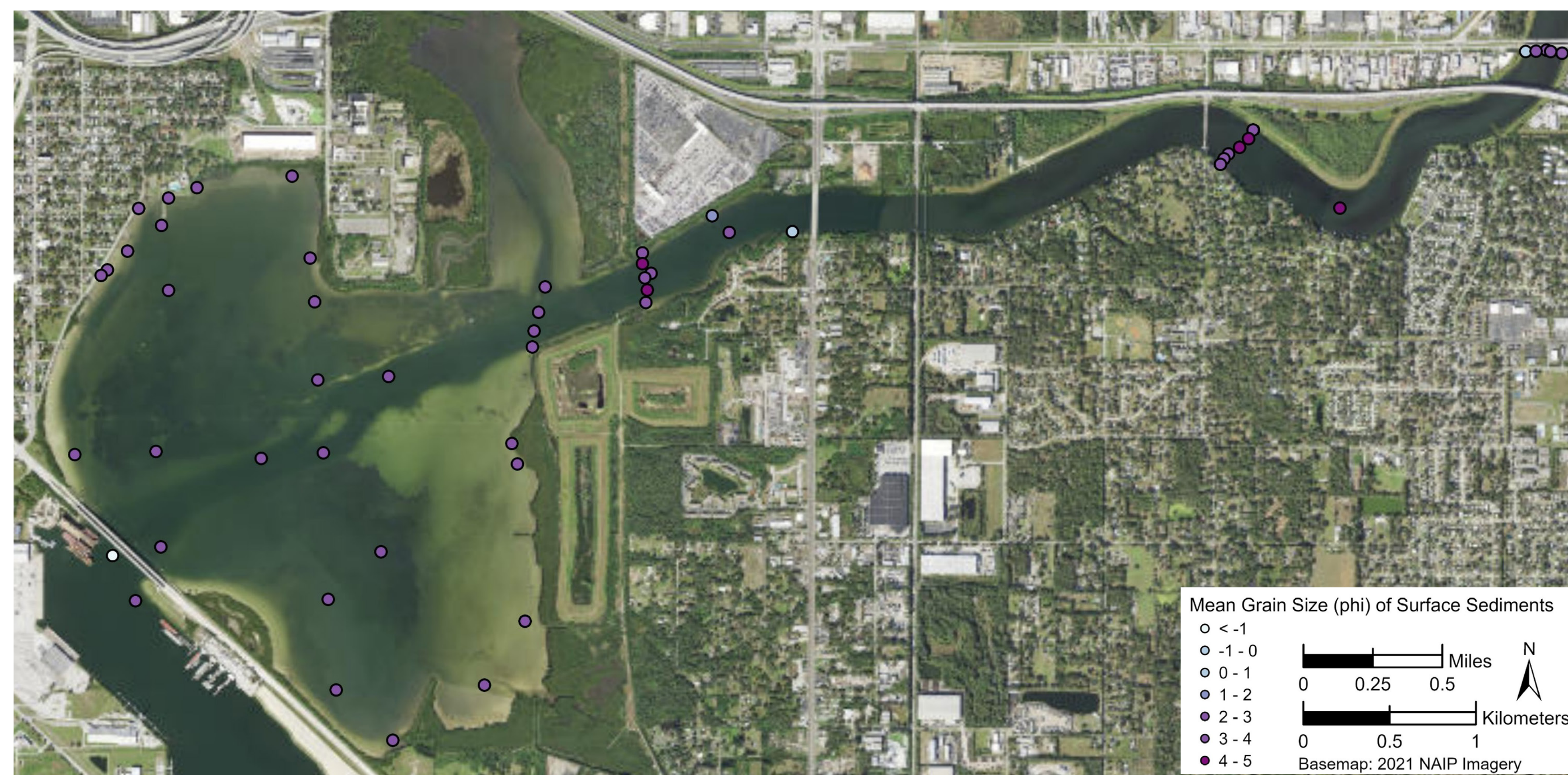
Historic Shoreline

Historic postcard images of Palmetto Beach show a shoreline that includes sandy beach with a gradient transition to a native Florida scrub environment. This could possibly be the reason for the naming of the community.

Sediment In-Situ Samples

Sixty-four sediment samples were collected and analyzed at the locations shown in the maps.

Concentrations of mud were found within the primary canal trench, at the mouth and estuary edge, and areas upstream. Mud particles were also found, to slightly lesser extent, in the northwest corner of the Bay. This is believed to be associated with stormwater, which captures runoff from the urban environment and directly discharges to the bay at twelve (12) locations along the Bermuda Boulevard seawall.



Sediment Cores

Ten sediment cores were taken at various locations around the bay, with the goal of understanding the geological control of McKay Bay, as well as depicting human modifications. The top right figure shows the core locations marked on the most recent aerial photo. The bottom left figure illustrates the core locations marked on the pre-engineering historical bathymetry map. The photos of the sediment core are shown in the bottom right figure. Cores VC1, VC2, VC3, and VC4 were taken along the northern coast of McKay. The bedrock (brown-yellow layer) is the shallowest in cores VC1 and VC3, while modestly deeper in core VC2. This antecedent geology controls the curvature of the shoreline there with VC1 at the protruding headland and VC2 at the apex of the curve (lower left figure). Un-natural sediments, e.g., rock fragments, were found at around 2 m below surface at cores VC5 and VC6, indication artificial fill material likely associated with the construction of the causeway. Shallow bedrock (light grey layers) was encountered in cores VC7a, VC7b, and VC8. These cores are located on the shallow shoal at the mouth of the Six-Mile River, indicating the geological control of the river and its delta. Overall, the sediment cores revealed the geological control of the McKay Bay and human impact.

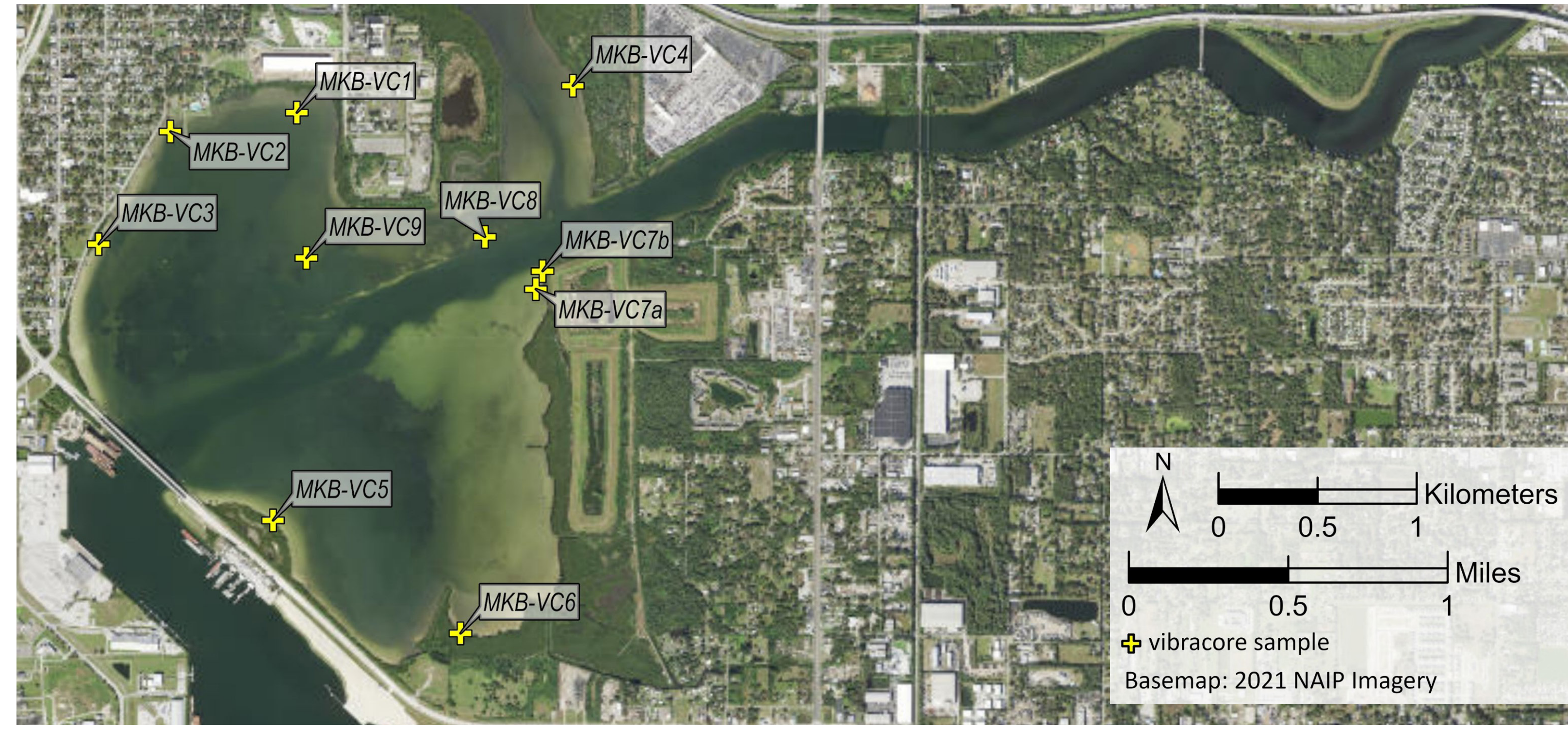
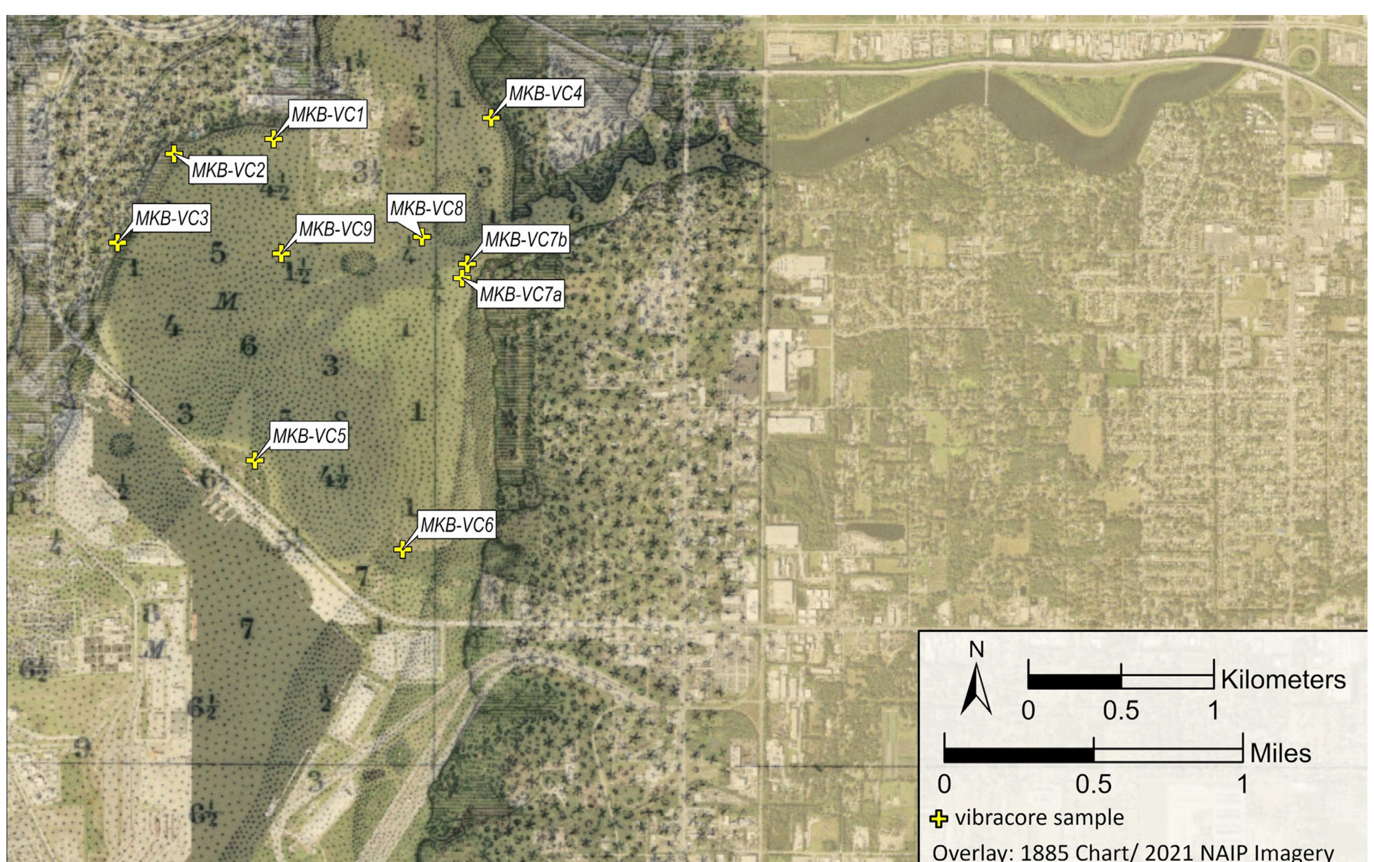
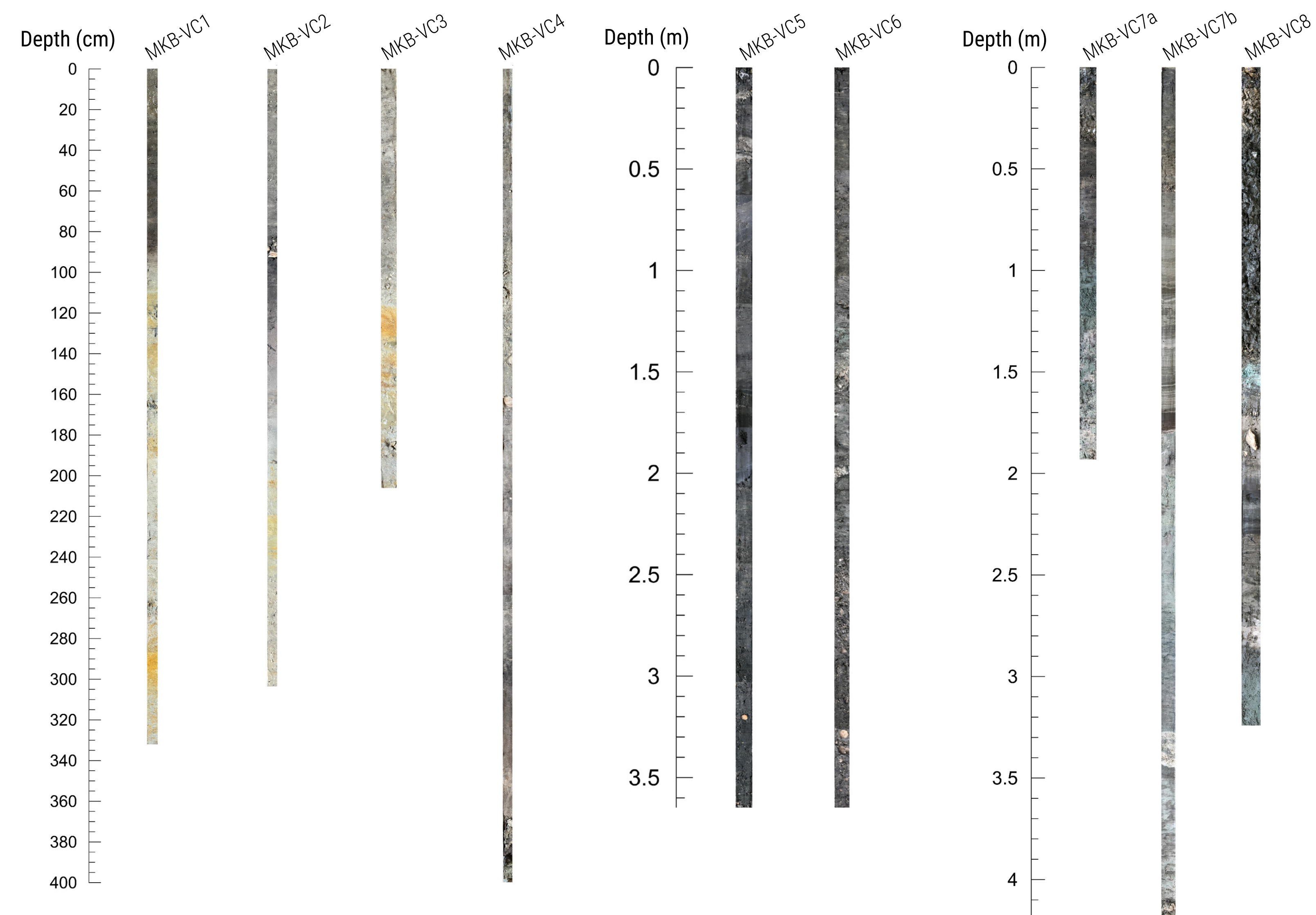


Image: Sediment Core Locations





TASK 2

HYDRODYNAMIC MODELING AND CHARACTERIZATION

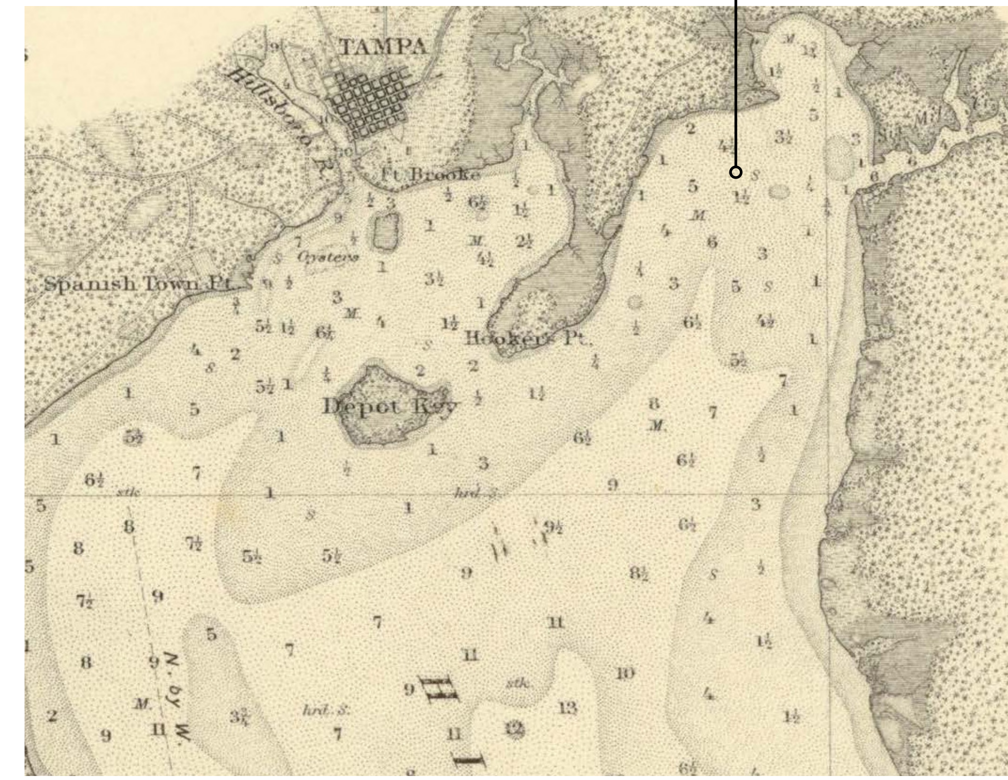
Numerical Modeling of Tidal Circulation in McKay Bay

The hydrodynamics of McKay Bay have been greatly impacted by human projects, primarily dredging and filling, which created new landforms and deep dredged channels/holes. The bay was once an open and shallow tidal estuary. As the Port developed near downtown Tampa, land was added to Hookers Point and Depot Key, widening and extending the land mass to the south. Land was also added to the eastern side of the bay for the Port. This changed the broad and shallow mouth of the bay into a deep channel lined with bulkheads and used for shipping. In the late 1920's the 22nd Street Causeway was constructed to cross the bay and formed an additional barrier to tidal flow, although an approximately 1,500 feet wide bridge was constructed, connecting McKay Bay to the south. This outflow point, on the south side of the causeway, has been dredged to create a turning basin.

In the 1950's and 1970's the U.S. Army Corps of Engineers (USACE) constructed the Tampa Bay Bypass Canal to alleviate inland flooding, re-routing flood water that would have gone through downtown Tampa around the city and discharging it into Six-Mile Creek, and eventually to the Palm River, which emptied into McKay Bay. The upper stream of Bypass Canal is used as a reservoir for City of Tampa drinking water, capturing and storing water via a dam rather than conveying it to McKay Bay. Fresh water is no longer provided by this system except in extreme precipitation events (TBEP, 2020). A recent study was completed to explore requirements for minimum flows and levels to be required from the Bypass Canal into McKay Bay. The study concluded that freshwater was not needed (SWFWMD, 2005). Downstream of the dam, the water level is controlled by tides. The dam serves as a boundary for the numerical model constructed during this study. The numerical modeling portion of the study included the following subtasks:

1. Model construction.
2. Model calibration and verification.
3. Circulation under existing condition.
4. Circulation under pre-engineering alteration condition.
5. Factors influencing circulation pattern:
    a. Land reclamation.
    b. Channel and bay-wise dredging for land reclamation.
    c. Causeway and bridge.
6. Options for improving circulation:
    a. Restore pre-engineering circulation pattern?
    b. Establish a new and improved (compared to existing condition) circulation pattern for water quality and ecosystem?

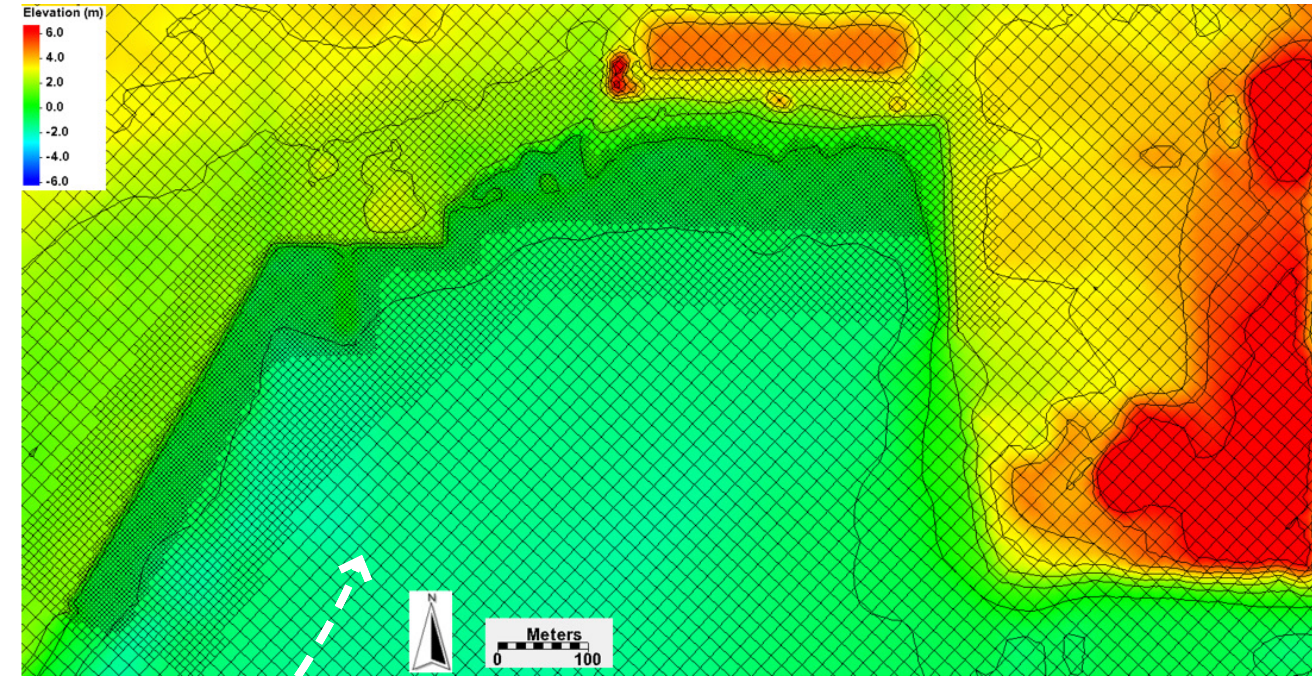
MCKAY BAY 1885

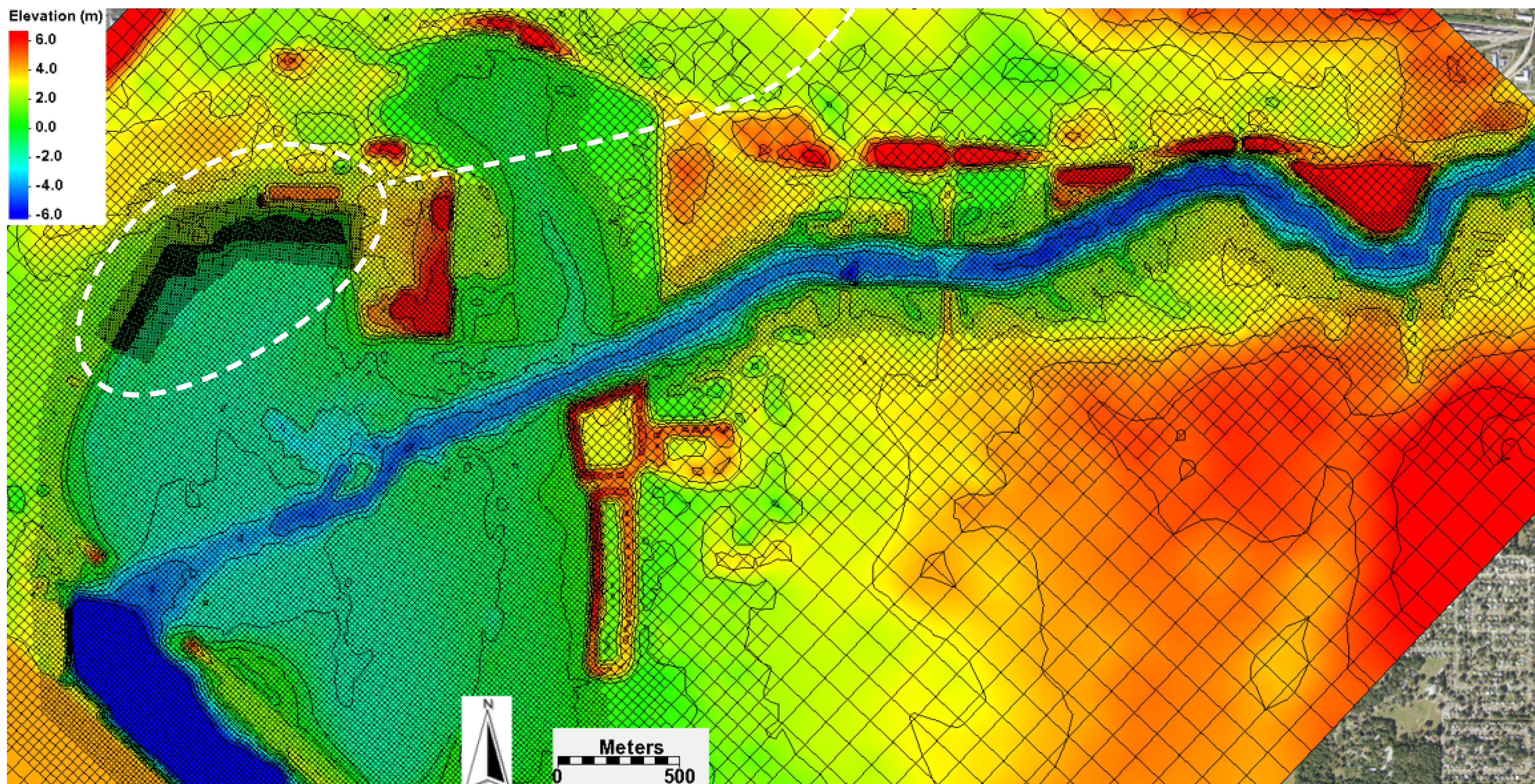


MCKAY BAY 2020

Grid for the Numerical Model

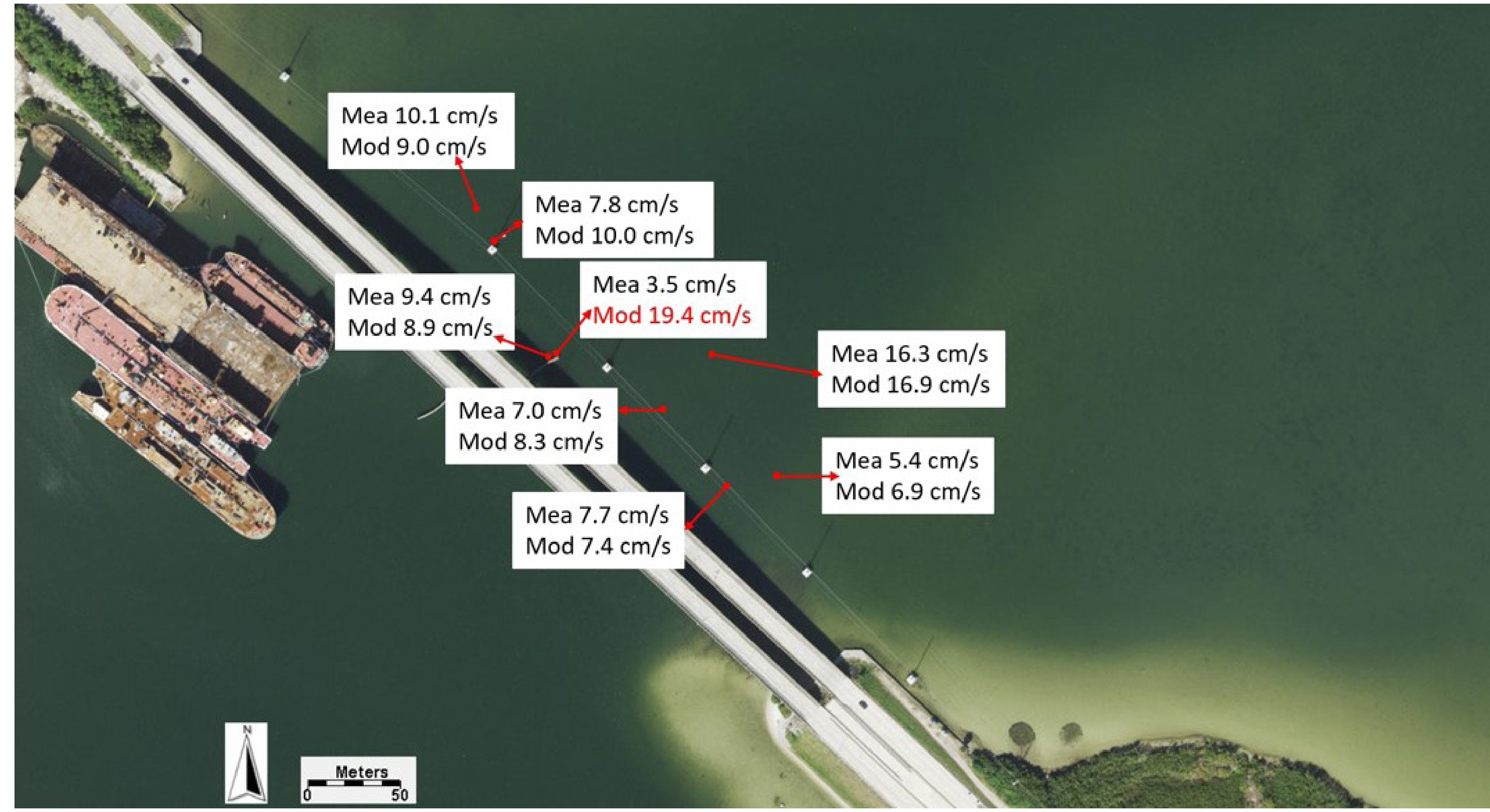
A telescoping grid was constructed to compute the tidal drive flow in McKay bay using the USACE's CMS Model. The telescoping grid ensures adequate model resolution at areas of interest. Along the Palmetto Beach coast (white oval), a small grid of 4x4m; was used to ensure potential proposed features such as artificial or oyster reefs can be resolved. The deep dredged channel and the nearshore area were represented by 8x8m gird. Most of the open McKay Bay was represented by 16x16m grid. Large grid cells of 32x32m and 64x64m were used to represent land area. This telescoping grid allows fine resolution at areas of interest, without excessively reducing computation speed

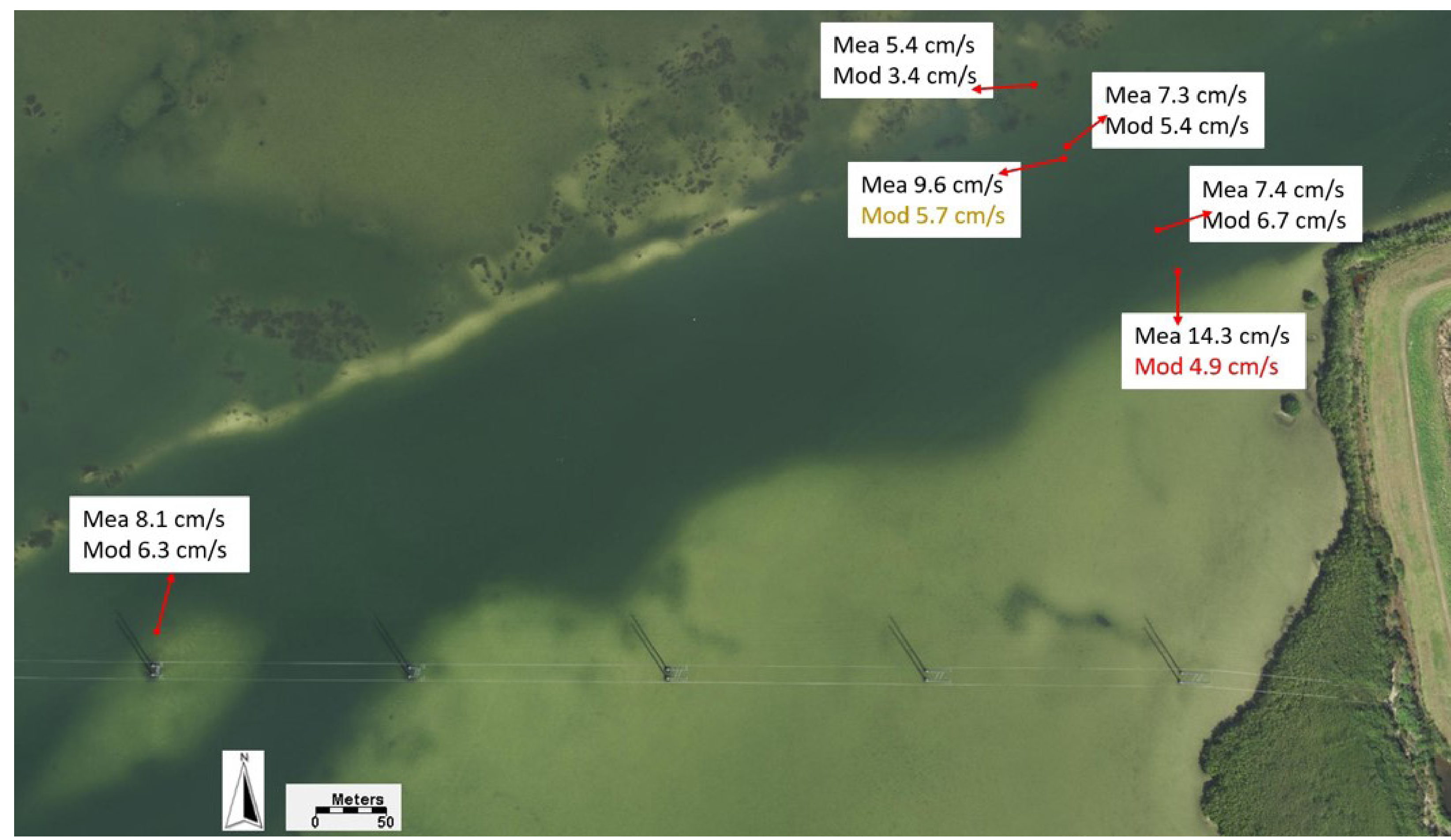




Model Calibration and Verification

The numerical model constructed during this study was calibrated and verified with in situ field measurements of water-level fluctuations and current velocities. Temporal and spatial variations of water-level and flow were measured. A 23-day measurement was conducted at one location (labeled as ADV in the following figure). Flow measurements at various locations in the bay were conducted during one flooding tide and one ebbing tide (labeled as ADCP in the following figure). The model calibration was conducted using the 23-day measurement. The model verification was conducted using the ADCP measurements at various locations.





Model Calibration and Verification

The numerical model was driven by measured tides at the NOAA East Bay tide station. As expected, the computed water level matched the modeled water level at the ADV site very well (Figure 1).

The computed flow velocity matched the measured velocity reasonably well at the ADV site. The calibrated model was further verified using the measurements at various locations in the bay. Overall, the numerical model is capable of accurately simulate tidal water-level fluctuations and flow field (Figure 2).

Model Scenarios

A series of model runs was conducted with the goal of improving bay-wide circulation, particularly along the Palmetto Beach coast. The following scenarios (Alternatives) were modeled, including:

1. Existing conditions based on the up-to-date bathymetry surveyed by this study.
2. Pre-engineering conditions based on the 1885 bathymetry (referred to as Alternative 3, or A3). This serves as a benchmark case representing the natural flow pattern.
3. A1–filling seaward portion of the dredged deep channel.
4. A2-filling most of the dredged deep channel.
5. A4-restore a shallow shoal (0.5 m deep relatively to MSL) in the bay.
6. A5-restore a shallow shoal (0.5 m) in the bay, but with a 3-m deep channel for the Harbor pilot boat. Various shoal configurations, e.g., size, shape, depth, and location, were examined.
7. A5B-restore a shallow intertidal shoal (0.3 m), with a 3-m channel for the Harbor pilot boat.
8. A5C-restore a shallow subtidal shoal (0.7 m), with a 3-m deep channel for the Harbor pilot boat.
9. A5D-restore a shallow shoal (0.5 m), with the 3-m deep channel and a spur to guide flow to desirable locations, particularly along the Palmetto Beach coast.
10. A5E-restore a shallow shoal (0.5 m), with the 3-m deep channel and a shorter (than A5D) spur.
11. A5F-restore a shallow shoal (0.5 m), with the 3-m deep channel and a spur with a different angle (than A5D).
12. A5G-restore a shallow shoal (0.5 m), with the 3-m deep channel and a spur with a different angle (than A5D and A5G), with the goal of optimize the flow guidance toward Palmetto Beach coast.

Not all the above scenarios are discussed in this report because some of them were designed to find optimal conditions, e.g., the alternatives examine the different depths, shapes, and locations of the artificial shoal. In the following, several selected scenarios are discussed, including the pre-engineering natural conditions, the existing conditions, Alternatives A1 and A2, Alternatives A5, A5D, A5E and A5G.

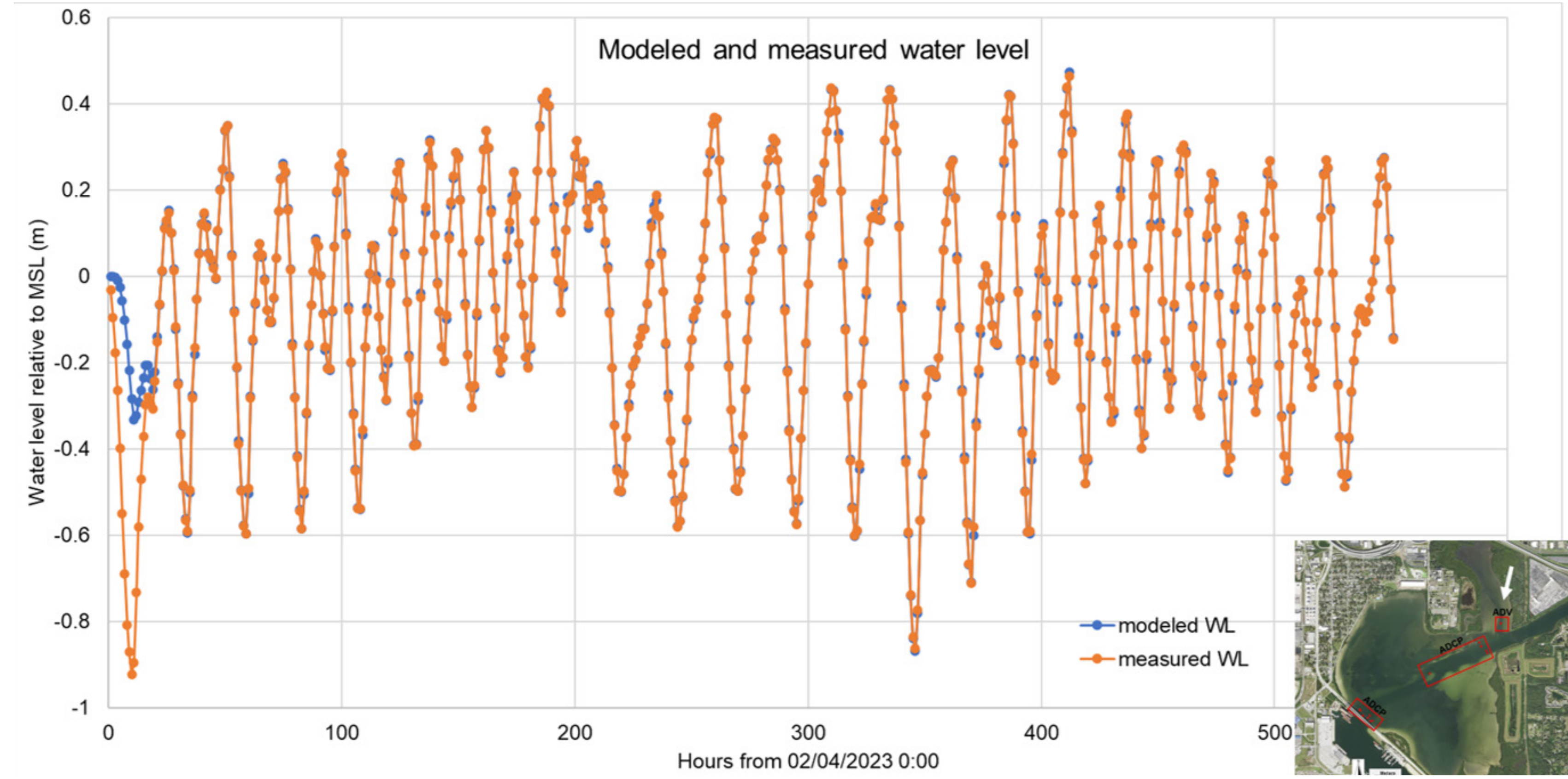


Figure 1

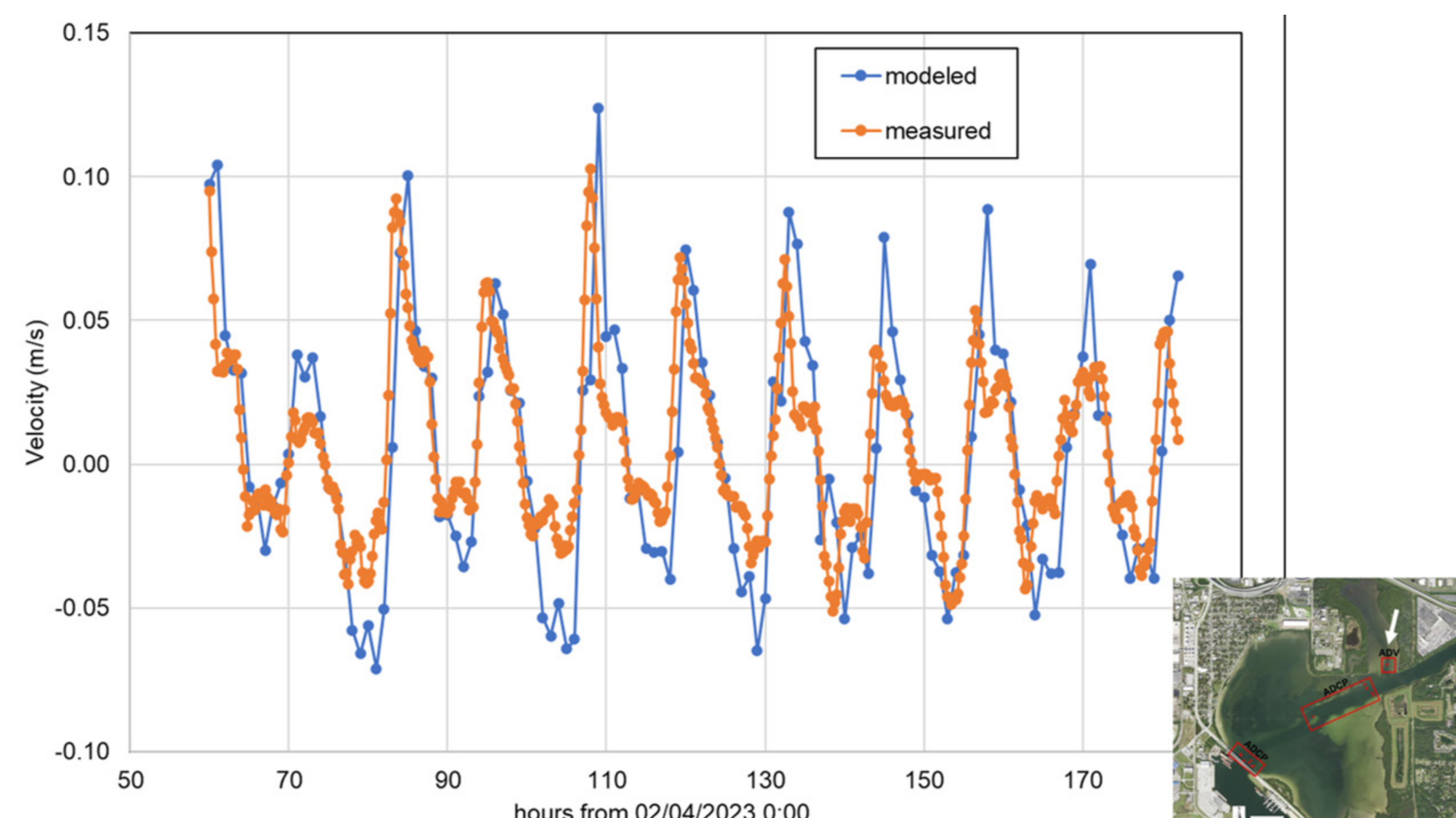
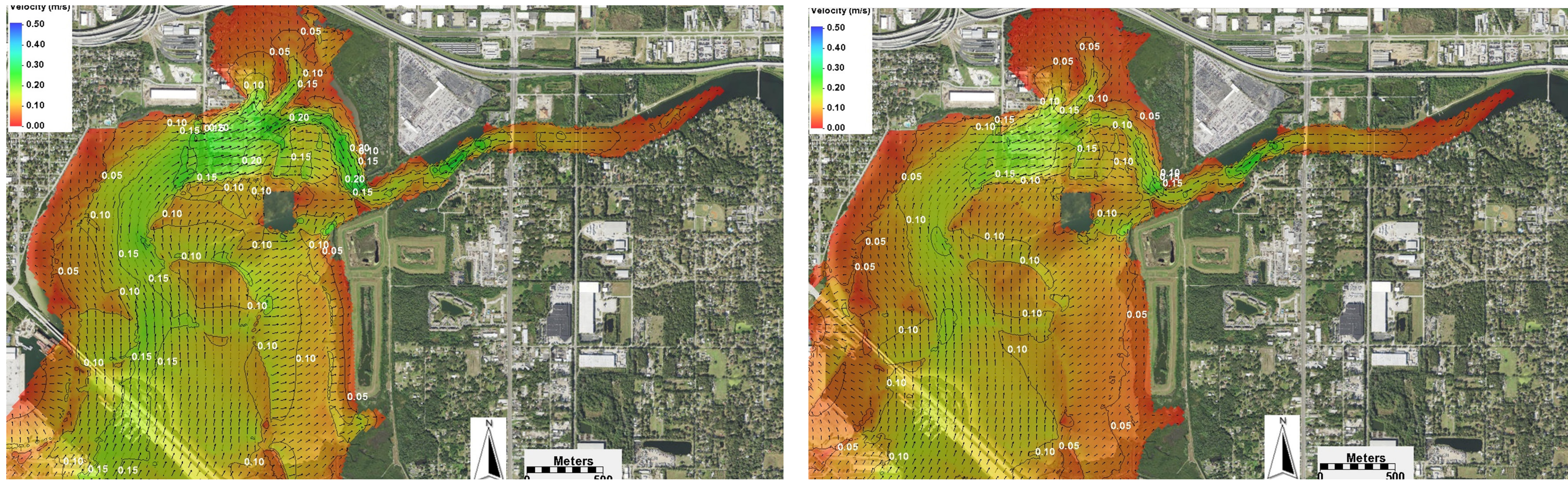


Figure 2

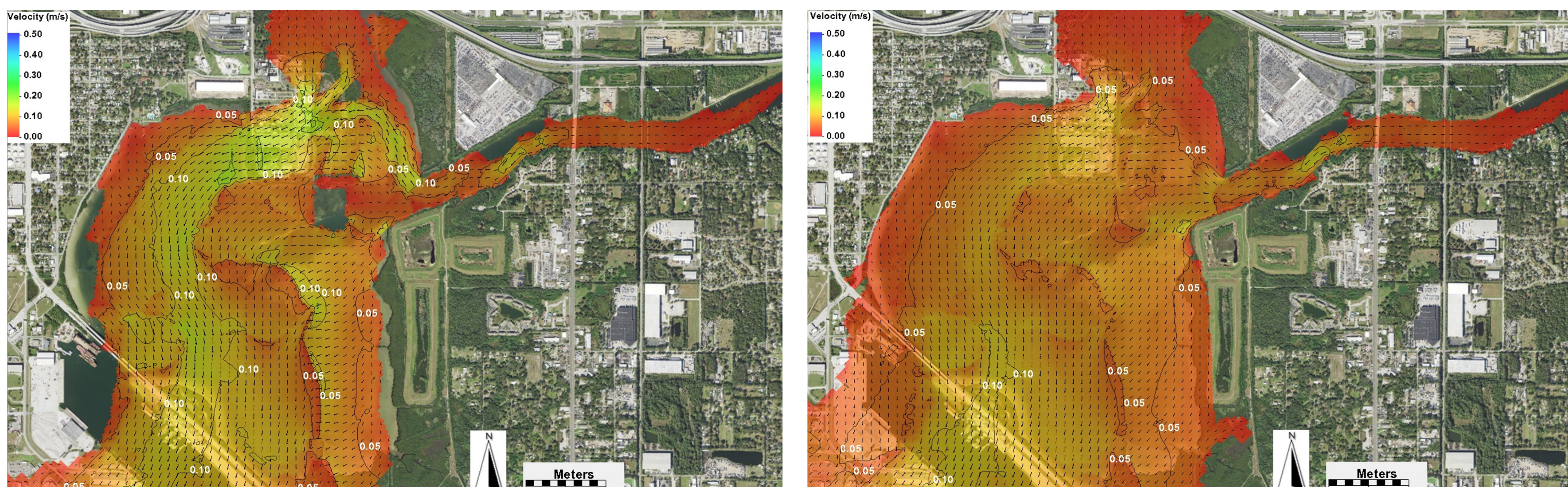
Modeling Results: Pre-engineering natural conditions – Benchmark Case

Examples of computed flow field under pre-engineering natural conditions, created based on the 1885 bathymetry map. The modeled flow fields are plotted over 2021 aerial photo. The top panels illustrate two examples of peak flooding flow driven by a rising tide, one at a lower tidal water level (left panel) and one at a higher tidal water level (right panel). The lower panels show two examples of peak ebbing flow driven by a falling tide. The naturally occurring bayhead delta and the associated shallow water, partially intertidal, at the mouth of the Six-Mile River guided the flood flow northward along the Palmetto Beach coast. At a lower tidal water level at the beginning of the rising tide (top left panel), the depth-averaged flow, as computed by the CMS-Flow, is stronger than at a higher tidal-water level near the end of the rising tide (top right panel). Similar to the spatial and temporal patterns of flooding flow, the ebb current also flows along the Palmetto Beach coast, and stronger at a lower water level near the end of the ebbing tide (bottom left panel) while weaker at a higher water level at the beginning of the ebbing tide (bottom right panel). The modeling results under the pre-engineering natural conditions indicate that the shallow delta at the mouth of the Six-Mile River, which was completely removed by the dredging operations, had a substantial control on the circulation pattern within McKay Bay, particularly in directing the flow along the Palmetto Beach coast. In the other words, the stagnant tidal flow along the Palmetto Beach coast can be attributable to the dredging of the shallow delta at the mouth of Six-Mile River and subsequent land fill along the northern shoreline.

The top two panels illustrate two examples of computed flooding tidal flow at different tidal stages: left panel illustrates the flow field at a lower tide; right panel illustrates the flow field at a higher tide.



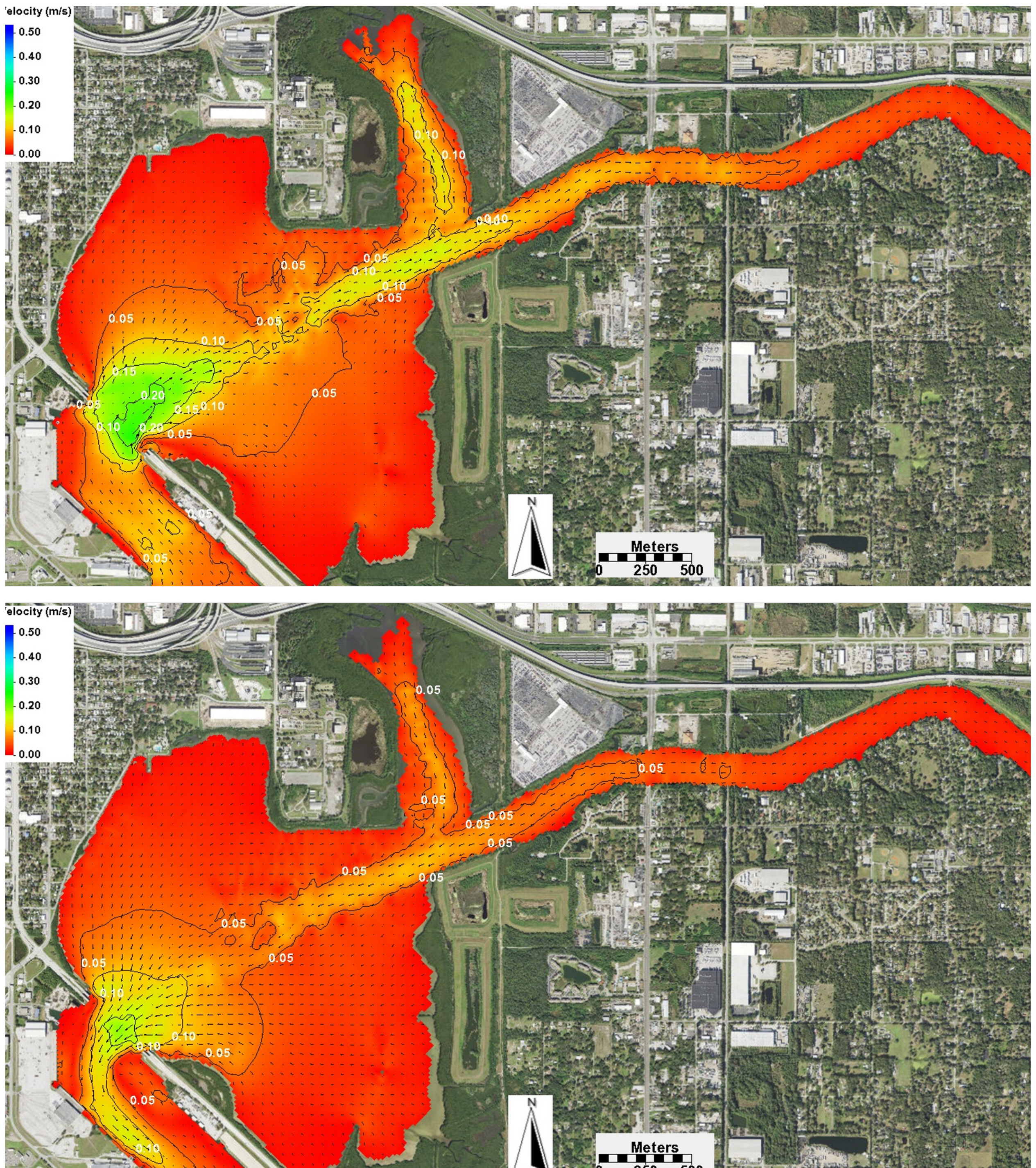
The bottom two panels illustrate two examples of computed ebbing tidal flow at different tidal stages: left panel illustrates the flow field at a lower tide; right panel illustrates the flow field at a higher tide.



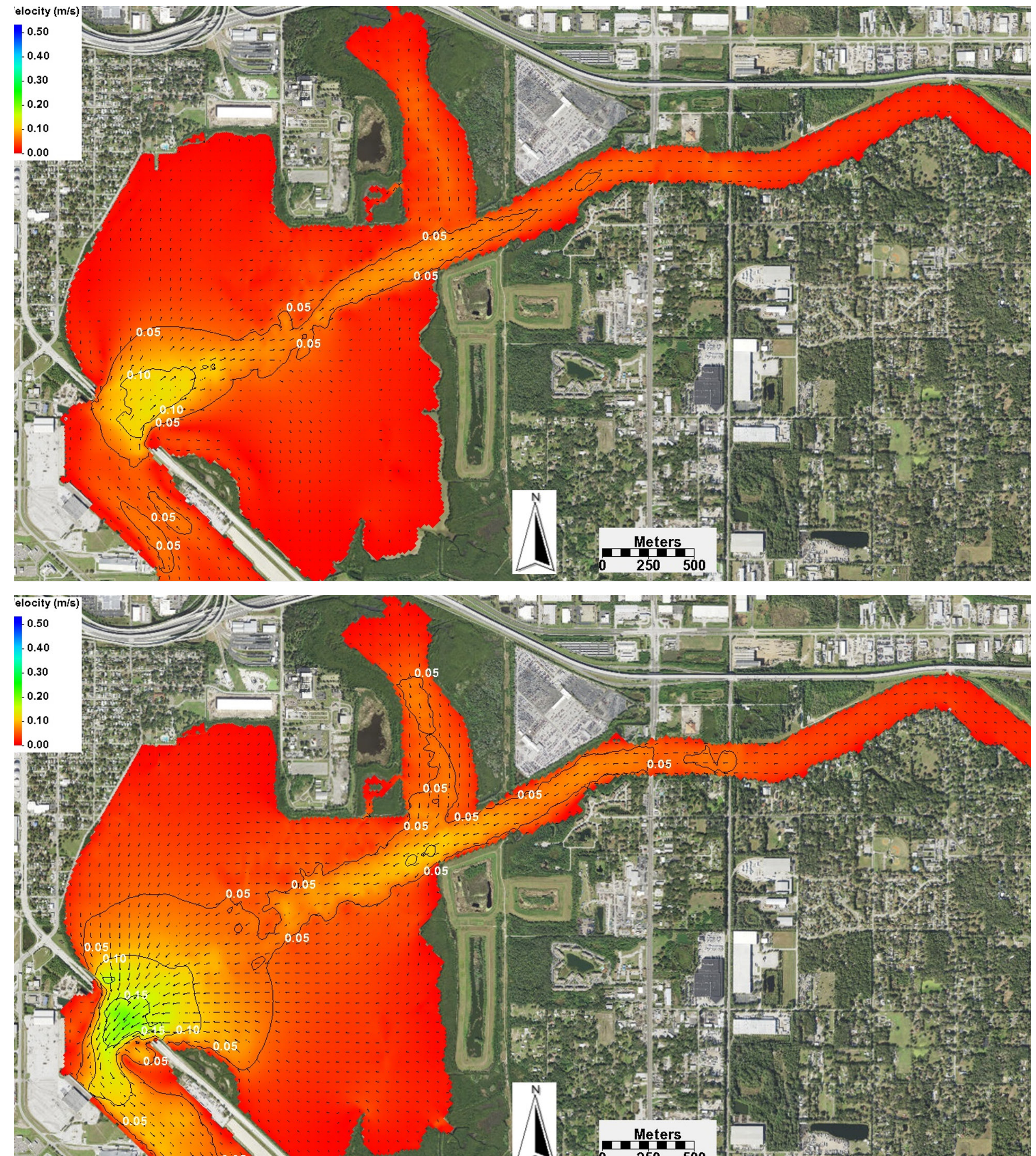
Modeling Results: Existing Conditions with Tide Only

Examples of computed flow field under existing conditions driven by tide only, based on the detailed bathymetry survey conducted by this study, are shown here. The top panels illustrate two examples of peak flooding flow driven by a rising tide, one at a lower tidal water level (left panel) and one at a higher tidal water level (right panel). The lower panels show two examples of peak ebbing flow driven by a falling tide (lower panels). Compared to the natural conditions, discussed above, the overall magnitude of tidal-driven flow is significantly lower, particularly along the Palmetto Beach coast. Under existing conditions, the tidal flow is concentrated in the dredged channel through the middle of the bay, while the flow in the rest of the bay is quite weak for both flooding and ebbing tides. Since the dredged channel is quite overwhelming for a shallow bay, of nearly 5 m deep and 200 m wide, the tidal flow through the channel is also weak although concentrated. In summary, the overall weak tidal circulation within in McKay Bay can be attributed to the artificial deep and wide dredged channel, in addition to the landfill along the northern coast. It is worth pointing out an interesting feature at a wetland restoration project just to the east of the McKay Bay Nature Park & Trail. The restored tidal creek allowed some tidal flow during both flooding and ebbing when the water level is above mean sea level, indicating a successful local improvement of tidal circulation.

Peak tidal flow velocities (above), and minimal ebb flow velocities (bottom)



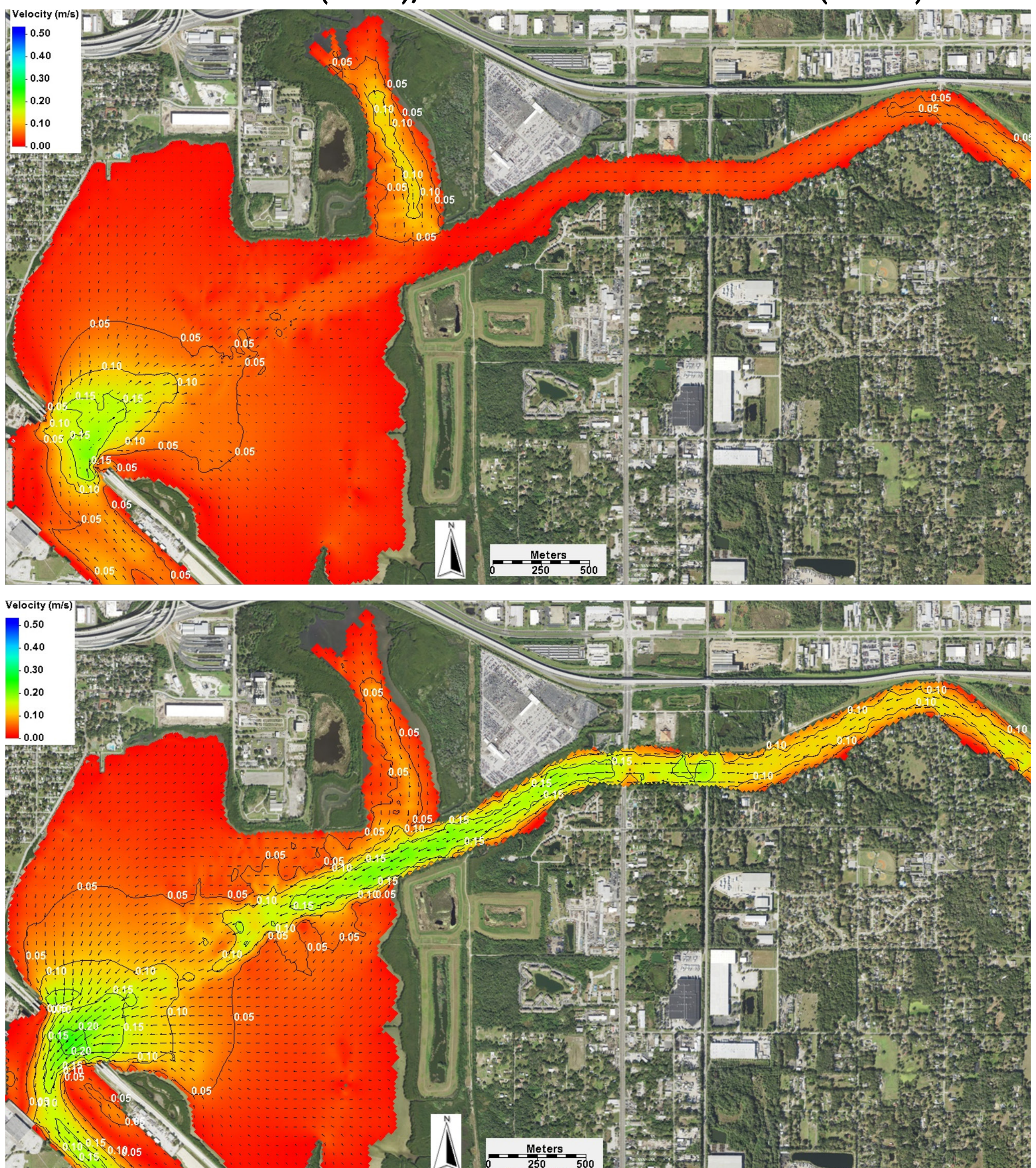
Minimal tidal flow velocities (above), and peak ebb flow velocities (bottom)



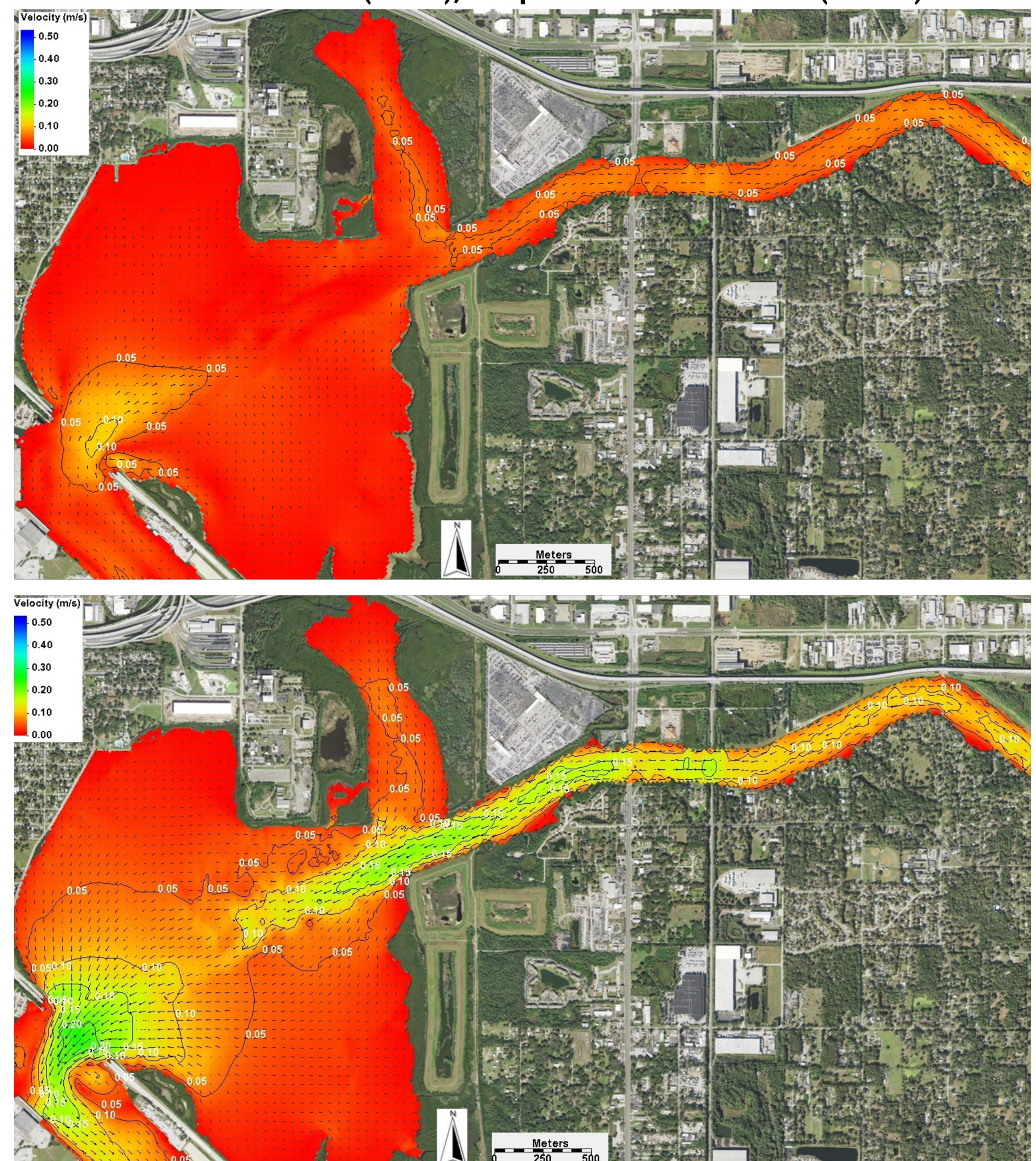
Existing Conditions Velocity - With 50 M^3 Per Second Discharge

Examples of computed flow field under existing conditions driven by both tide and discharge from the Bypass Canal are shown here. Given the Bypass Canal is designed prevent flooding in the downtown area during heavy rainfall conditions, a rather large discharge of 50 m3/s was applied in this simulation to examine the contribution of flood water to the McKay Bay circulation. The top panels illustrate two examples of peak flooding flow driven by a rising tide, one at a lower tidal water level (left panel) and one at a higher tidal water level (right panel). The lower panels show two examples of peak ebbing flow driven by a falling tide (lower panels). Compared to the tide only case discussed above, the large discharge from the Bypass Canal suppressed the flood flow, while enhanced the ebb flow. Since the dredged Bypass Canal is deep (~ 5m) and wide (~200 m), even the large 50 m3/s discharge is not able to generate strong enough flow to flush the soft mud at the bottom of the dredged channel, as documented by the sediment sampling, throughout the entire McKay Bay. It is worth noting that the very large 50 m3/s discharge occurs very rarely. Overall, the discharge from the Bypass Canal has minor influence on the circulation pattern within McKay Bay. Compared to the influences of the dredge and fill operations, the flow-pattern modification by the discharge from the Bypass Canal is not significant.

Peak tidal flow velocities (above), and minimal ebb flow velocities (bottom)



Minimal tidal flow velocities (above), and peak ebb flow velocities (bottom)



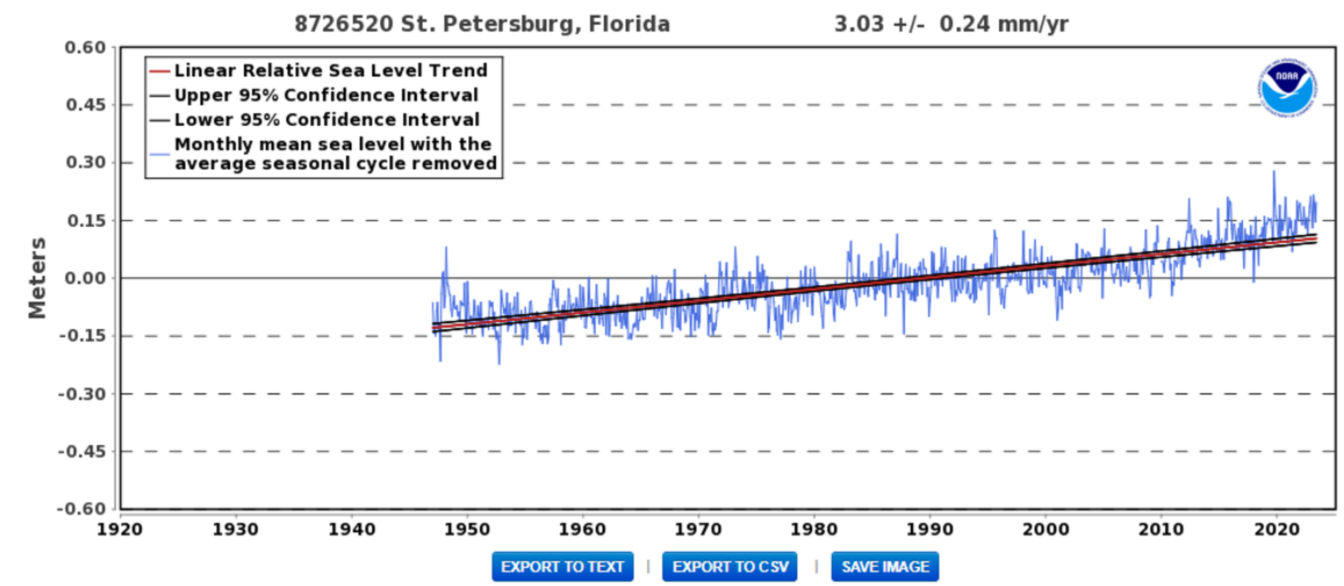
TASK 3

STORM SURGE ANALYSIS

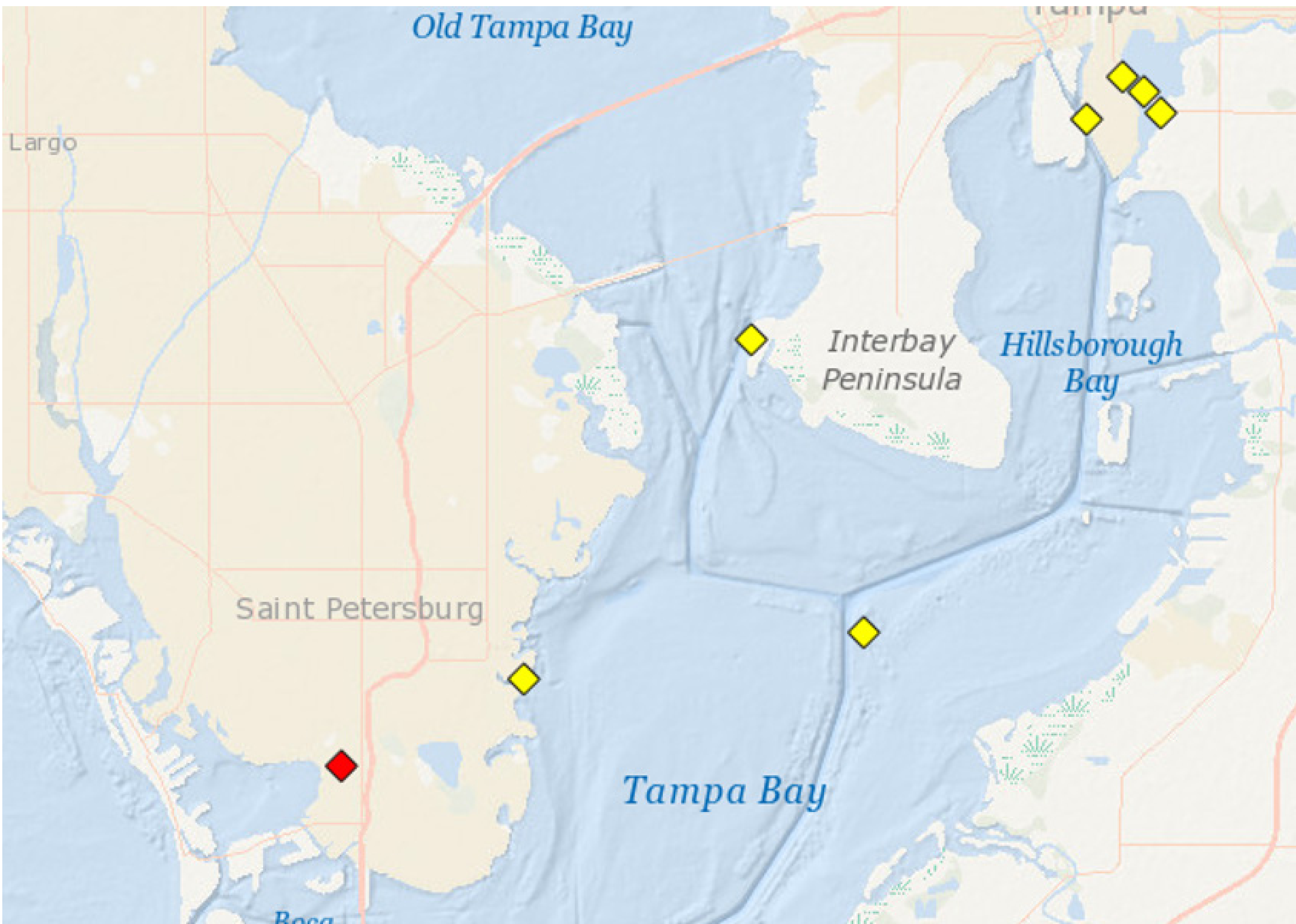
Storm Surge Analysis

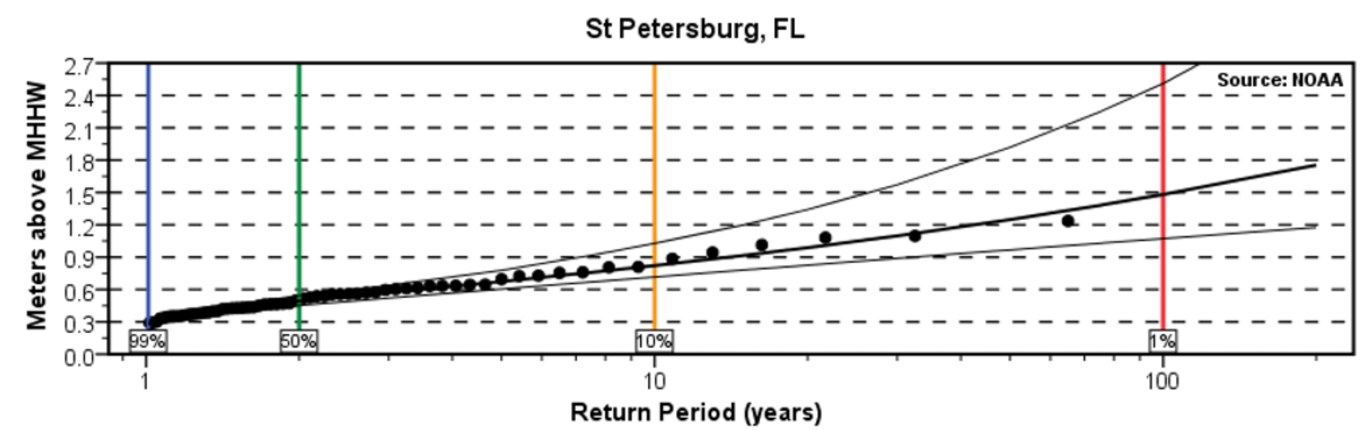
The water level is well measured with several long-term NOAA tide stations at the greater study area, including Station SAPF1 - 8726520 - St. Petersburg, Tampa Bay (1947-2023), Station OPTF1 - 8726607 - Old Port Tampa (2006-2023), Station TPAF1 - 8726694 - TPA Cruise Terminal 2, Tampa (2008-2023), Station TSHF1 - 8726679 - East Bay Causeway (2009-2023). The SAPF1 – 8726520 Station has the longest record of 76 years and is used here for storm surge and sea-level rise analysis. The measured sea-level rise is shown in the following figure. Extreme water-level analysis results are also provided at this Station and is shown in the following. Furthermore, the relative sea-level change (RSLC) projections used by USACE at St. Petersburg Florida is used and illustrated below. These RSLC projections were used by the USACE in the 2023 Tampa Harbor Navigation Improvement Study. The USACE design horizons of 25 year (2056) and 50 year (2081) are included in this figure.

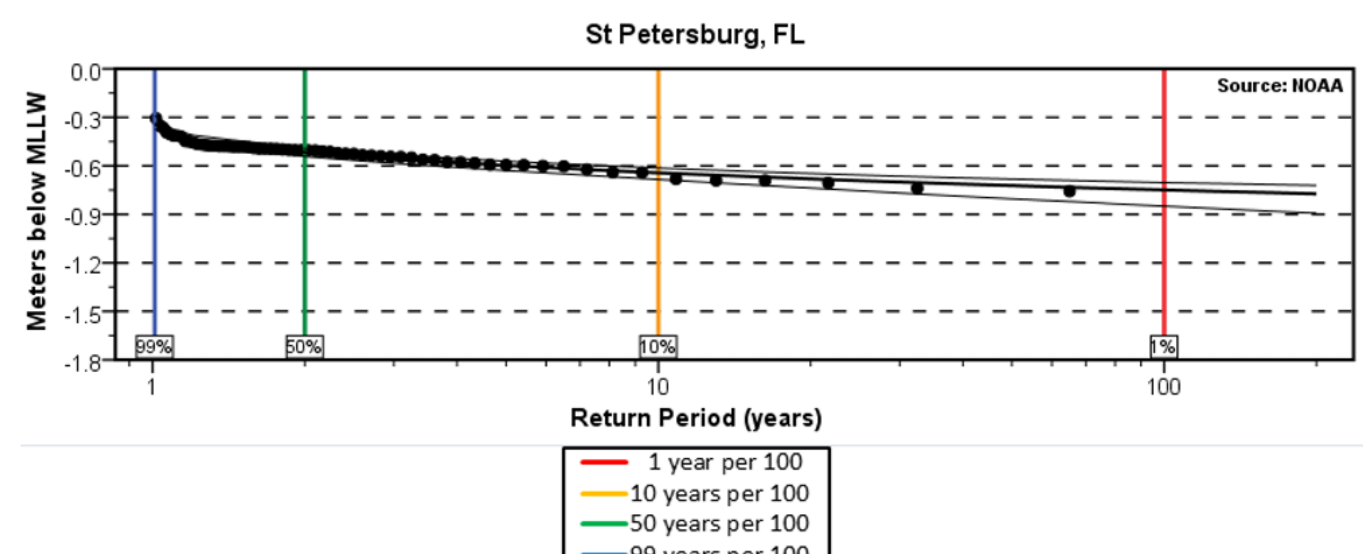
Relative Sea Level Trend
8726520 St. Petersburg, Florida



The relative sea level trend is 3.03 millimeters/year with a 95% confidence interval of +/- 0.24 mm/yr based on monthly mean sea level data from 1947 to 2022 which is equivalent to a change of 0.99 feet in 100 years.







Storm Surge Analysis

Based on the SAPF1 – 8726520 Station, the following water levels are summarized using the 1983-2001 Epoch (with 1992 as the mid-year):

1)	Mean Sea Level (MSL):	0.000 m
2)	Mean Higher High Water (MHHW):	0.322 m
3)	Mean High Water (MHW):	0.236 m
4)	NAVD 88 datum (0 m):	0.084 m
5)	Mean Low Water (MLW):	-0.249 m
6)	Mean Lower Low Water (MLLW):	-0.366 m
7)	Maximum Tide (measured on 08/31/1985 at 12:42)	1.541 m
8)	Minimum Tide (measured on 09/11/2017 at 02:12)	-1.446 m

Based on the extreme water-level and sea-level rise analysis, as illustrated above, the extreme water levels are estimated in the following. Since the extreme water level is mostly driven by storms, these water levels represent storm surge levels incorporating projected sea-level rise under three different climate scenarios. In the following, the extreme water levels are referred to MSL and NAVD88 in meters, with feet in brackets.

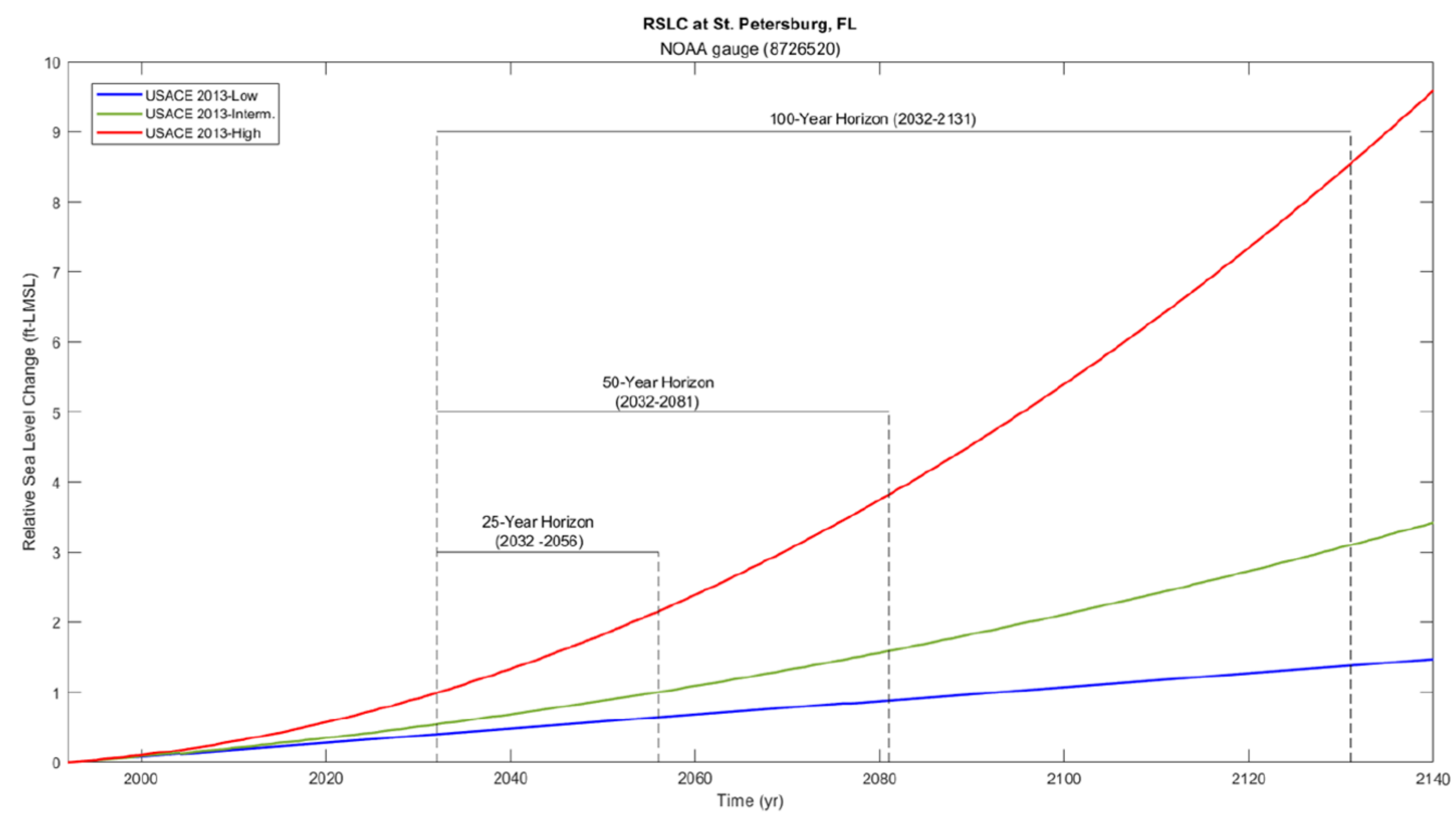
1) Projected sea-level rise based on the USACE sea-level curve, as shown above, in meters with feet in brackets:

a.	Projected sea level in 2050 – low curve:	0.18 (0.58)
b.	Projected sea level in 2050 – mid curve:	0.25 (0.81)
c.	Projected sea level in 2050 – high curve:	0.53 (1.75)
d.	Projected sea level in 2100 – low curve:	0.30 (1.00)
e.	Projected sea level in 2100 – mid curve:	0.50 (1.65)
f.	Projected sea level in 2100 – high curve:	1.59 (5.20)

2)	Storm surge with a 10-year return period:	MSL	NAVD88
a.	Without projected sea-level rise (SLR)	1.09 (3.58)	1.01 (3.31)
b.	With projected SLR to 2050 – low curve:	1.27 (4.16)	1.18 (3.89)
c.	With projected SLR to 2050 – medium curve:	1.34 (4.39)	1.25 (4.12)
d.	With projected SLR to 2050 – high curve:	1.63 (5.33)	1.54 (5.06)
e.	With projected SLR to 2100 – low curve:	1.40 (4.58)	1.31 (4.31)
f.	With projected SLR to 2100 – medium curve:	1.60 (5.23)	1.51 (4.96)
g.	With projected SLR to 2100 – high curve:	2.68 (8.78)	2.59 (8.51)

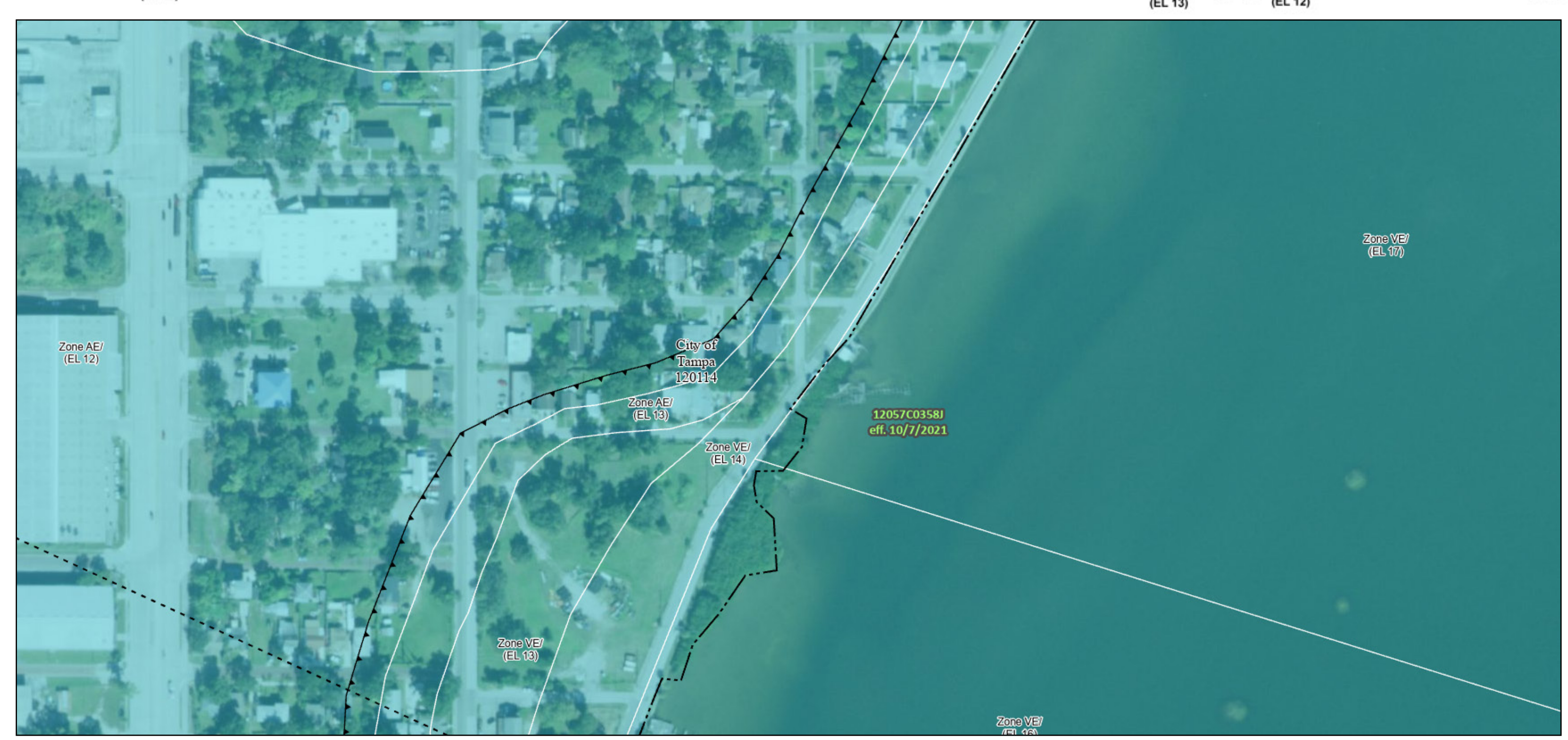
3)	Storm surge with a 50-year return period:	MSL	NAVD88
a.	Without projected sea-level rise (SLR):	1.57 (5.16)	1.49 (4.88)
b.	With projected SLR to 2050 – low curve:	1.75 (5.74)	1.66 (5.46)
c.	With projected SLR to 2050 – medium curve:	1.82 (5.97)	1.73 (5.69)
d.	With projected SLR to 2050 – high curve:	2.11 (6.91)	2.02 (6.63)
e.	With projected SLR to 2100 – low curve:	1.88 (6.16)	1.79 (5.88)
f.	With projected SLR to 2100 – medium curve:	2.08 (6.81)	1.99 (6.53)
g.	With projected SLR to 2100 – high curve:	3.16 (10.36)	3.07 (10.08)

4)	Storm surge with a 100-year return period:	MSL	NAVD88
a.	Without projected sea-level rise (SLR):	1.82 (5.98)	1.74 (5.70)
b.	With projected SLR to 2050 – low curve:	2.00 (6.56)	1.91 (6.28)
c.	With projected SLR to 2050 – medium curve:	2.07 (6.79)	1.98 (6.51)
d.	With projected SLR to 2050 – high curve:	2.36 (7.73)	2.27 (7.45)
e.	With projected SLR to 2100 – low curve:	2.13 (6.98)	2.04 (6.70)
f.	With projected SLR to 2100 – medium curve:	2.33 (7.63)	2.24 (7.35)
g.	With projected SLR to 2100 – high curve:	3.41 (11.18)	3.32 (10.90)



Flood Zones

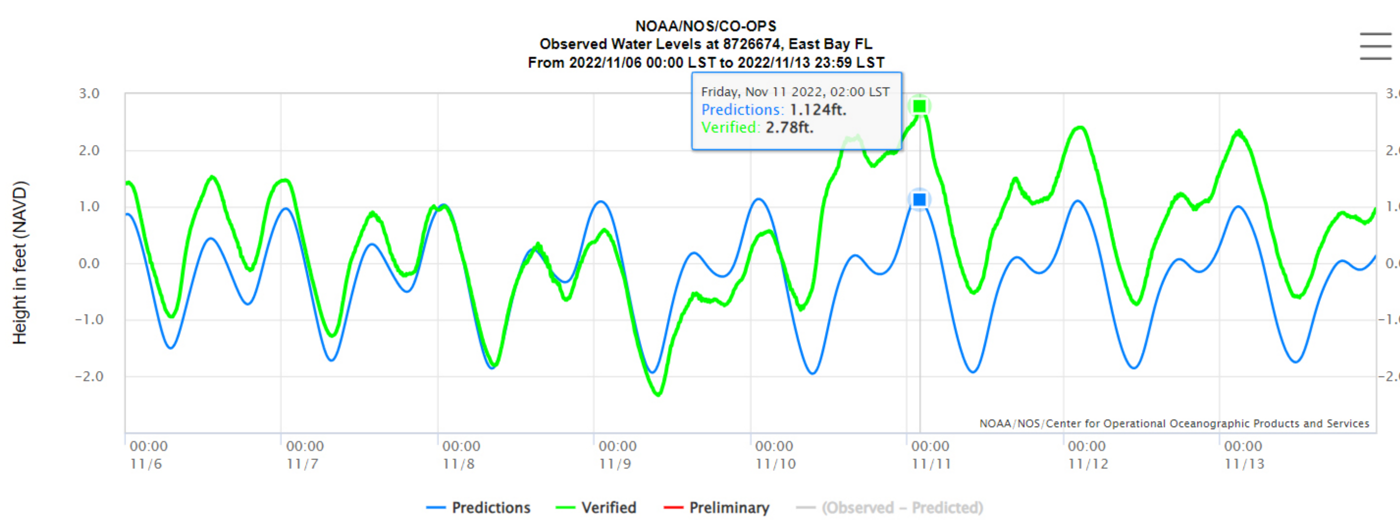
The Palmetto Beach community is almost entirely within FEMA's 100-year (1%) flood zone. This is shown by FEMA's recently updated (2021) Flood Insurance Rate Maps (FIRMs). Near the shoreline of Bermuda Boulevard many properties are within the VE zone, with base flood elevations from 13 to 17 feet NAVD88. An additional area, containing about 1 block from the shoreline, is within the Limit of Moderate Wave Action (LIMWA) area - denoted by a line with triangle flags. Inland from that, the community is within the AE zone with base flood elevations between 11 and 13 NAVD88.



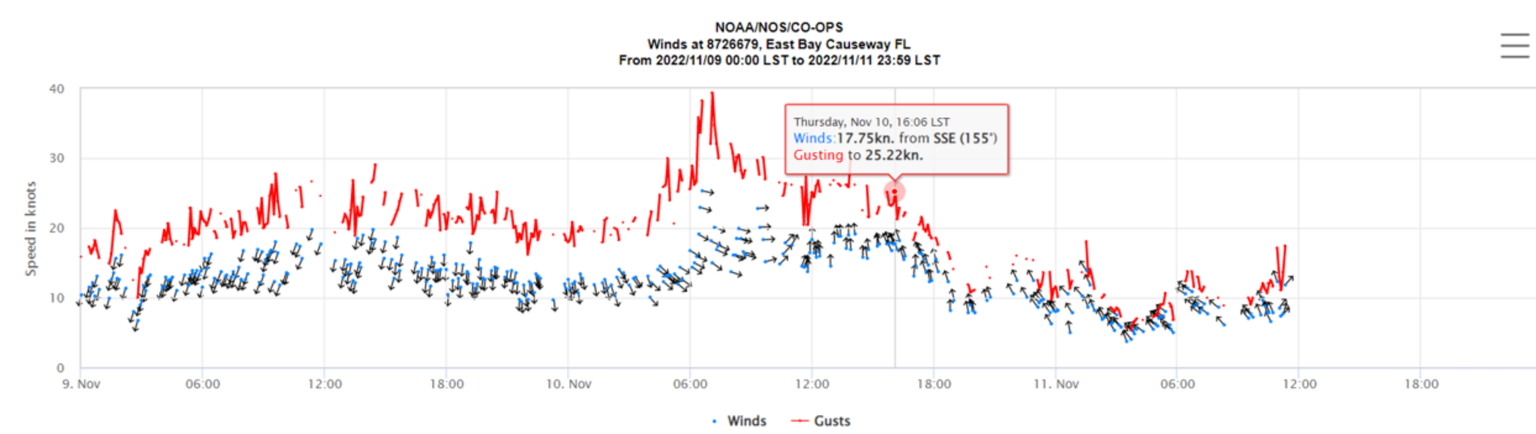
Observed Storm Surge - During Tropical Storm Nicole

Tropical Storm Nicole in 2022 passed the study area distally providing an opportunity to observe the impact of a modest storm and its surge to the project area. As measured by the NOAA East Bay tide gauge, Tropical Storm Nicole generated a 1.64 ft storm surge above a spring high tide. Based on the NOAA extreme water-level estimate at the SAPF1 – 8726520, St. Petersburg Station, the 1.64 ft (0.5 m) storm surge generated by Tropical Storm Nicole corresponds to a 2-year return period storm. The seawall along Bermuda Boulevard and Desoto Park have, based on review of surveys, a minimum elevation of 4.3' NAVD. The highest recorded surge with Tropical Storm Nicole was 2.78' NAVD88. Based on the extreme water level estimated above, the 4.3 ft (NAVD 88) seawall would be overtopped by:

1) a 50-year storm surge without incorporating SLR, or
2) A 10-year storm surge superimposed on the mid SLR curve by 2050, or
3) A 10-year storm surge superimposed on the low SLR curve by 2100



Source: NOAA Tide Gauge for East Bay, Tampa

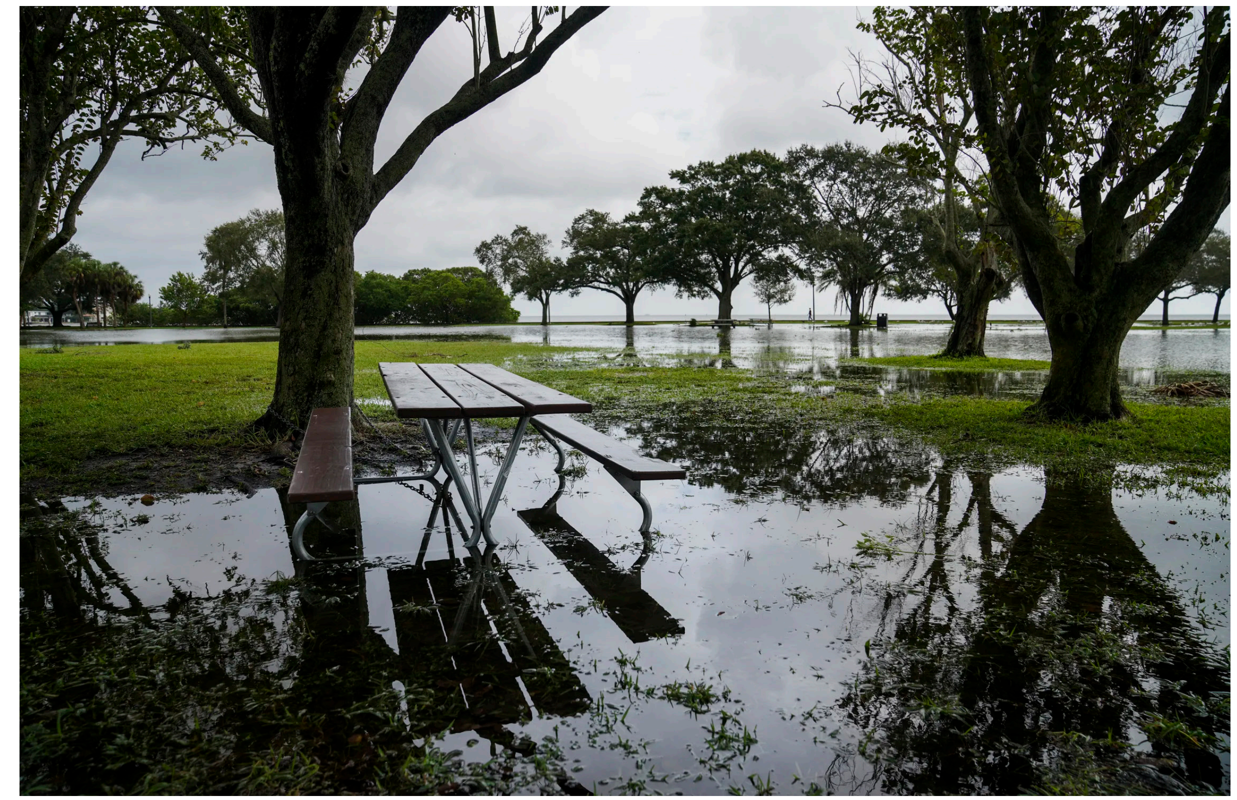


Source: NOAA Meteorological Gauge for East Bay, Tampa

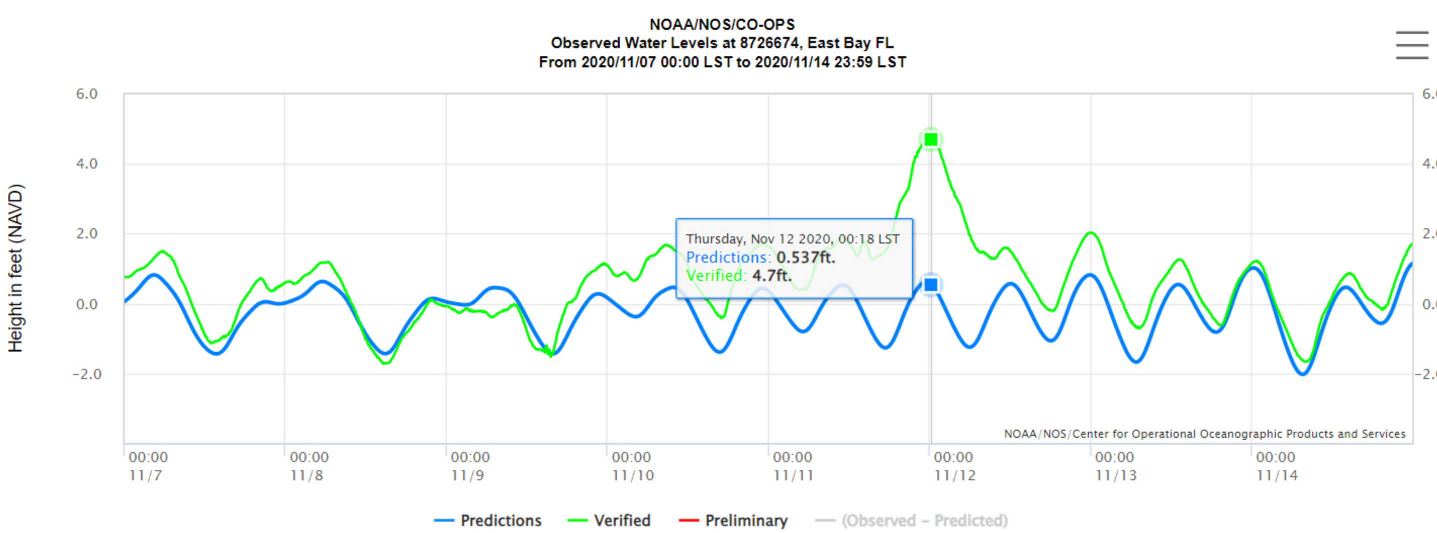
Observed Storm Surge - During Tropical Storm Eta

Tropical Storm Eta represented a recent high water event. Different from Tropical Storm Nicole, Eta passed the study area much closer on November 10-11, in 2020. The NOAA East Bay tide gauge near Palmetto Beach recorded a high water level of 4.7' NAVD88, which overtopped some sections of the seawall. Tropical Storm Eta generated a storm surge of nearly 4.2 ft. However, the storm surge was superimposed on a neap tide, resulting in a total water level of 4.7 ft. Based on the NOAA extreme water-level estimate at the SAPF1 – 8726520, St. Petersburg Station, the 4.2 ft (1.3 m) storm surge generated by Tropical Storm Eta corresponds to a slightly over 50-year return period storm. Fortunately, it occurred during a neap tide. If it had occurred during a spring high tide, much more flooding would have occurred. In summary, the observations during the passages of Tropical Storms Nicole and Eta confirmed the extreme water-level estimates by NOAA. Given the NOAA estimates were based on measurements, this agreement is expected.

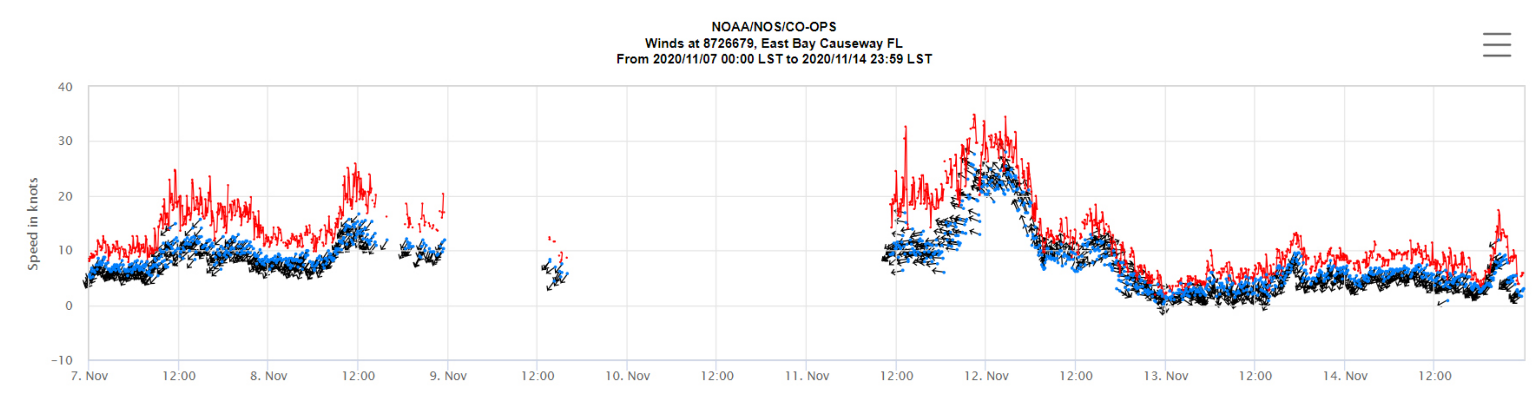
Source: Tampa Bay Times



Source: Tampa Bay Times



Source: NOAA Tide Gauge for East Bay, Tampa



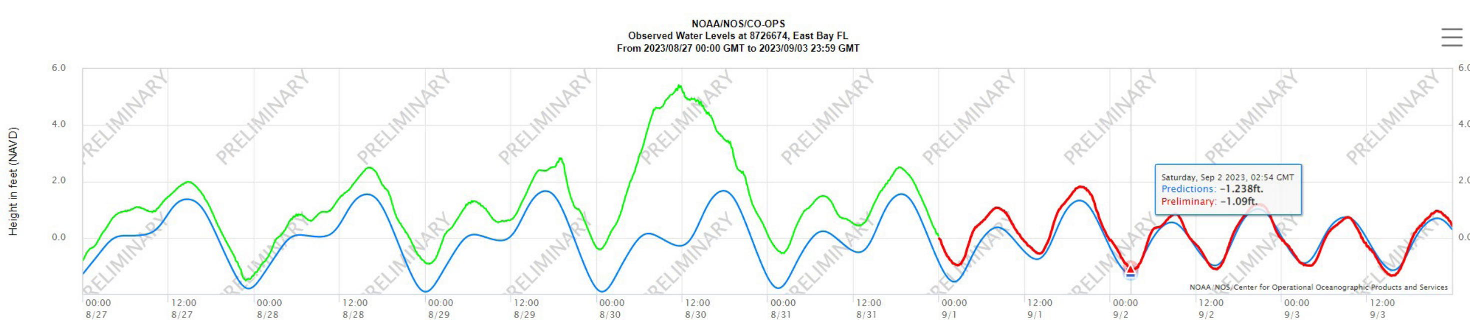
Source: NOAA Meteorological Gauge for East Bay, Tampa

Observed Storm Surge - During Hurricane Idalia

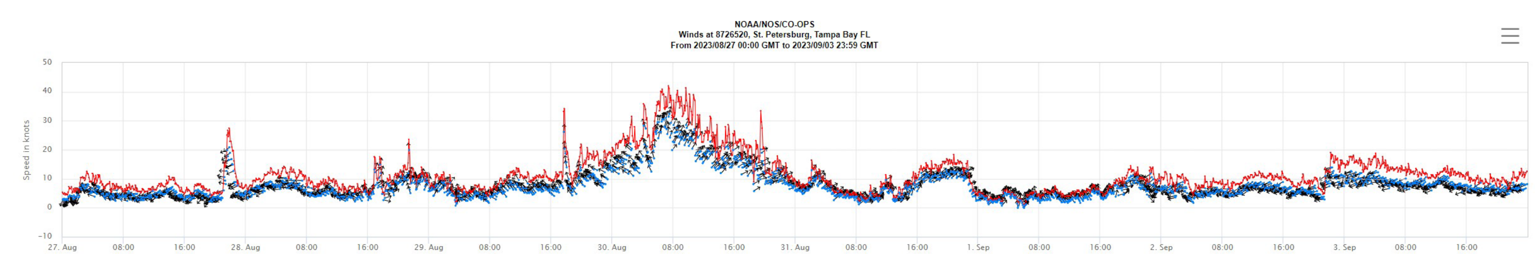
Hurricane Idalia did not bring extreme weather to McKay Bay and Palmetto Beach, but it did bring a significant amount of elevated tide -- up to elevation 5.42’ NAVD88 according to the NOAA East Bay tide gauge. Hurricane Idalia passed approximately 100 miles to the west on August 30, 2023, making landfall in the Florida Panhandle. The apex of surge occured during a low tide period, buffering the overall impacts, but was during a high tide associated with 1-year stillwater elevations. NOAA tide predictions estimated 1.66’ for the higher high tide that day, which is close to the 2.0’ 1-year stillwater elevation. Water levels overtopped the Desoto Park and Bermuda Boulevard seawall and filled the community with water, 2-3’ in some areas.

Rack line shown in post-surge condition from Hurricane Idalia, August 30, 2023 - at elevation 5.42 NAVD.

Seawall overtopping from Hurricane Idalia.



Tide data. Source: NOAA Tide Gauge for East Bay, Tampa



Wind data. Source: NOAA Meteorological Gauge for St. Petersburg

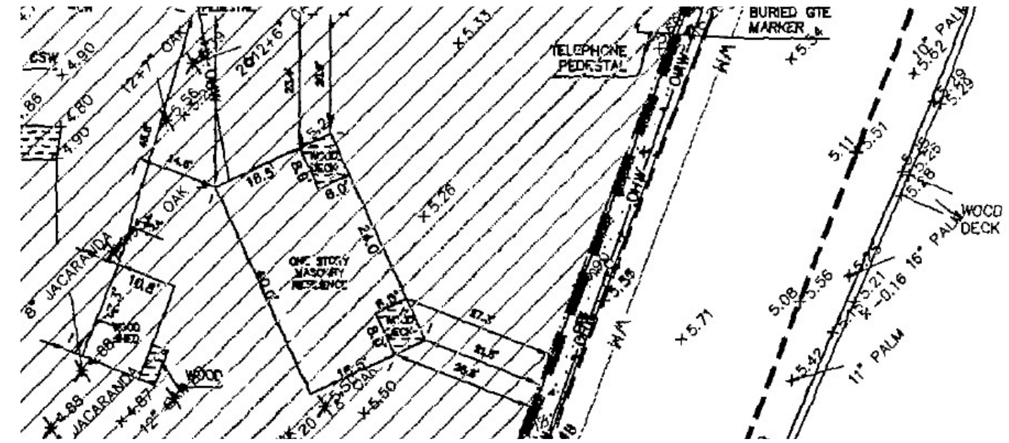
Observed Storm Surge - During Hurricane Idalia

Images in Palmetto Beach during Hurricane Idalia.

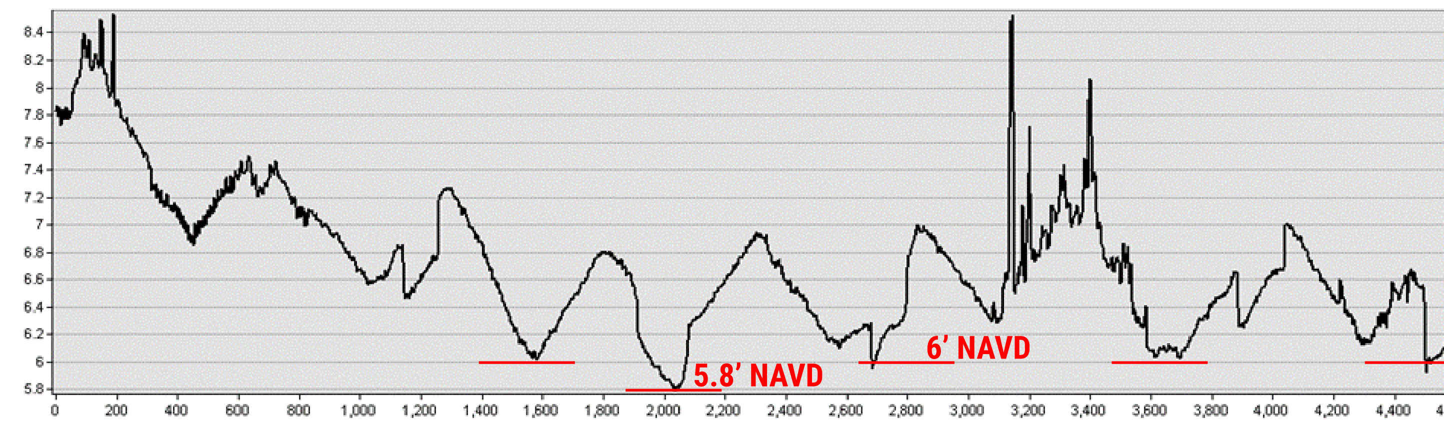
Bermuda Boulevard

Seawall and topographic elevations were studied for the Palmetto Beach Community to evaluate protection levels from coastal surge. The lowest elevations along 20th Street, a major boundary for the area, is at approximately 5.8' NAVD88, with a consistent low elevation of about 6'. On the eastern edge, at Bermuda Boulevard, the roadway elevations are mostly between 3.3' and 5' NAVD88. Top of seawall elevations included in a PD development application survey near Saxon Street were between 4.3' and 4.8' NAVD. Because the streets are connected to the Bay through the numerous stormwater drains, seawater can be backed up onto the streets through the drains. In other words, the seawater does not need to overtop the seawall to induce flooding in areas that are lower than the seawall.

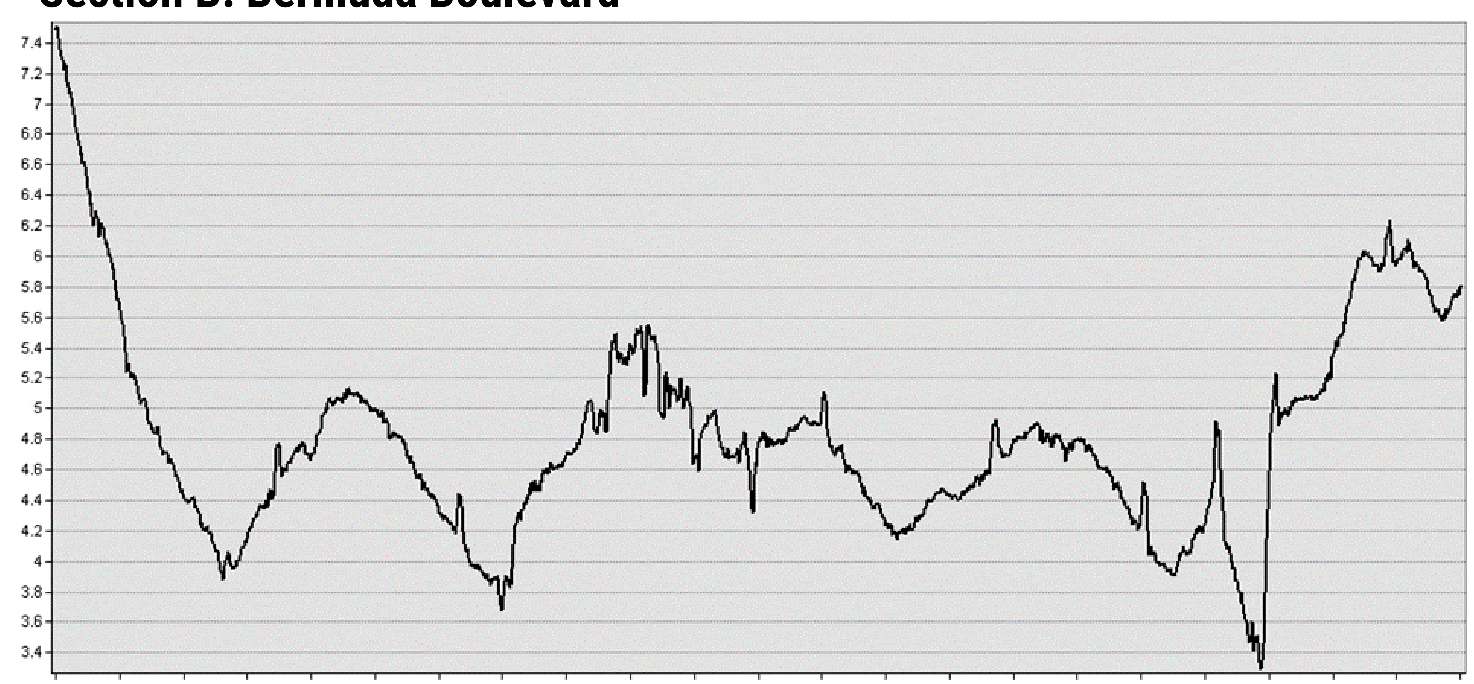
Seawall Survey



Section A: 20th Street



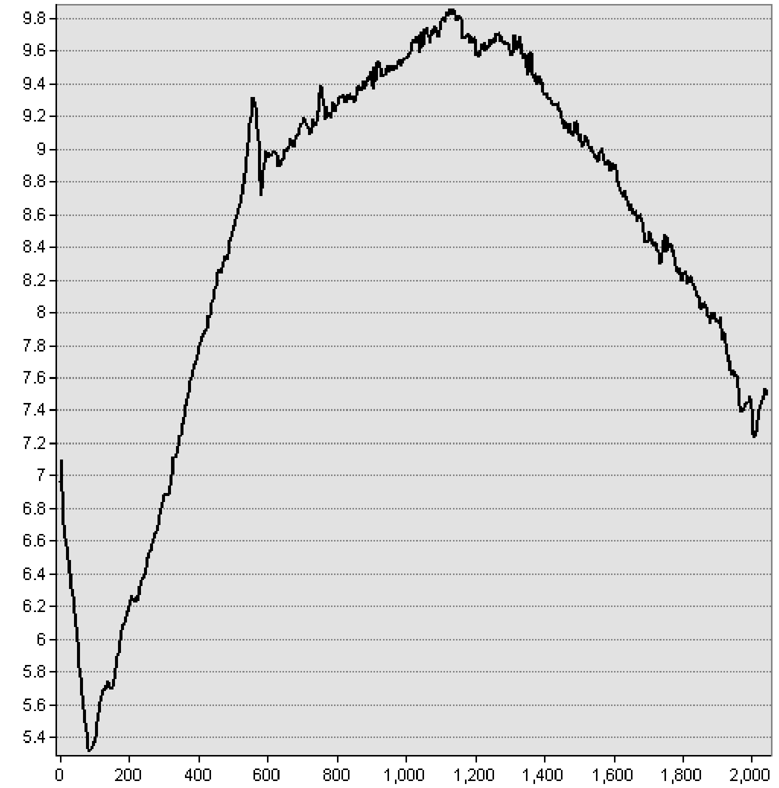
Section B: Bermuda Boulevard



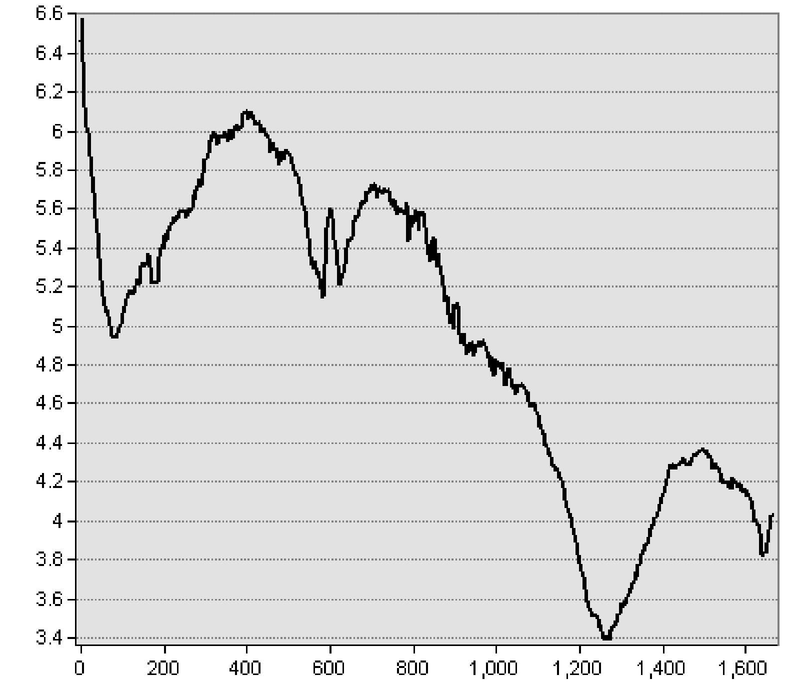
Street Elevations

The low elevation stretches of Streets D, E, F, and G, at slightly above 3 ft NAVD88, are vulnerable to flooding from coastal waters that go inland through the system and exit through storm drains. Based on the analysis above, a 10-year return period storm without incorporating projected sea-level rise would flood these low sections of the road.

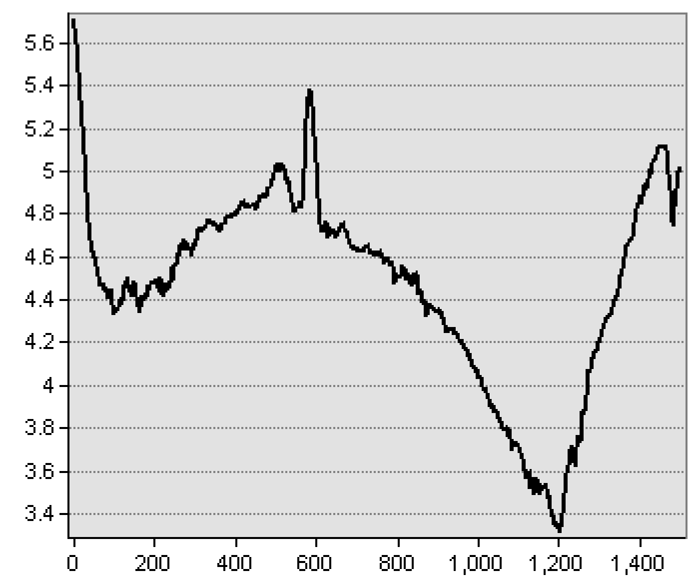
Section C: Harper Street



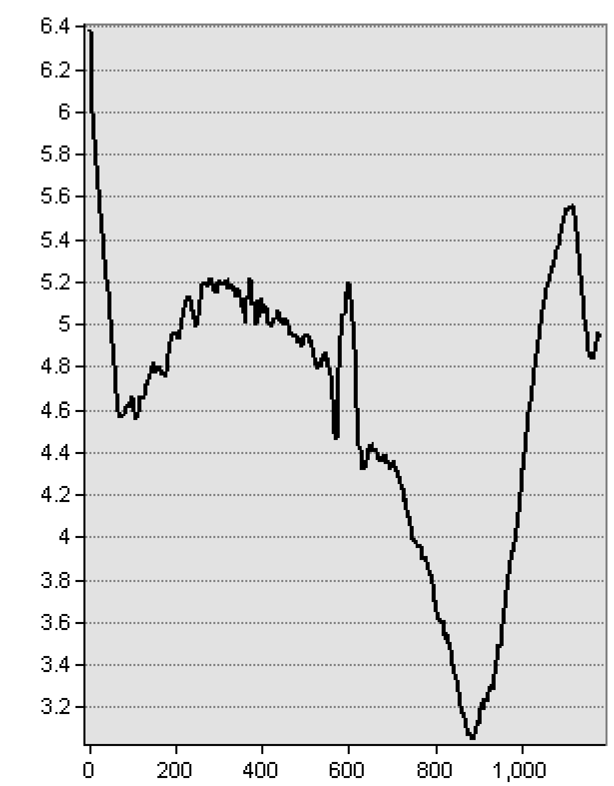
Section D: Davis Street



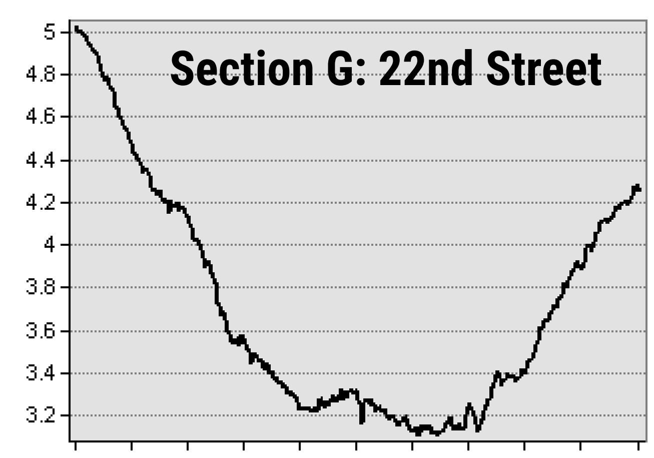
Section E: Grant Street



Section F: Saxon Street

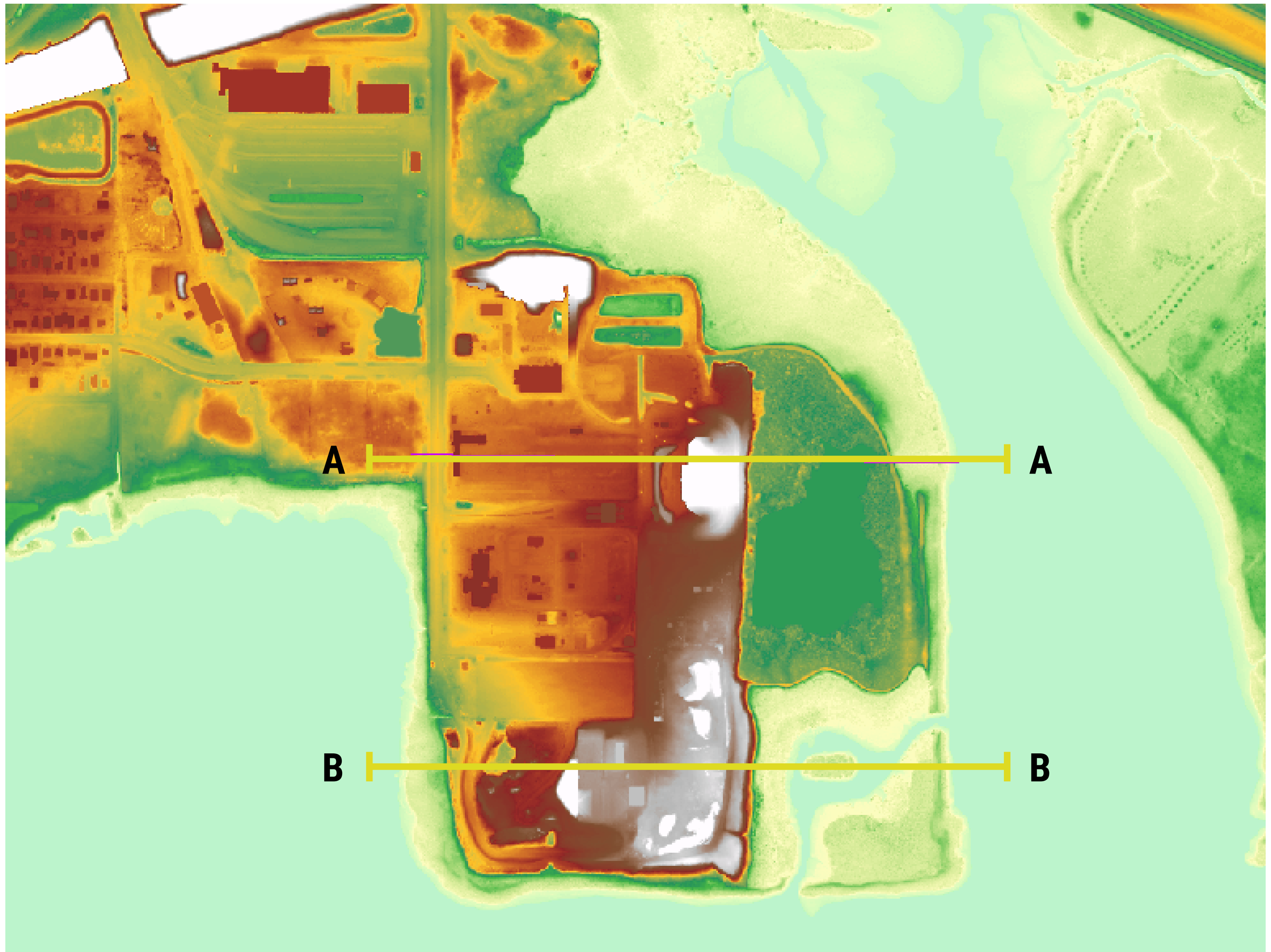


Section G: 22nd Street

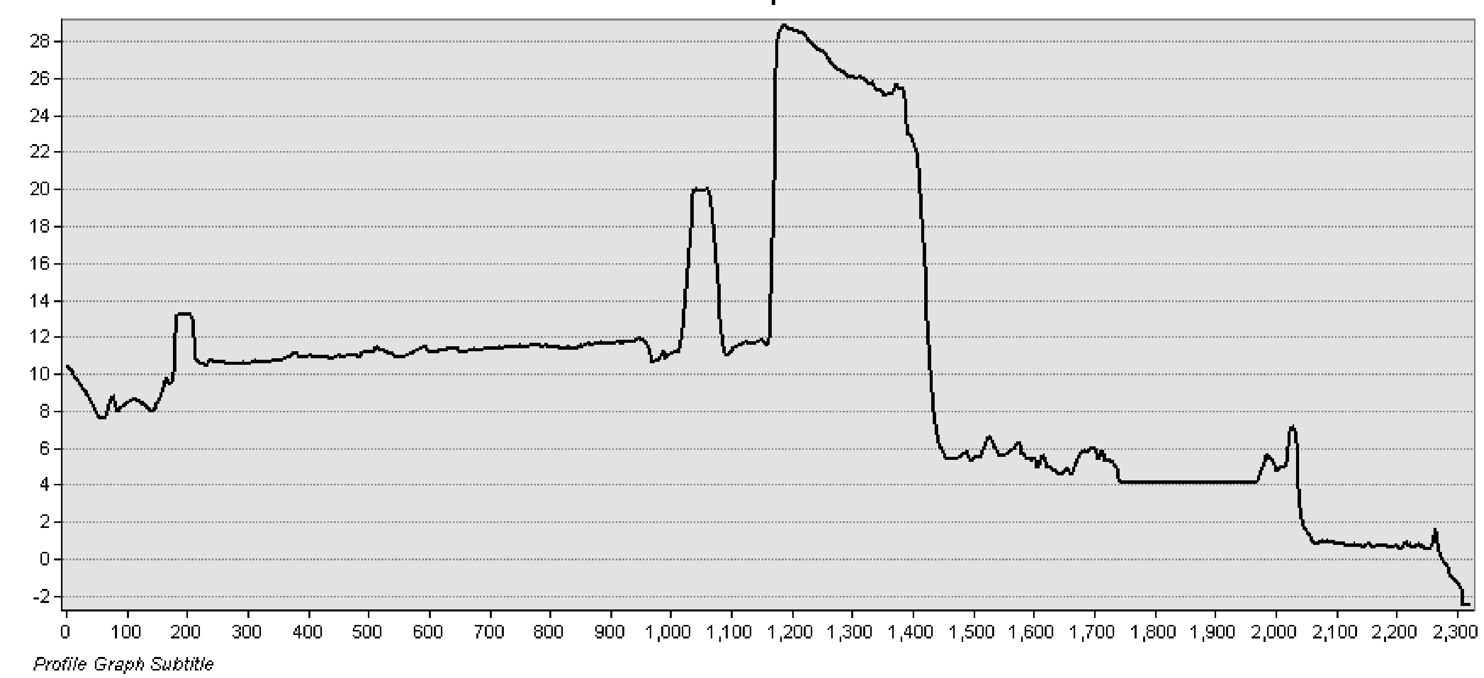


McKay Bay Facility

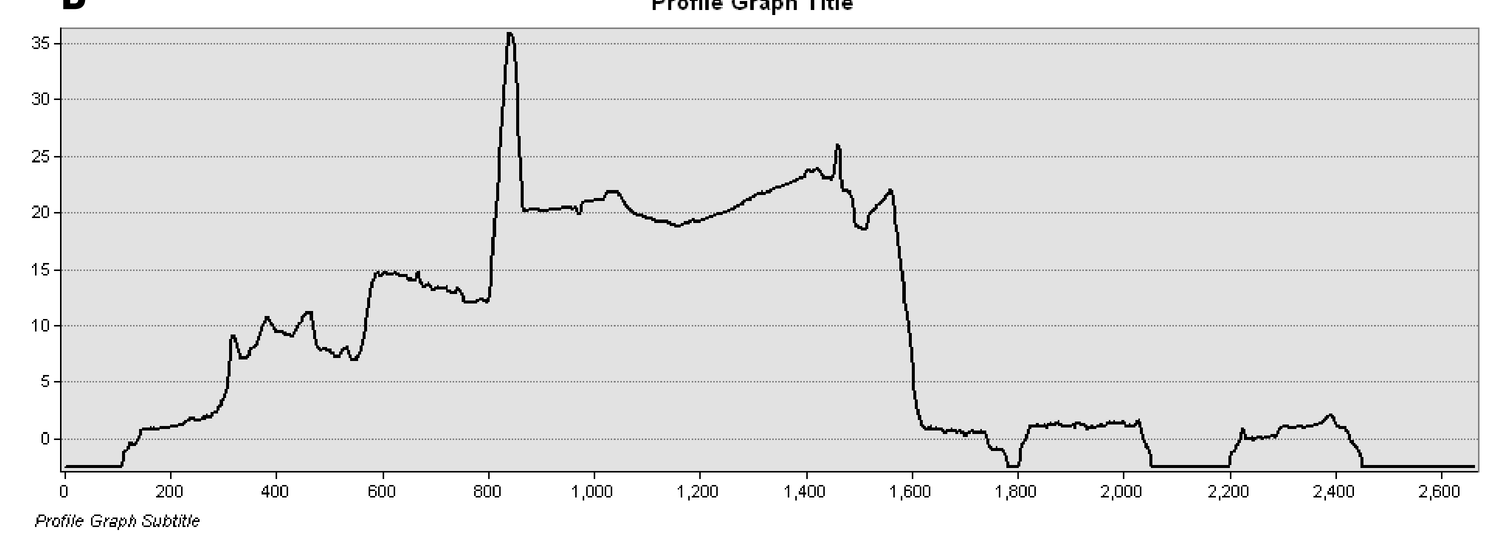
The land associated with the McKay Bay Waste Transfer Center and Waste to Energy facilities were reclaimed from the dredging in the 1950s and 1960s. The restored wetland and tidal creek along Section B allowed some circulation during higher tide, based on the modeling results. Overall, the developed portion of the peninsula is much higher than the surrounding area.



A



B



TASK 4

BIOLOGIC CHARACTERIZATION AND MIGRATION ANALYSIS

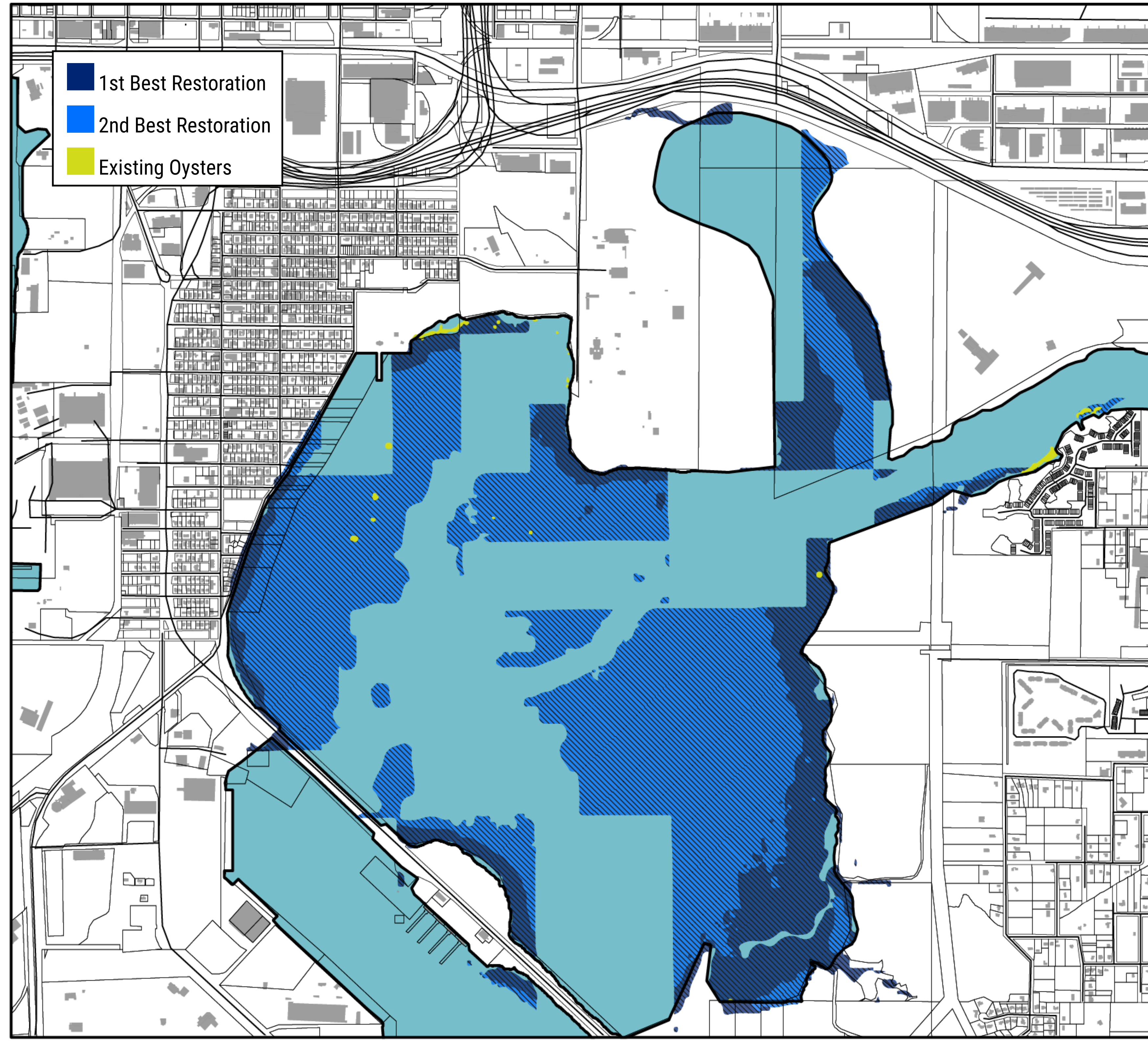
Current and Potential Oyster Locations

Oysters are endemic to the McKay Bay estuary, and represent a significant habitat type for the bay. The Tampa Bay Oyster Habitat Sustainability Index was created by the Tampa Bay Estuary Program to provide a suitability mapping for where oysters may successfully be restored. The model to the right helps by showing focus areas for this work.

Inputs that determine oyster suitability include:

Model Score = bathymetry score + isohaline score + seagrass score + navigation channels score + sediment score

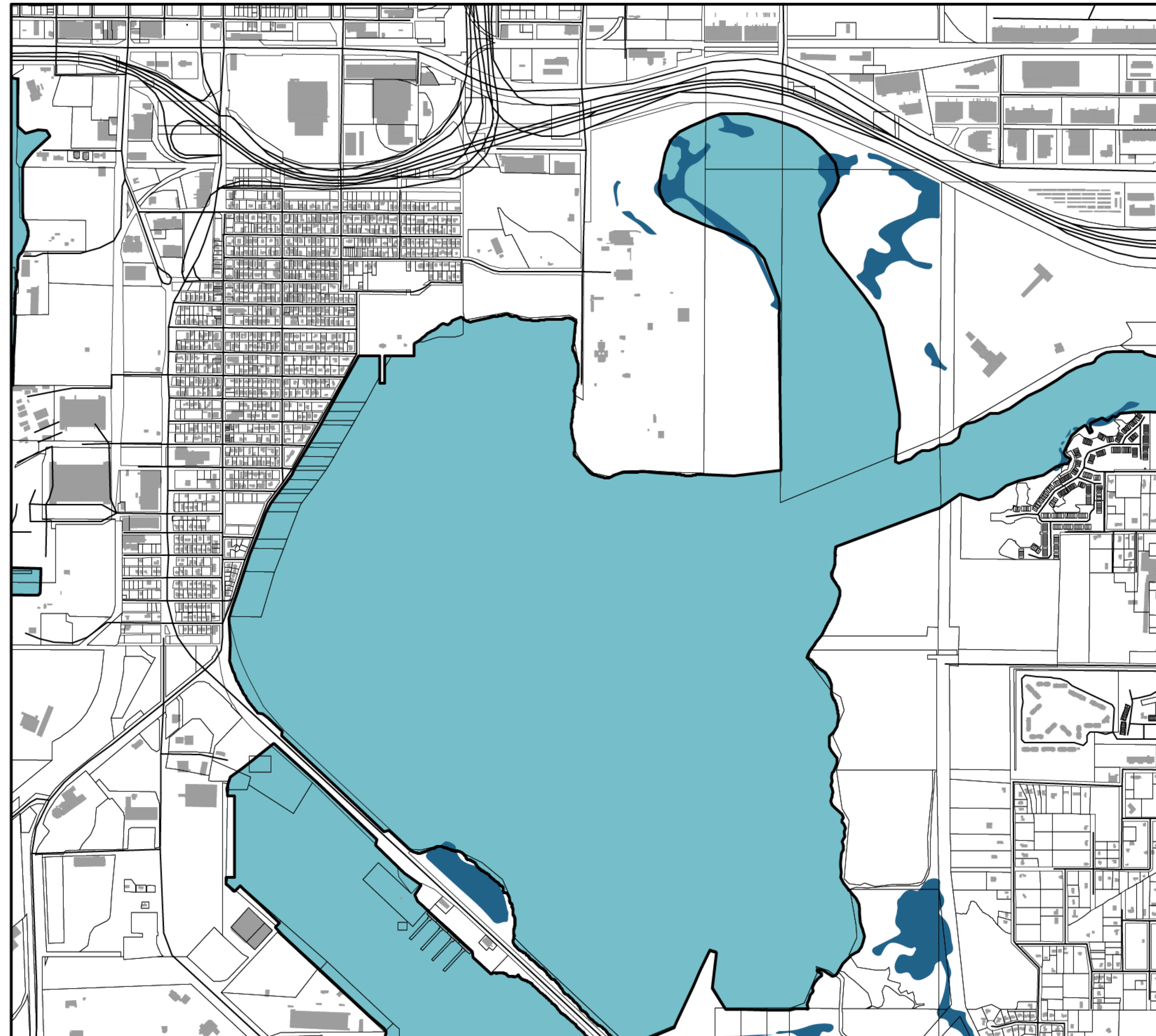
Within McKay Bay there are multiple areas that can be readily populated with oysters, but the map also shows areas that could be improved, for example the dredged channel that bisects the bay.



Source: Tampa Bay Estuary Program, Tampa Bay Oyster Habitat Sustainability Index

Salt Marsh Locations

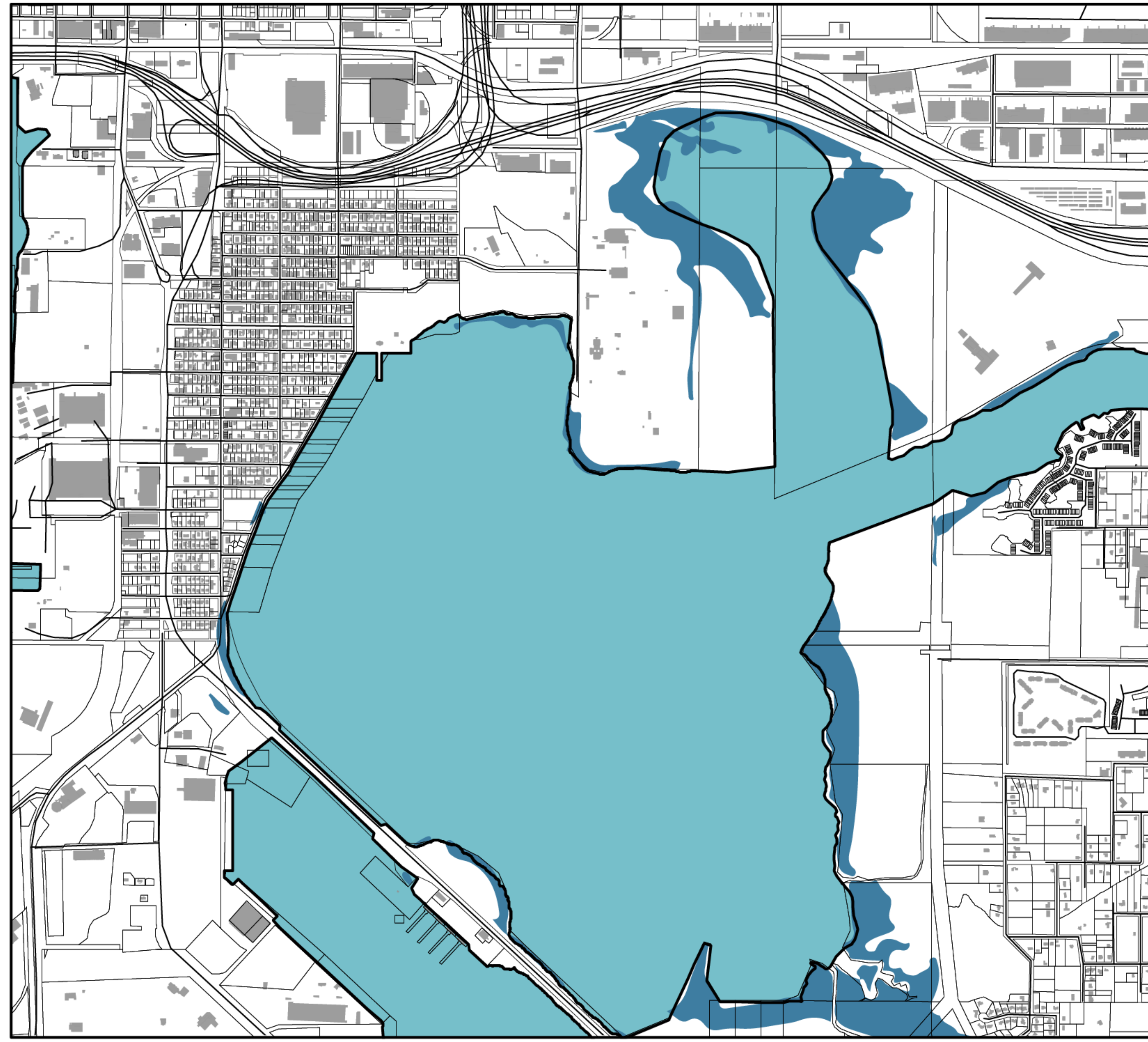
Salt marshes were found in limited areas within McKay Bay.



Source: Florida Fish and Wildlife Conservation Commission GIS & Mapping Data Downloads

Mangrove Locations

Mangroves are typical shoreline colonizers, and contribute to both habitat and erosion control. They are located at almost all shoreline edges of McKay Bay, except where seawalls and other heavy human disturbances occur.

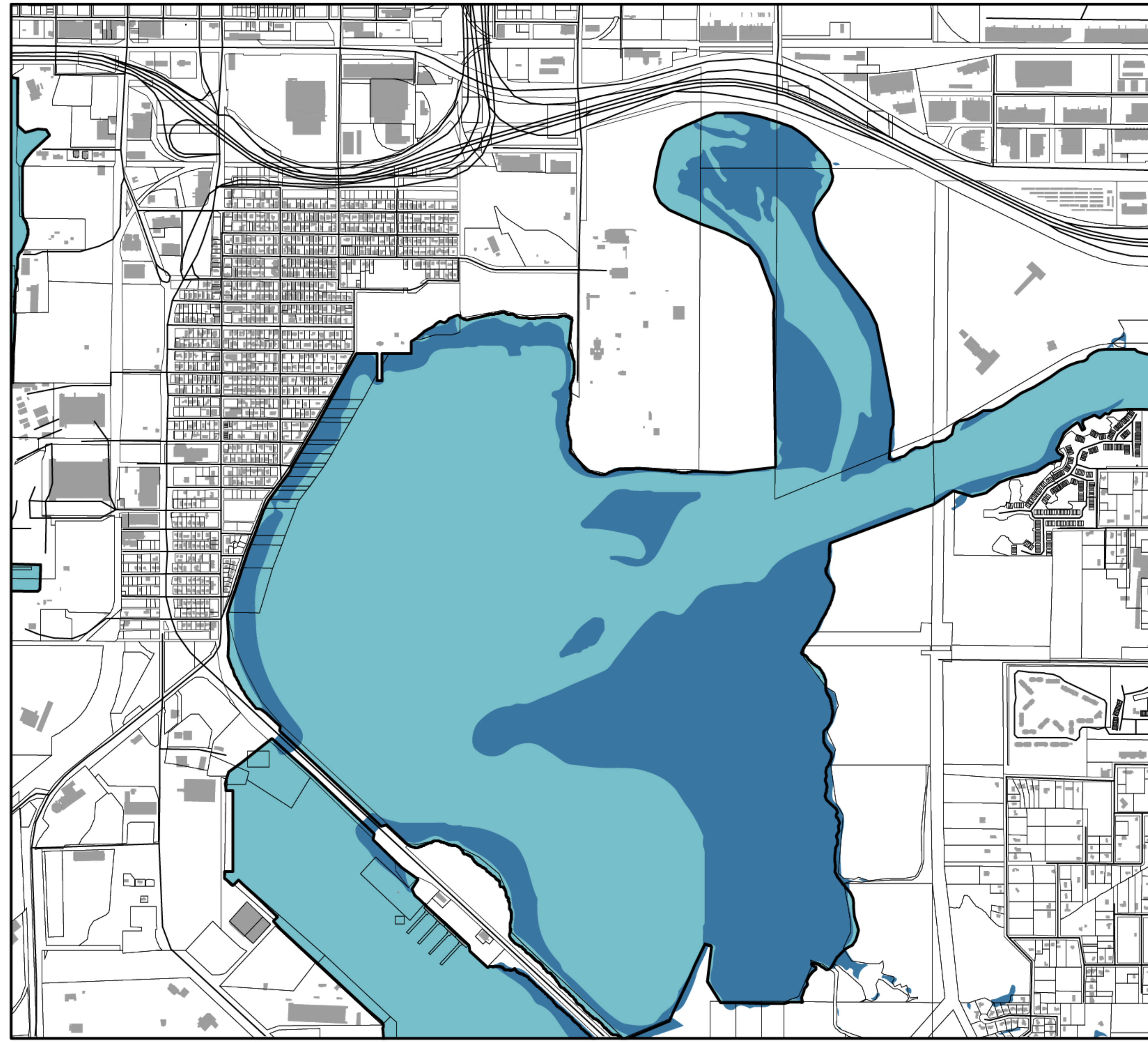


Source: Florida Fish and Wildlife Conservation Commission GIS & Mapping Data Downloads

Tidal Flat Locations

McKay Bay has a low topographic gradient, especially where no dredging has previously occurred. The vertical tidal range has a very large horizontal effect, exposing a large amount of land at spring low tide. Tidal flats are highly productive ecosystems. Although their associated diversity is low, they contain large volumes of microorganisms and benthic infauna, which are food for fin and shellfish, as well as birds. Clean water and sediments are important factors for maintaining a healthy tidal flat environment.

As illustrated by the modeling results and discussed earlier, the tidal flow over the tidal flat along the Palmetto Beach coast, shown in the photo, is quite weak caused by the significant bathymetry modification associated with the dredge and fill. Some of the proposed mitigation alternatives are aimed at restoring the nature conditions to a certain extent and improving the tidal circulation and subsequently water quality in this area.



Source: Florida Fish and Wildlife Conservation Commission GIS & Mapping Data Downloads

TASK 5

COMMUNITY ENGAGEMENT AND PLANNING

Meetings

The project team met with community members and stakeholders throughout the process through the following efforts:

Date	Meeting	No. of Attendees
Community Meetings		
04/12/2022	Project/Engagement Kickoff	~20 people and news coverage
09/17/2022	Community Clean-up with Keep Tampa Bay Beautiful	~30 people
12/09/2022	Public Outreach Day #1 at 22nd Street Coffee	~30 people
05/15/2023	Palmetto Beach Neighborhood Association Meeting	10 people
05/28/2023	Opening Day at Desoto Pool	14 people
06/15/2023	Summer Camp at Desoto Community Center	40 kids, 4 staff
Other Meetings		
10/25/2022	Hillsborough County Environmental Lands Acquisition Program	2 people
02/28/2023	FEMA	9 people
05/16/2023, 08/15/2023	Port Tampa Bay	2 people
08/15/2023	Tampa Bay Estuary Program	1 person
08/15/2023	Tampa Bay Watch	2 people
08/17/2023	US Army Corp of Engineers	4 people
Various	Florida Dept. of Environmental Protection	Phone and Emails

Image: Research team in the McKay Bay study area..

Engagement Metric		Target Amount	Actual Amount
No. of Properties with Enhanced Protection		823	
No. of Government Entities Participating		9	8
No. of People Reached		795 total	640
	Community Representatives	min. 5 - 10	5
	Distribute Surveys	200	200
	Distribute Project Design Brochures	200	200
	Community Workshops	2x50	2
	Community Site Walk	20	n/a
	City Admin. Review of Project Work	2x10	5
	Design Concepts Exhibit at the Park (people reached)	50	30
	Concept Designs Sent Throughout the Neighborhood, Distributed by Ambassadors	200	200

<u>Overview of Engagement Activities and Outcomes</u>

Palmetto Beach is a small and diverse community, which is facing a number of daily stressors as well as longer-term challenges. Due to transient nature of the visible population and the physical isolation of the community (it is surrounded by industrial uses and major roadways), reaching a broad spectrum of the neighborhood population was challenging. Outreach successes were associated with a small group of dedicated residents and non-neighborhood user groups or advocates. The City continues to engage and work with project designers in order to find implementable solutions and funding sources. -

During outreach activities residents were very clear about their desire for a healthier, safer, and more engaged waterfront.

Meetings

Public Outreach Day #1 at 22nd Street Coffee

The team combined outreach efforts for multiple planning initiatives, specifically the outreach around the Coastal Area Action Plan. Both teams provided a community-wide invitation and open house at a local coffee shop. Multiple residents and land holders came through to provide feedback. City employees and council members additionally came to listen to residents.

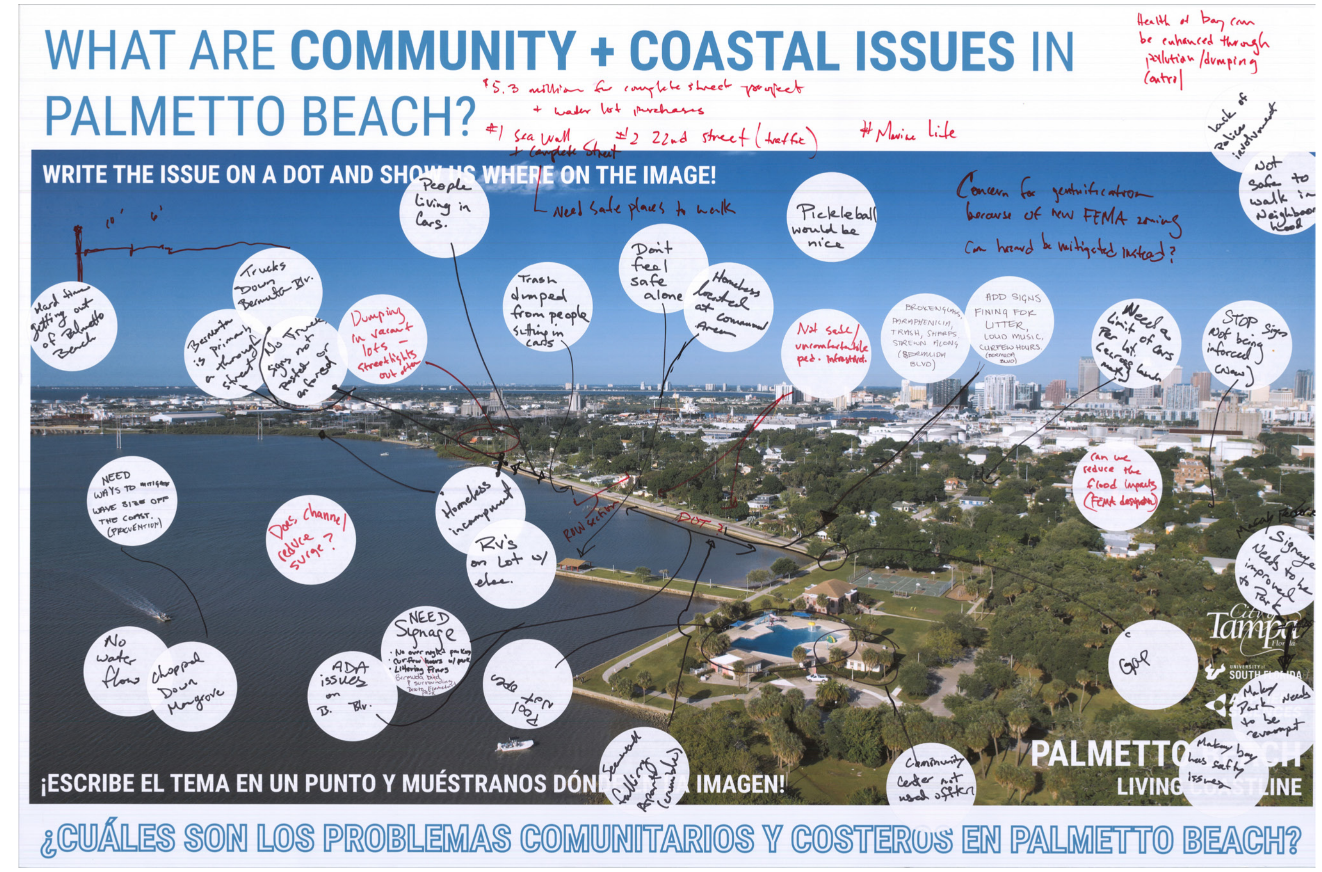
Feedback demonstrated a high level of concern for community safety, specifically to illegal activities that they have been witnessing along the shoreline.

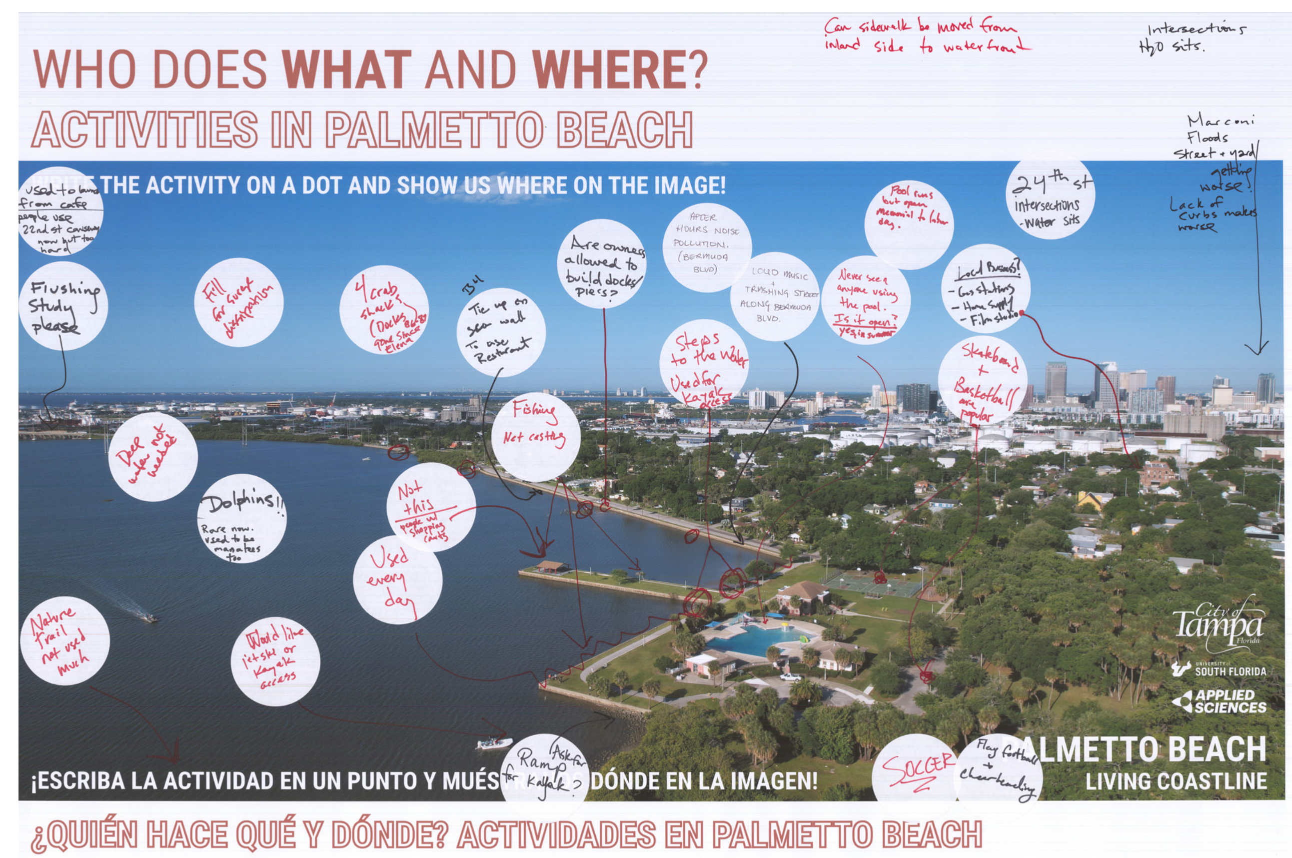
Community members love to see native species, both flora and fauna, in the bay. However, descriptions from long-term residents about the natural conditions underscore the team's research about biodiversity decline. Waste and pollution are a notable problem.

DeSoto Park is seen a special and well-loved community asset. It's condition could be improved, including making the amenities more accessible year-round and adding safety elements like better lighting.

Residents are well aware that the seawall is in poor condition. Without a sidewalk, there is no opportunity to stroll along the water on Bermuda Blvd in the way that other publicly accessible waterfronts provide.

Images: Outreach boards from Public Outreach Day #1





Images: Outreach boards from Public Outreach Day #1

Meetings

Palmetto Beach Neighborhood Association Meeting

The team gave a presentation to the community about research findings. A robust discussion followed about possible futures for the shoreline and the community.

Opening Day at DeSoto Pool

Memorial Day is a well-known and highly anticipated season start to DeSoto Pool opening up. The outreach team partnered with one of the neighborhood community ambassadors to set up an educational and engagement table to meet the neighbors showing up to swim.

The pool did not open that day, due to staffing issues. The team engaged with the few people who were exploring that portion of the park. Concerns were expressed about recent FEMA reclassification from AEII to VE16, having to do with potential wave reach. They believe they can get a reclassification if they can prove less wave reach - or reduce the wave reach.

Summer Camp Youth Engagement

Age appropriate education about estuary ecology and living shorelines. Children attending ranged between 5 and 11 in age. Conservation and biodiversity messaging was a key component, with most information sourced from Tampa Bay Estuary Program and Tampa Bay Watch open access teaching modules.

Neighborhood kids were engaged and excited to learn about their back yards. All of them live within a short walk to the waterfront.

Design Option Follow-Ups

The team designed and distributed pamphlets with next steps and questionnaires for community residents to review. Design options were presented to community members with an on-line/ digital option to provide feedback. Next steps include continued engagement with the waterfront in various programing activities and clean-ups. Residents who are interested have accessible tools, images, and information to promote and educate around the various shoreline improvement options.

Images: Student with his work (above) and wall display with student work (below). Students exploring habitat and species connections, matching species to 3 different ecosystems found locally.

TASK 6

PRELIMINARY PROJECT DESIGNS

Projects Overview

The project identified multiple project opportunities to improve the habitat of McKay Bay, ranging from work with submerged lands to renovation of inland stormwater systems. Each is described in more detail on the subsequent pages, including a scope and opinion of probable cost.

A storm surge analysis for each design option is included in the appendix.

Project 1 - Dredge Channel Fill

Filling the existing deeply dredged channel in McKay Bay would improve overall circulation based on the findings of the numerical modeling. Beneficial use of dredged materials from the planned Port of Tampa expansion project can be a potential source of sediment for channel filling. Various alternatives, as listed above, were examined using the numerical model described above. Six of the twelve modeling scenarios are discussed here. Two of the scenarios, the existing conditions and the pre-engineering nature conditions (serving as a benchmark), are discussed in the modeling results section. In the following, four channel-fill alternatives are discussed. Two optimal alternatives are recommended.

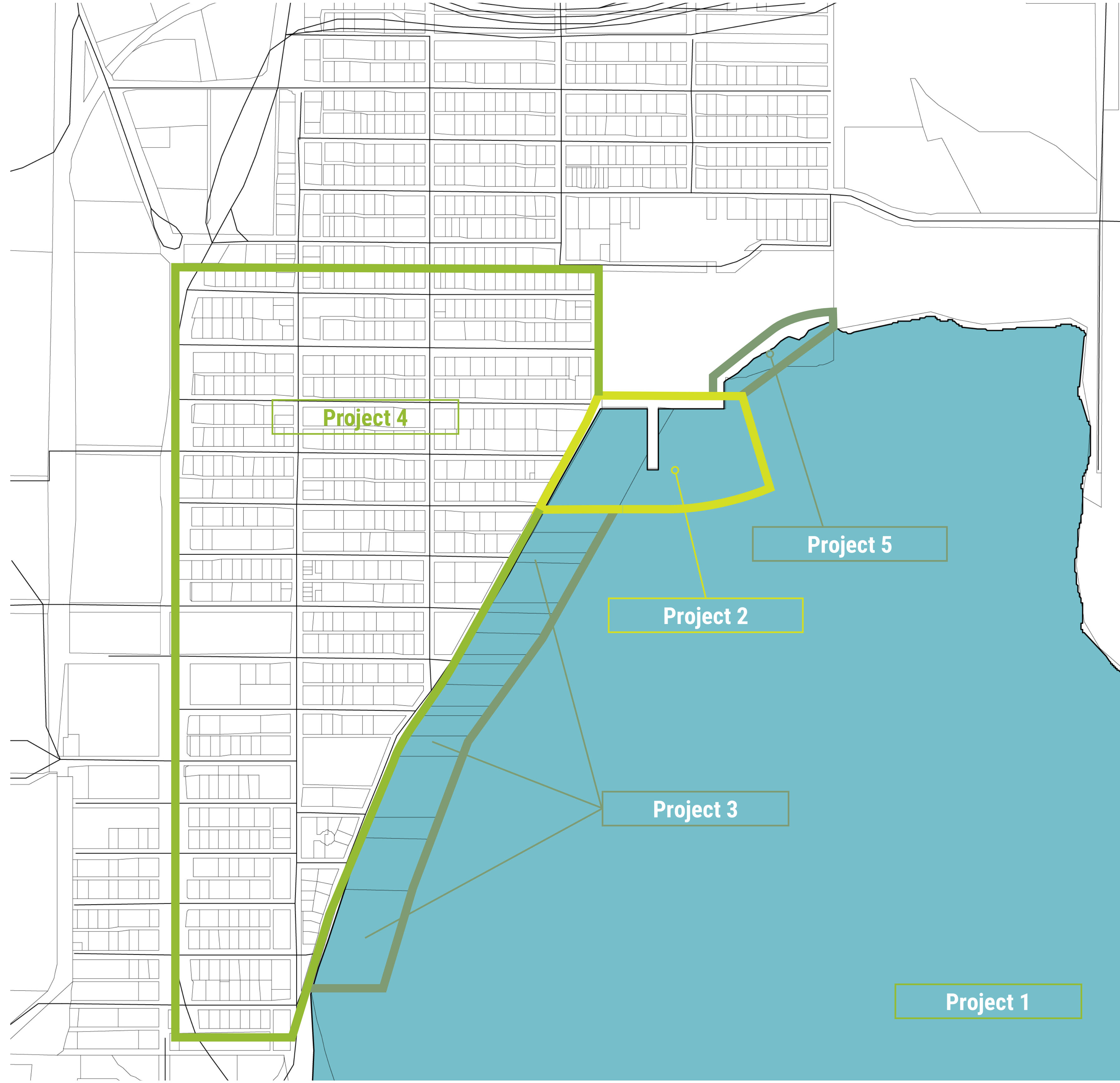
Alternative 2 (A2): Fill the channel from the 22nd Street Causeway to the mouth of the Bypass Canal. This alternative would eliminate all the artificially deepened area, except the Bypass Canal. Discharge from the Bypass Canal was simulated to ensure there is no resultant flooding due to the elimination of the deep channel.

Alternative 1 (A1): Fill the channel from the 22nd Street Causeway to the McKay Bay peninsula. This alternative would require less sediment than A2, Discharge from the Bypass Canal was simulated to ensure there is no resultant flooding due to the partial elimination of the deep channel.

Alternative 5D: In addition to filling the deep dredged channel (A2), a couple of modifications were included in this alternative: 1) a narrower (than the original channel) 3-m channel was maintained to allow the access of Harbor pilot boat to its dock near the mouth of the Bypass Canal, and 2) a shallow 0.5-m deep shoal with a spur was designed to guide the flow toward the Palmetto Beach coast.

Alternative 5G: Similar overall design as compared to A5D, but with a different configuration of the spur for guiding the flow toward the Palmetto Beach coast.

Alternative 6C: Different from Alternative 5, this option does not significantly fill the channel through the middle of the bay. Instead, to divert water flow toward Desoto Park and the Bermuda Boulevard shoreline, an oyster reef system would be constructed to direct flows. This option reduces effectiveness by 50%, but it releases reliance on large quantities of fill, which could only come from the upcoming Port Tampa Bay channel-dredging project.



Project 2 - Desoto Park Coastline

This project redesigns the coastal edge of Desoto Park. There are multiple options for the design to meet varying interests for scope and budget.

Project 3 - Bermuda Boulevard Coastline and Piers

The City of Tampa owns multiple submerged properties in front of Bermuda Boulevard. Construction of piers, especially if incorporating nature-based infrastructure, could dissipate wave energy along the seawall and provide habitat.

Project 4 - Storm Drains and Outfalls

Renovation of the pipes and outfalls in Palmetto Beach would provide an opportunity to concentrate stormwater into underground basins, where it can be cleaned prior to release into McKay Bay. Reducing the number of outfalls would also reduce costs for installation of backflow prevention (tidal valves), which would prevent intrusion with sea level rise.

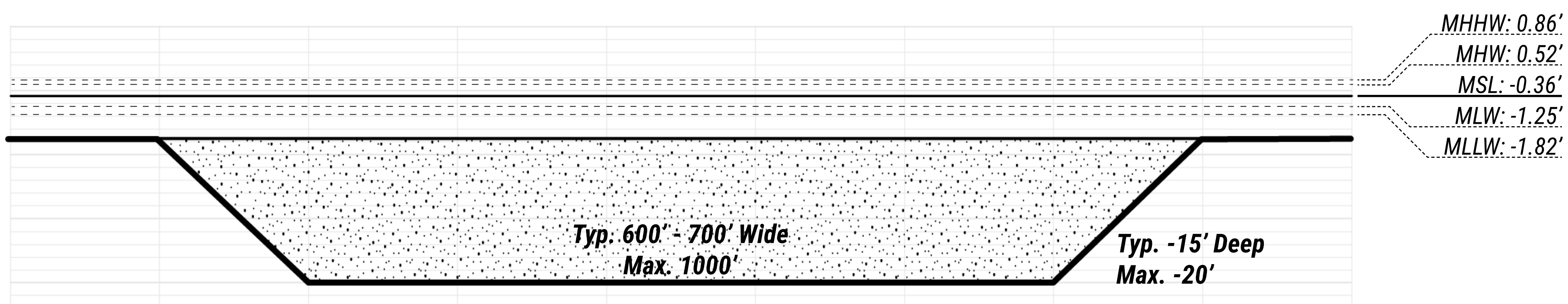
Project 5 - Brazilian Pepper Removal at Desoto Park

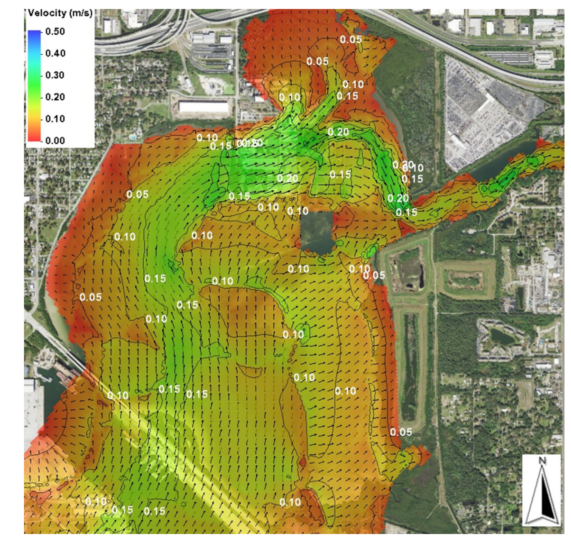
Removal of Brazilian Pepper, as an aquatic invasive plant, is a low-cost restoration option for coastal wetland areas of McKay Bay. So far, the only area identified is the southern shoreline of Desoto Park.

Alternative 2 (A2): Fill the Channel From 22nd Street Causeway to the Mouth of the Bypass Canal

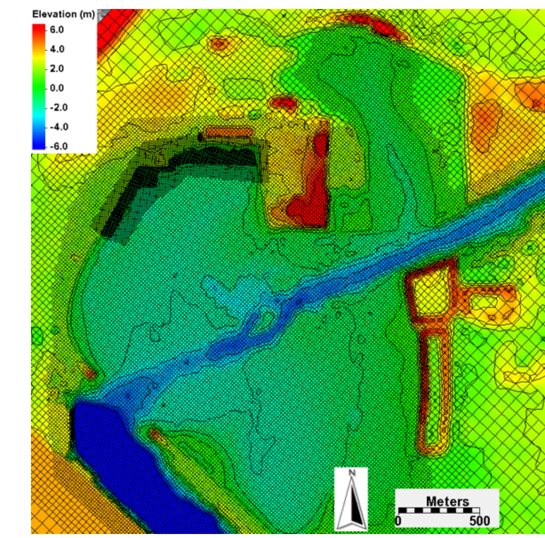
The Tampa Bay Dredged Hole Habitat Assessment Project, completed in 2005, recommended filling the dredged channel of McKay Bay as one of many important projects that should be completed in Tampa Bay. A small partial fill was accomplished in 2014. Monitoring of this partial fill project indicated significant positive benthic impact, with 279% increase in species richness at the dredge hole site, and 34.5% increase in areas around it. Filling also increased the dissolved oxygen concentrations (Karlen, 2015). A2 would fill the entire dredged channel to the mouth of the Bypass Canal with the expectation that the benefits observed after the partial fill would expand over a much larger area. Results from the flow modeling shows that filling the channel will disperse the flow through a large portion of the bay and therefore improve circulation, Instead of concentrating flow within a deep channel. Model results indicated that discharge from the Bypass Canal would not induce additional flooding due to the filling of the deep channel.

This project option extends filling to the greatest amount possible, from the causeway to the mouth of the Bypass Canal. A total of 1,060,000 cubic yards of sediment will be needed for A2. Based on the cost estimate provided by Hershorin et al. (2019), i.e., a dredging cost at $18/cy plus turbidity containment at $128/lin ft of dredged hole perimeter, the total cost is estimated at $21,128,000. Since this is proposed as a potential beneficial use of the material from Port of Tampa expansion, the dredging cost would be part of the channel improvement, with the additional turbidity containment cost of $2,048,000.



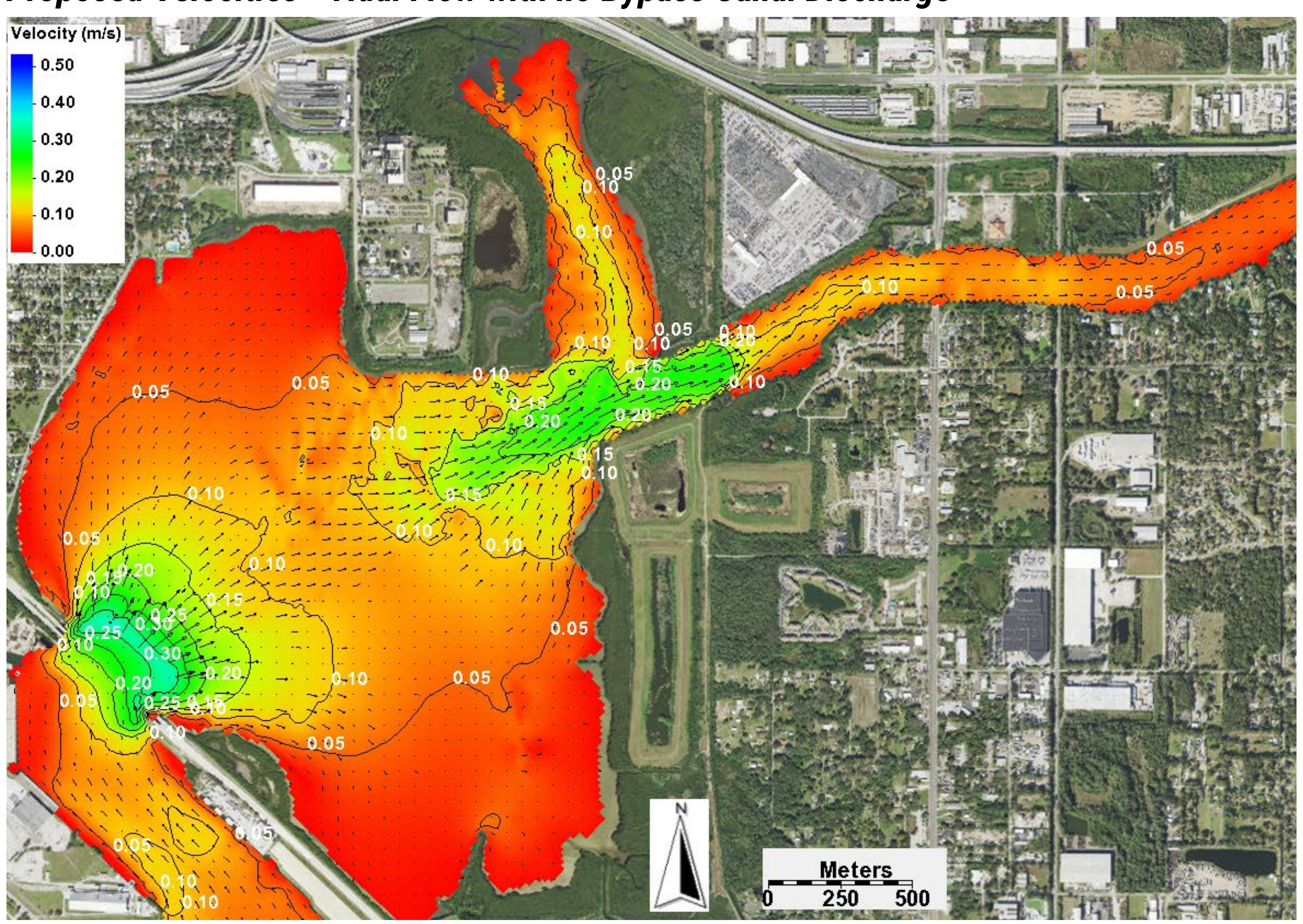


1885 Historic Velocities

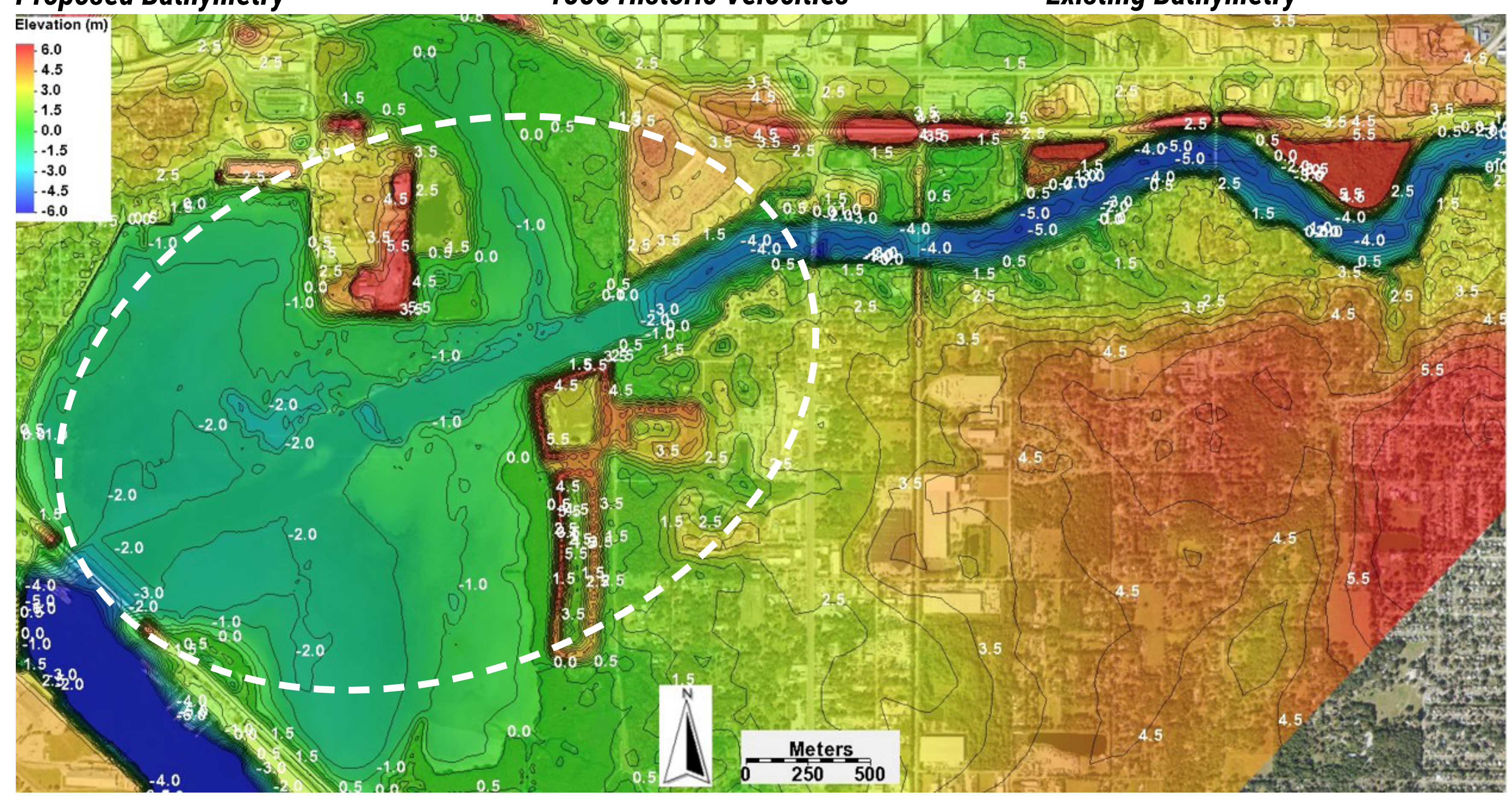


Existing Bathymetry

Proposed Velocities - Tidal Flow with no Bypass Canal Discharge



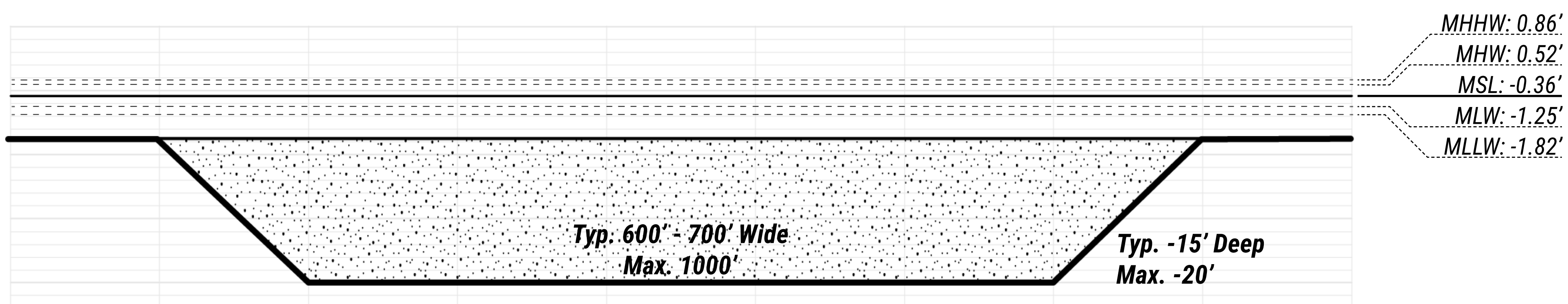
Proposed Bathymetry

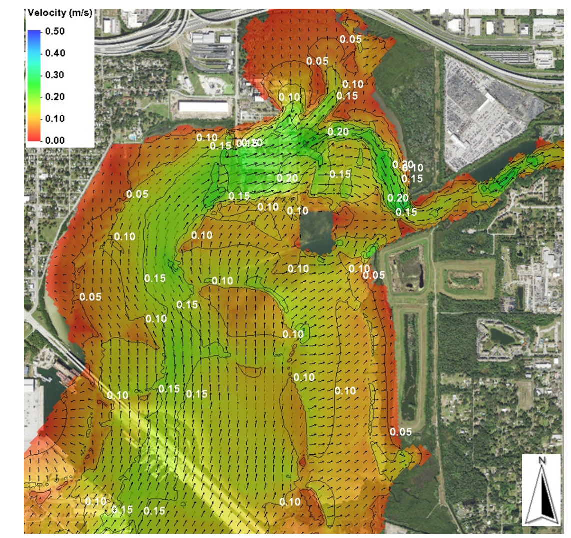


Alternative 1 (A1): Fill the Channel From 22nd Street Causeway to the Mouth of the McKay Bay Peninsula

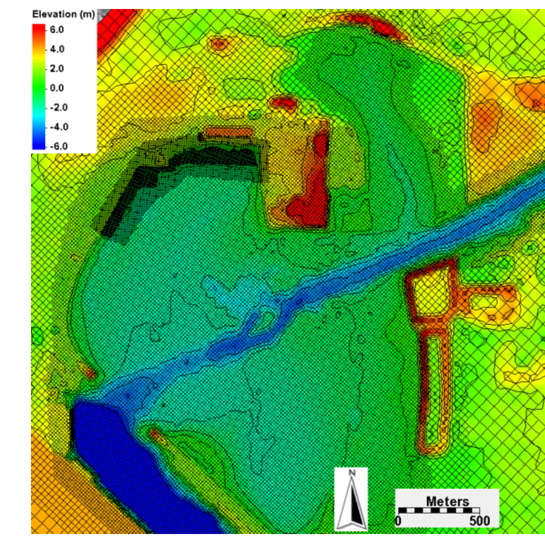
A1 involves filling the dredge channel from the 22nd Street causeway to the McKay Bay peninsula. A1 would fill a portion of the deeply dredged channel and require less material as compared to A2. Results from the flow modeling shows that filling this portion of the channel will also disperse the flow through a large portion of the bay and therefore improve circulation, instead of concentrating flow within a deep channel. Model results indicated that discharge from the Bypass Canal would not induce additional flooding due to the filling of the deep channel.

A total of 390,000 cubic yards of sediment will be needed for A1, much less than A2. Based on the cost estimate provided by Hershorin et al. (2019), i.e., a dredging cost at $18/cy plus turbidity containment at $128/lin ft of dredged hole perimeter, the total cost is estimated at $7,920,000. Since this is proposed as a potential beneficial use of the material from Port of Tampa expansion, the dredging cost would be part of the channel improvement, with the additional turbidity containment cost of $896,000.



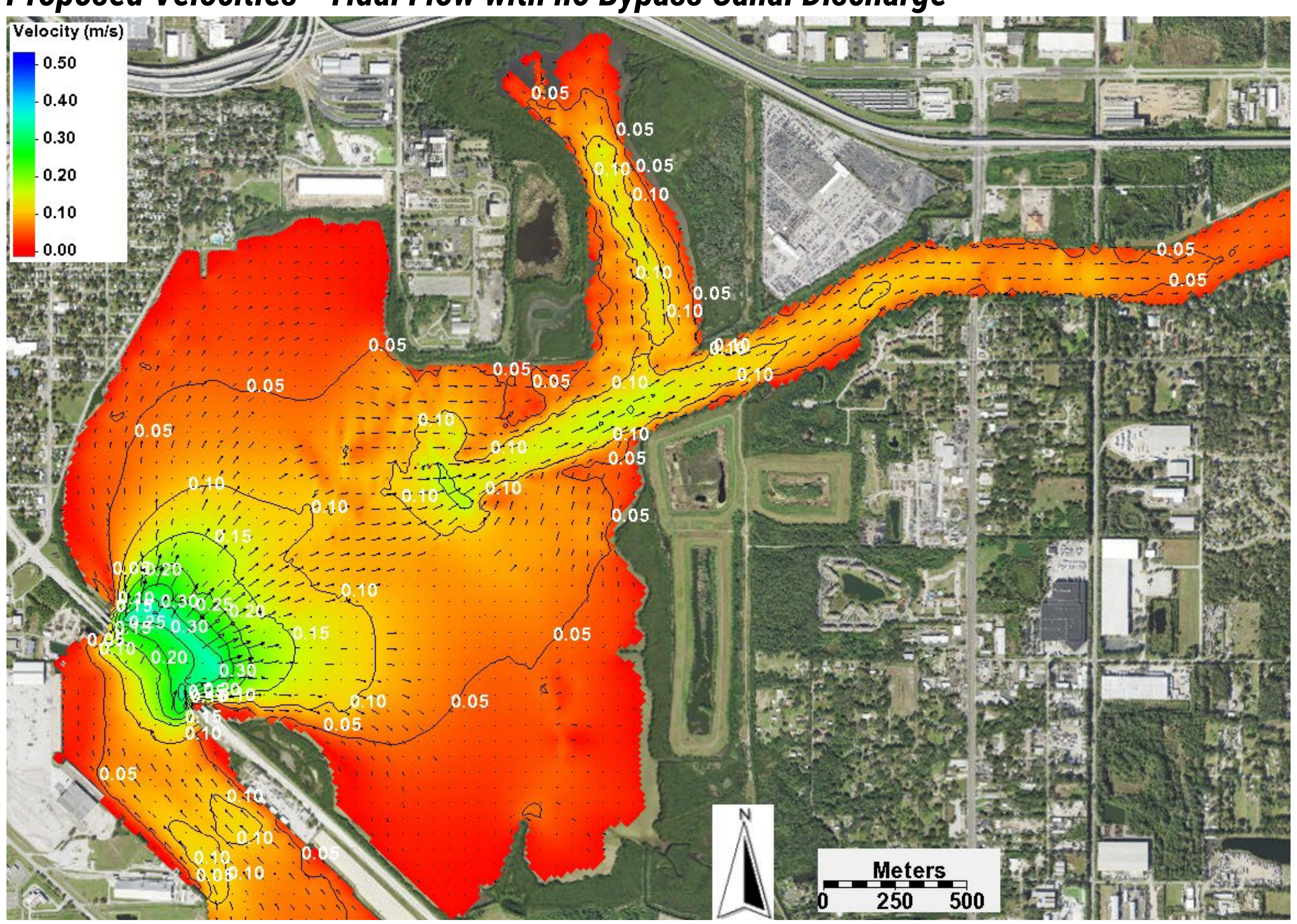


1885 Historic Velocities

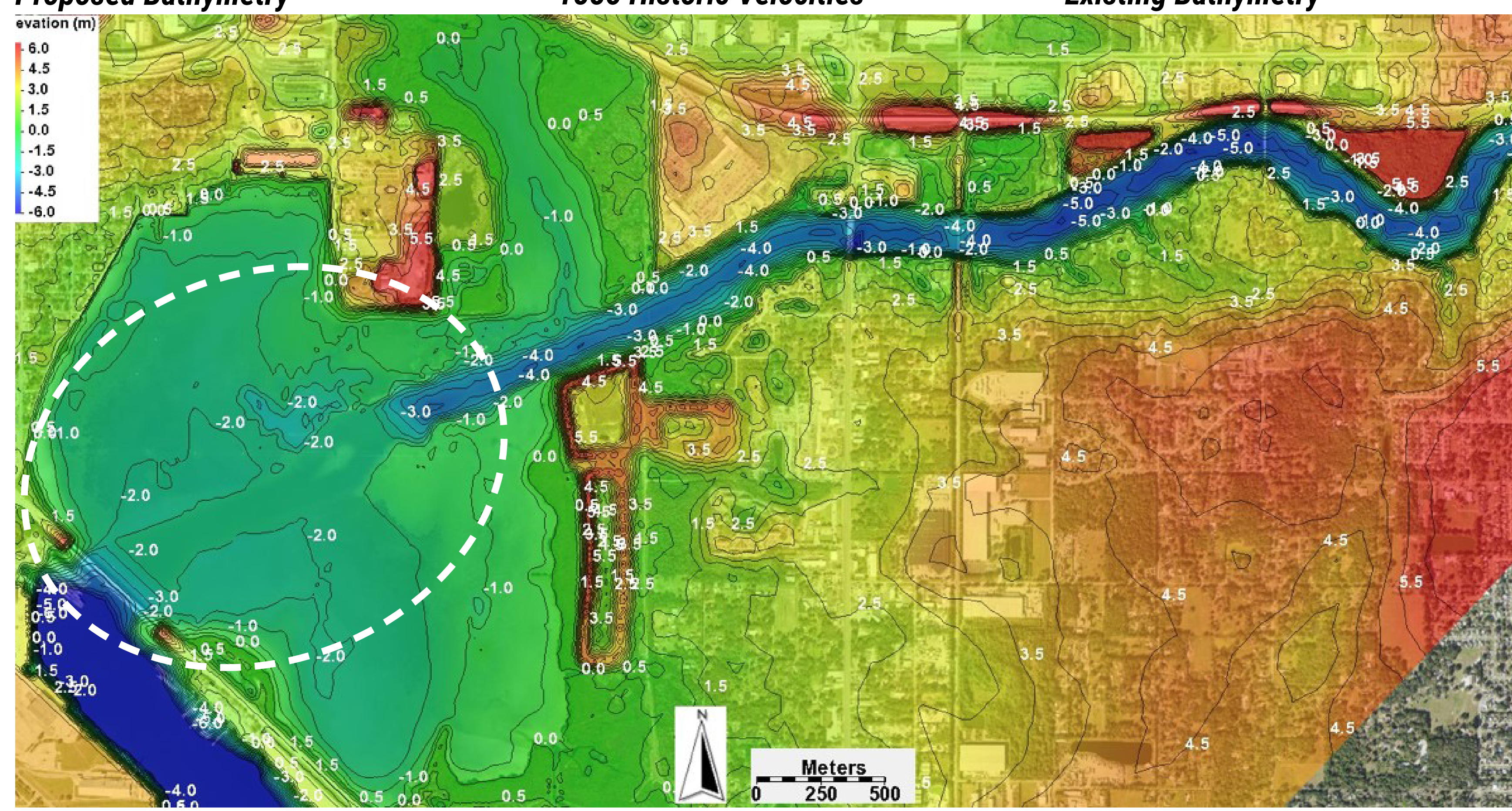


Existing Bathymetry

Proposed Velocities - Tidal Flow with no Bypass Canal Discharge



Proposed Bathymetry

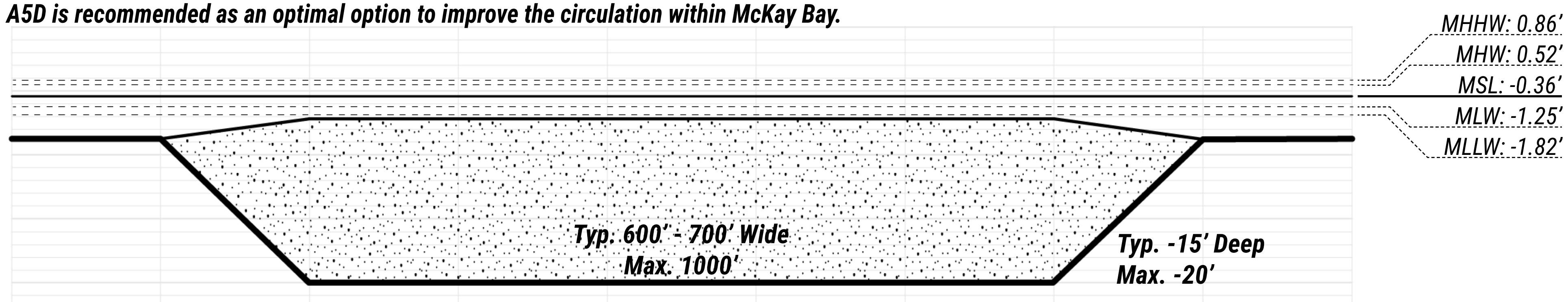


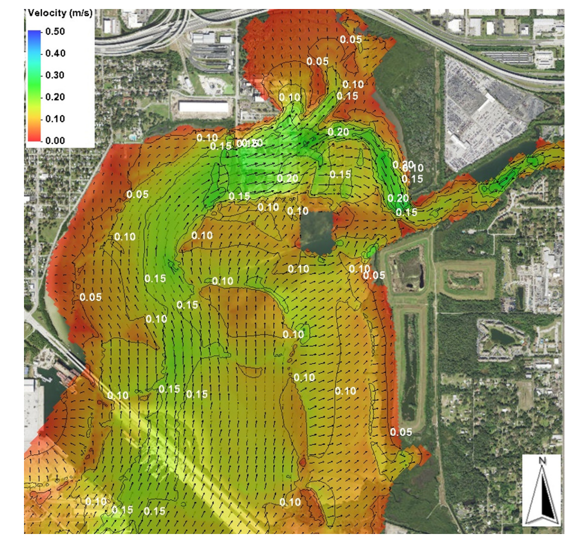
Alternative 5D: Emulate Historic Delta with Strategic Fill (Version 1)

A5D includes a 3-m channel through the entire bay for Harbor pilot vessel. In addition, it includes a strategically designed shoal emulating the historical delta, although at a different location, with a spur. The modeling results show that the shoal and spur would guide the tidal flow along the Palmetto Beach coast. Overall, A5D would restore the flow pattern comparable to the pre-engineering natural pattern.

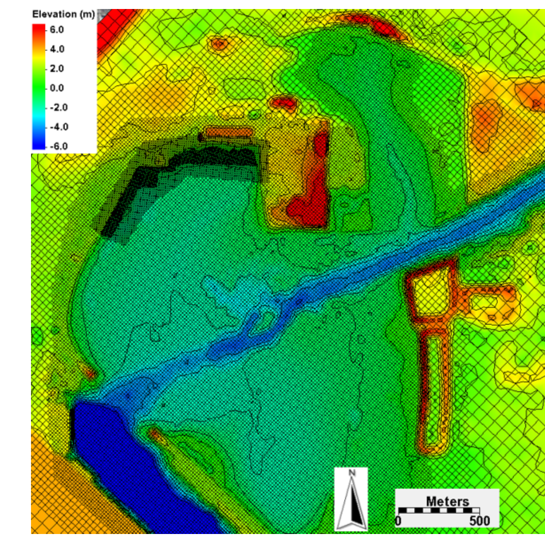
A total of 1,350,000 cubic yards of sediment will be needed for A5D. The shoal and spur would require additional material. Based on the cost estimate provided by Hershorin et al. (2019), i.e., a dredging cost at $18/cy plus turbidity containment at $128/lin ft of dredged hole perimeter, the total cost is estimated at $27,884,000. Since this is proposed as a potential beneficial use of the material from Port of Tampa expansion, the dredging cost would be part of the channel improvement, with the additional turbidity containment cost of $3,584,000.

A5D is recommended as an optimal option to improve the circulation within McKay Bay.



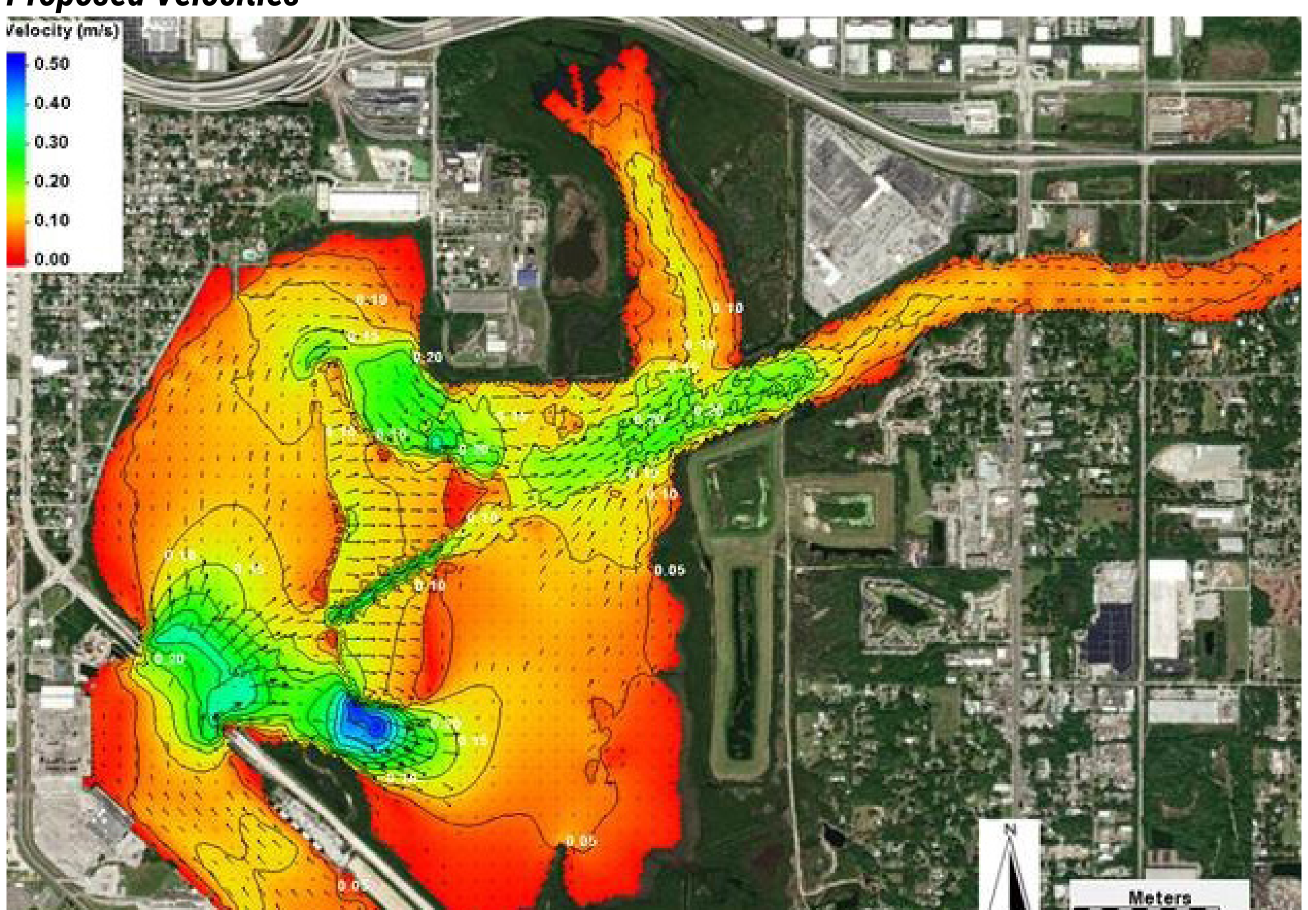


1885 Historic Velocities



Existing Bathymetry

Proposed Velocities

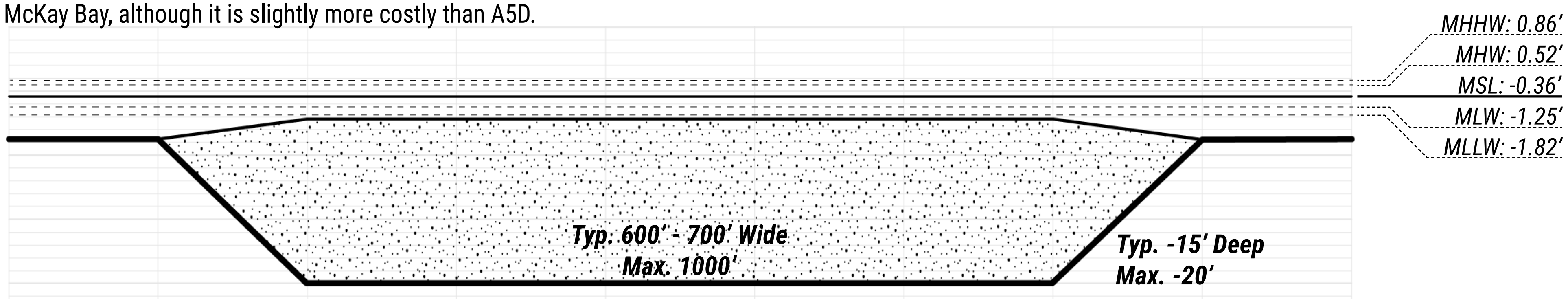


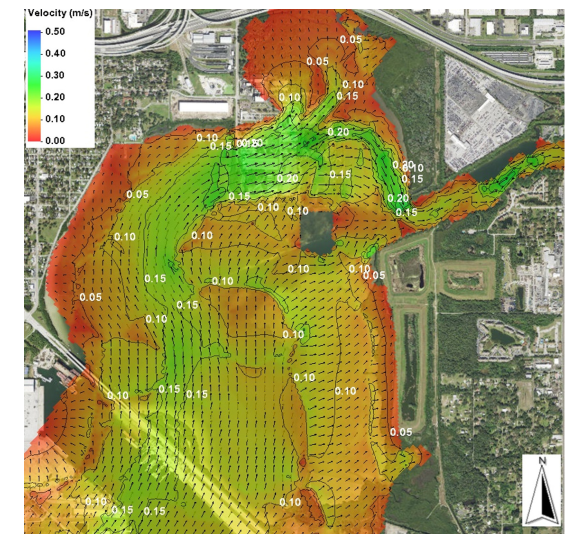
Proposed Bathymetry

Alternative 5G: Emulate Historic Delta with Strategic Fill (Version 2)

Similar to A5D, A5G includes a 3-m channel through the entire bay for Harbor pilot vessel. As compared to A5D, a different spur configuration was designed for A5G with the goal of maximizing the flow guidance to the Palmetto Beach coast. The modeling results show that the shoal and spur successfully guided the tidal flow along the Palmetto Beach coast. The flow magnitude and spatial pattern are rather similar to those of A5D. Overall, A5G would restore the flow pattern comparable to the pre-engineering natural pattern.

A total of 1,362,000 cubic yards of sediment will be needed for A5G, quite similar to the volume needed for A5D. Based on the cost estimate provided by Hershorin et al. (2019), i.e., a dredging cost at $18/cy plus turbidity containment at $128/lin ft of dredged hole perimeter, the total cost is estimated at $28,356,000. Since this is proposed as a potential beneficial use of the material from Port of Tampa expansion, the dredging cost would be part of the channel improvement, with the additional turbidity containment cost of $3,840,000. A5G is recommended as an option to improve the circulation within McKay Bay, although it is slightly more costly than A5D.





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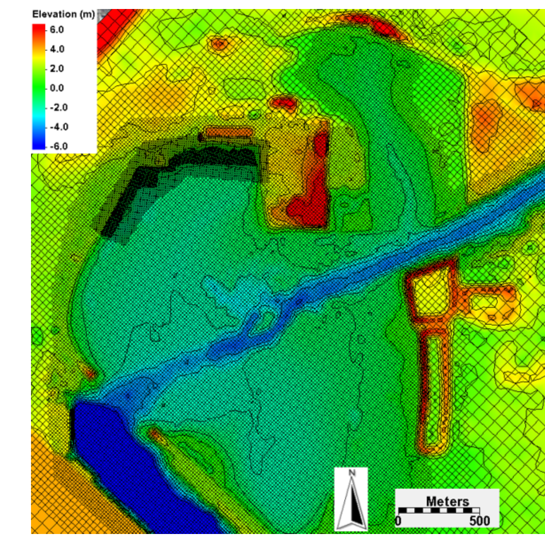
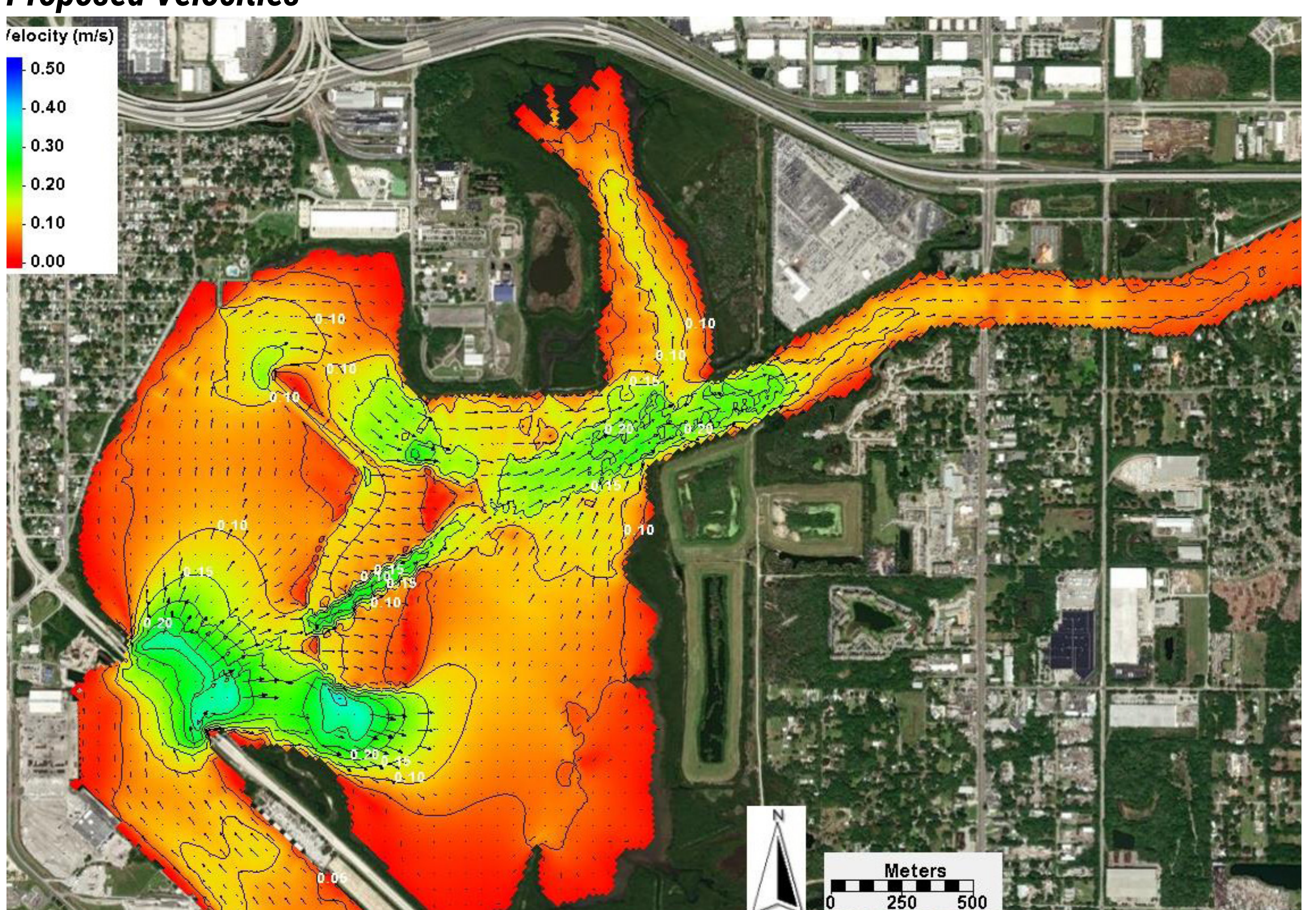
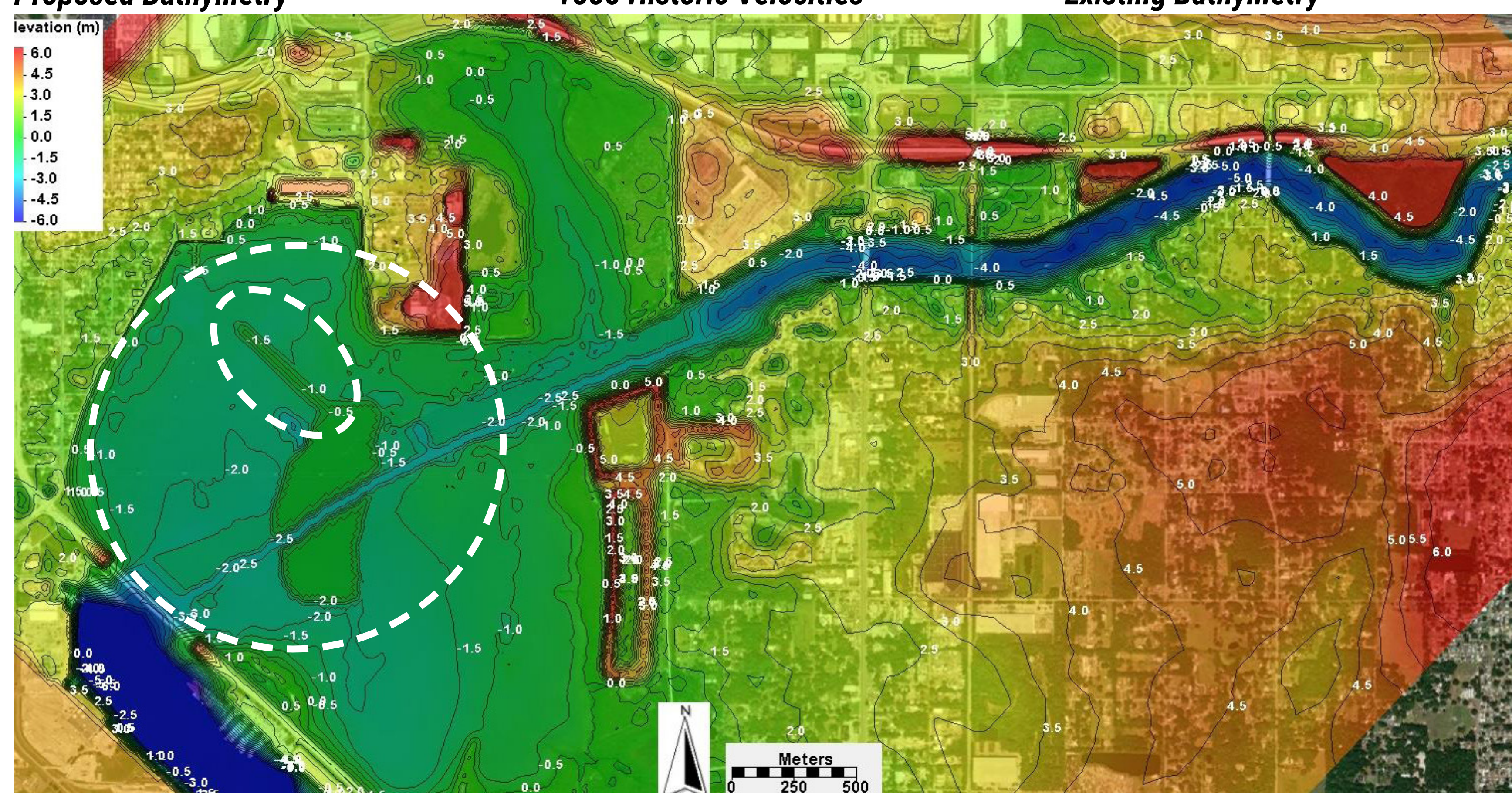


Existing Bathymetry

Proposed Velocities



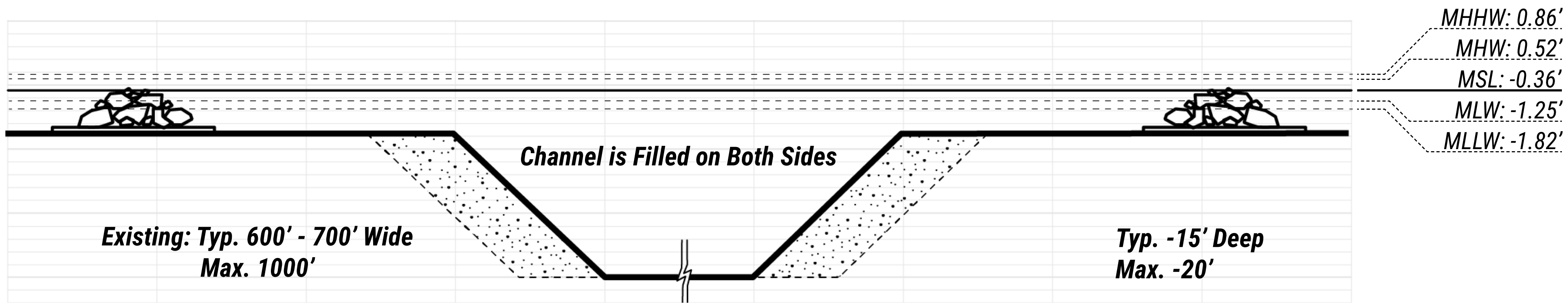
Proposed Bathymetry

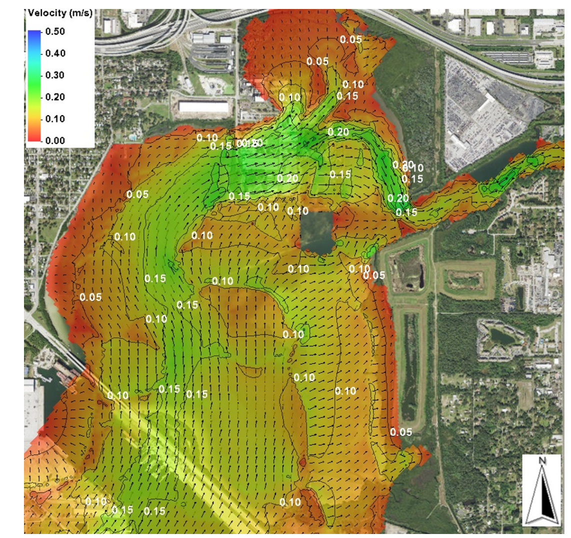


Alternative 6C: Strategically Designed Oyster Reefs for Flow Improvement

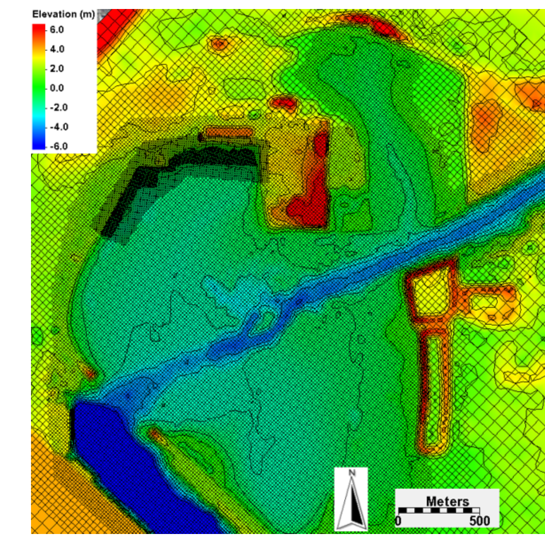
Different from Alternative 5, A6C does not involve significant fill. The deep channel through the Bay would remain at existing condition. A strategically designed oyster reef system with a spur would be constructed. The oyster reef system outlines the shallow shoal for the Alternative 5 cases. The main difference is that no fill is designed for the channel or the shallow shoal. The function of the shallow shoal is achieved, at least partially, by the oyster reef. The modeling results indicate that the oyster reef system would improve the flow along the Palmetto Beach coast. However, the velocity magnitude is about 50% of the scenario with the channel and shoal filled. A6C includes a small fill to narrow the deep channel at the intersections.

A total of 35,000 cubic meters, or 45,000 cubic yards, of materials and oyster reef are needed for the construction of A6C. Based on the cost estimate provided by Hershorin et al. (2019), i.e., a dredging cost at $18/cy plus turbidity containment at $128/lin ft of dredged hole perimeter, the cost is estimated at $2,129,604.00. The cost of the oyster reef is at $1,300/lin ft, putting the reef cost at $13,260,000, making the overall project cost estimate $15,389,604.00.



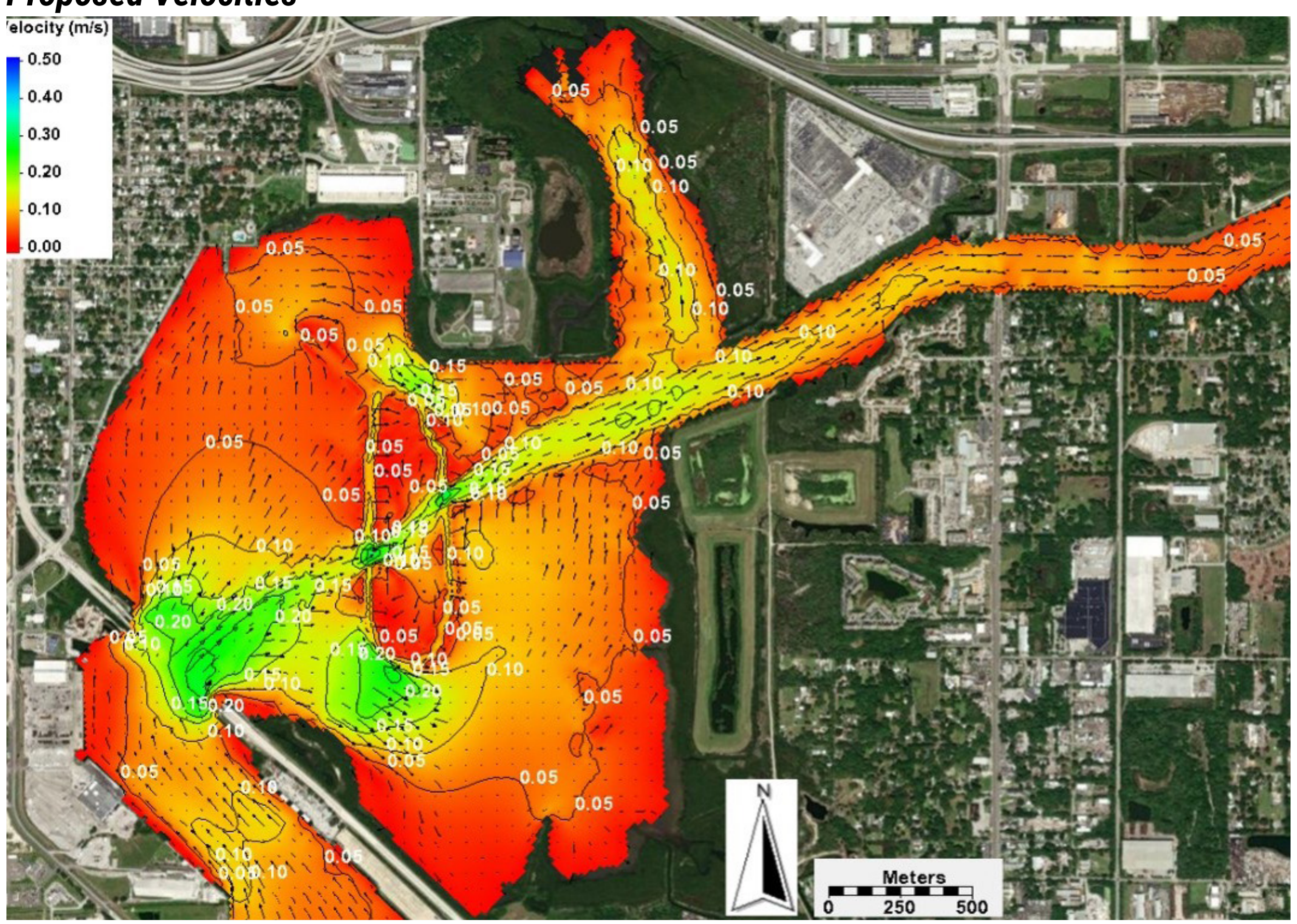


1885 Historic Velocities

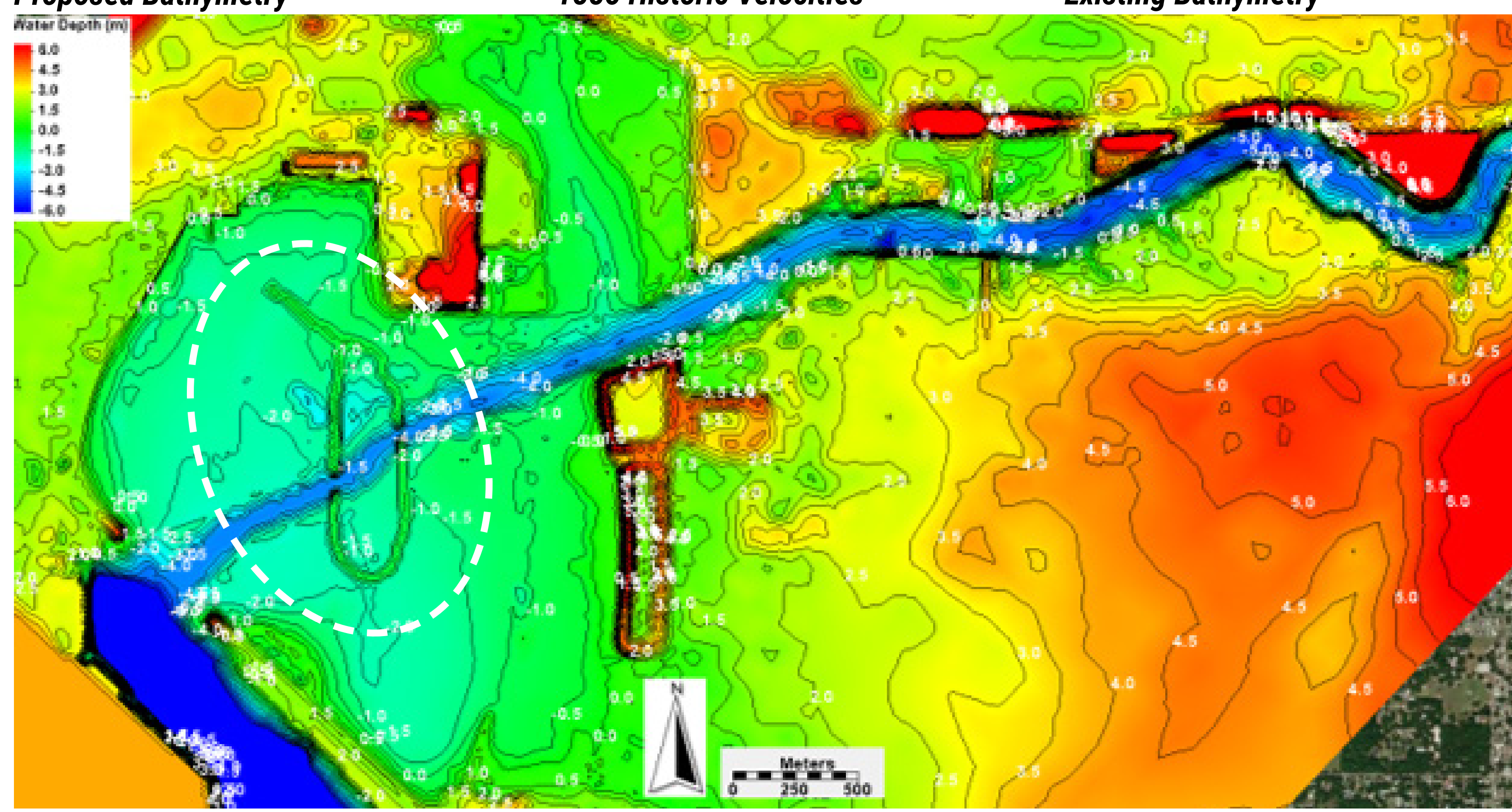


Existing Bathymetry

Proposed Velocities



Proposed Bathymetry



Historic Precedence for Dredge Fill in McKay Bay

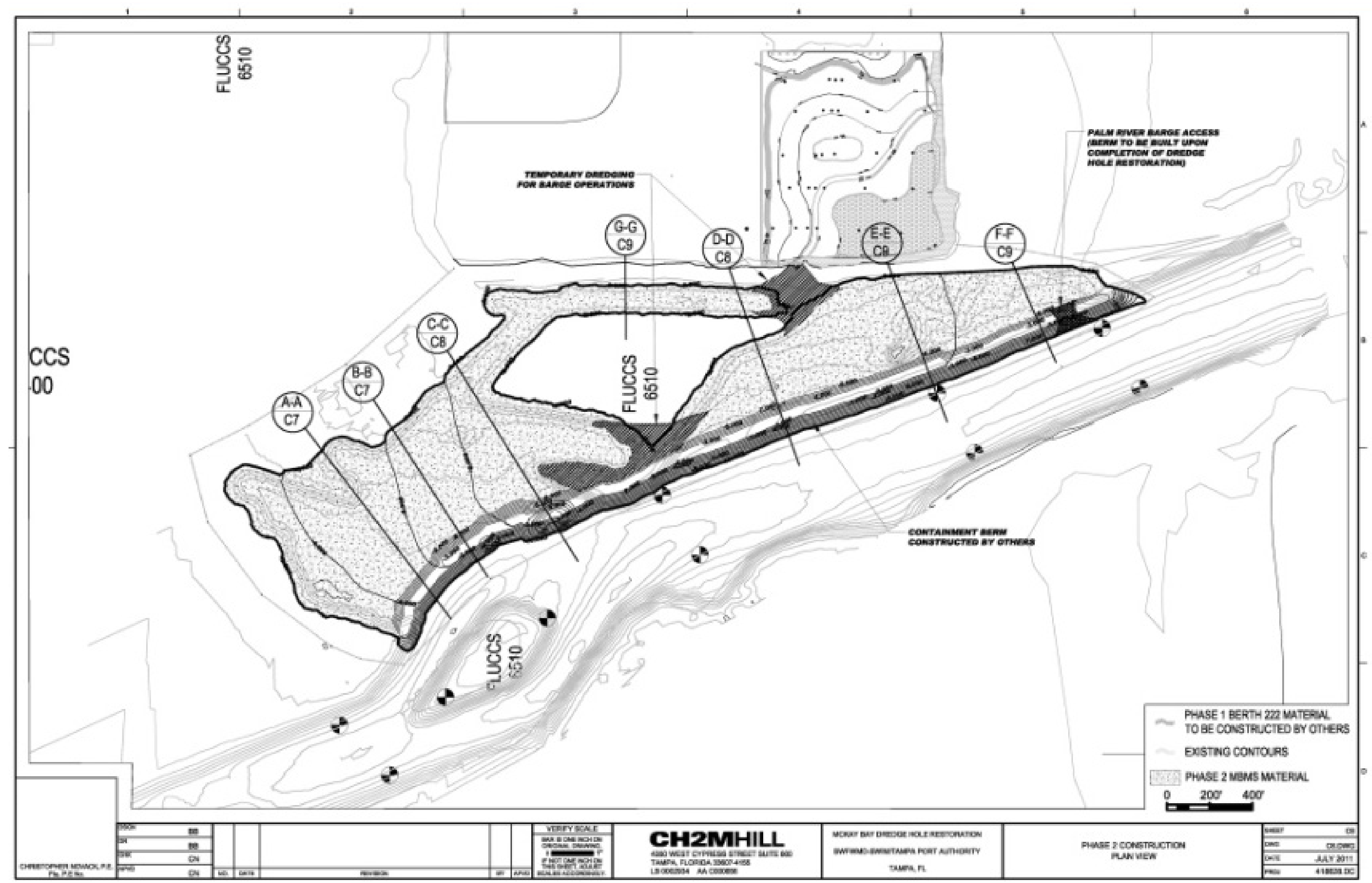
In 2005, the Tampa Bay Estuary Program published the Tampa Bay Dredged Hole Habitat Assessment Project. This report highlighted the McKay Bay channel as a highly recommended project (TBEP, 2005).

In 2010 the Tampa Port Authority and the Southwest Florida Water Management partnered to partially fill the channel, and to create a mitigation wetland. They used approximately 326,000 cubic yards of material within 59 acres of submerged lands. The material was sourced from the construction of Berth 222 at the Port and from a mitigation site just to the north, adjacent to the McKay Bay peninsula.

Pre- and post-restoration monitoring of the 2014 project concluded that filling of the McKay Bay dredge hole was successful in improving the bottom dissolved oxygen concentrations and increasing benthic activity (Karlen, 2015).

2008 - Pre-fill project

2014 - Post-fill project



Project 2 - Desoto Park Coastline

Desoto Park is a large public space at the edge of McKay Bay, in the Palmetto Beach community. The shoreline is mostly hardened with seawall, except for the previous restoration site at the eastern half of the park. There are no marshes, mangroves, or oysters within this part of the bay. Sediment has an elevated percentage of muddy material, likely coming from storm drains, as was shown in the Task 1 sediment analysis.

The park is a significant community amenity. Currently the park caters to residents of Palmetto Beach, which is mostly within a 1/4 mile radius - a distance generally associated with a 5-minute walk. There are multiple new developments and the historic Ybor City community within a 1-mile radius, which is a 20 minute walk or a 5 minute bike ride. The park is one of the largest waterfront public spaces within the City.

Public engagement with the community helped to discover the popularity of the park as a walking path, for fishing, and for general relaxation. There is not currently any water access from the park. A shelter at the end of the main pier has been found to provide a space for vagrancy. Community comments suggested providing alternative access points to create more traffic through the space, or removal of the structure, which is used for shade and protection by people doing illegal activities.

Each design includes a summary and detailed opinion of probably cost.

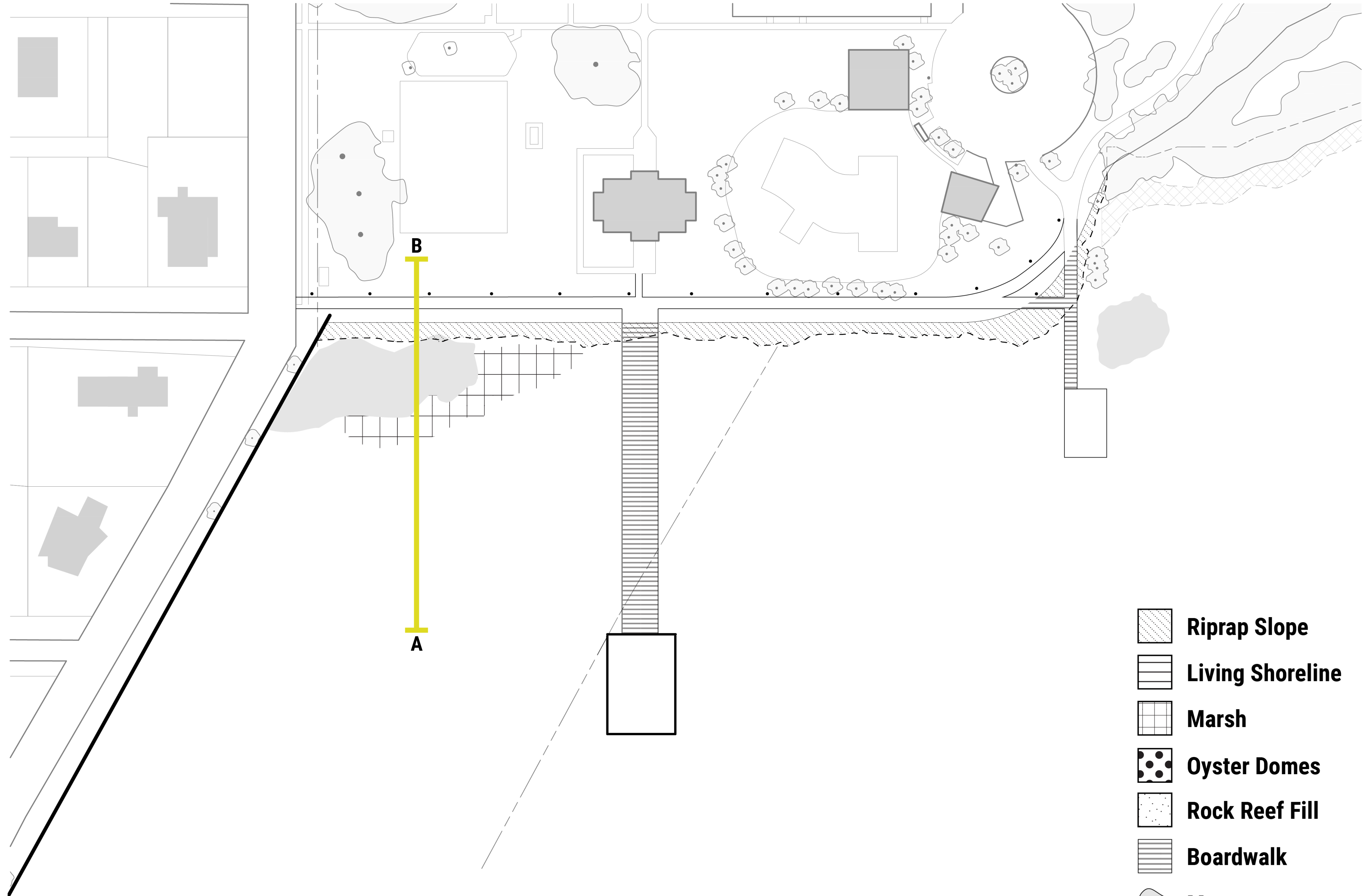
Project 2 - Desoto Park Coastline

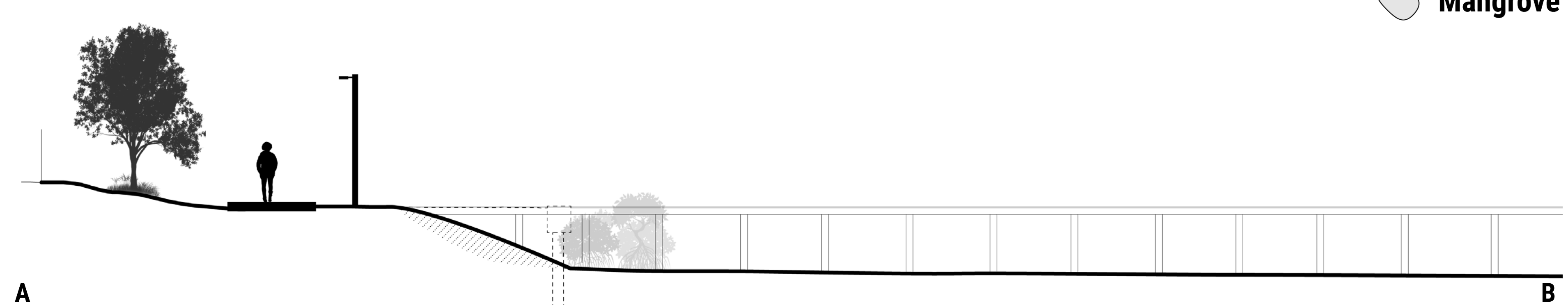
Concept: Rip Rap Coastline
Option 1

In this design, the original seawall was removed along the Desoto Park property (only), and was replaced by a new undulating rip-rap slope. In the northwest corner of the bay an oyster sill was placed in front of marsh and mangrove plantings. This isolated planting would not obscure views to the end of the pier, where there has historically been illegal activity and vagrancy. To improve this condition, the end of pier shade structure has been removed. The seawall around the pier was also removed, as well as the fill material, and was replaced with a boardwalk to increase water circulation.

A new floating kayak launch was added on the east side of the park, which can be accessed from the parking lot.

Estimated Cost: $2,774,195





Project 2 Cost Estimates - Desoto Park Coastline

Concept: Rip Rap Coastline
Option 1

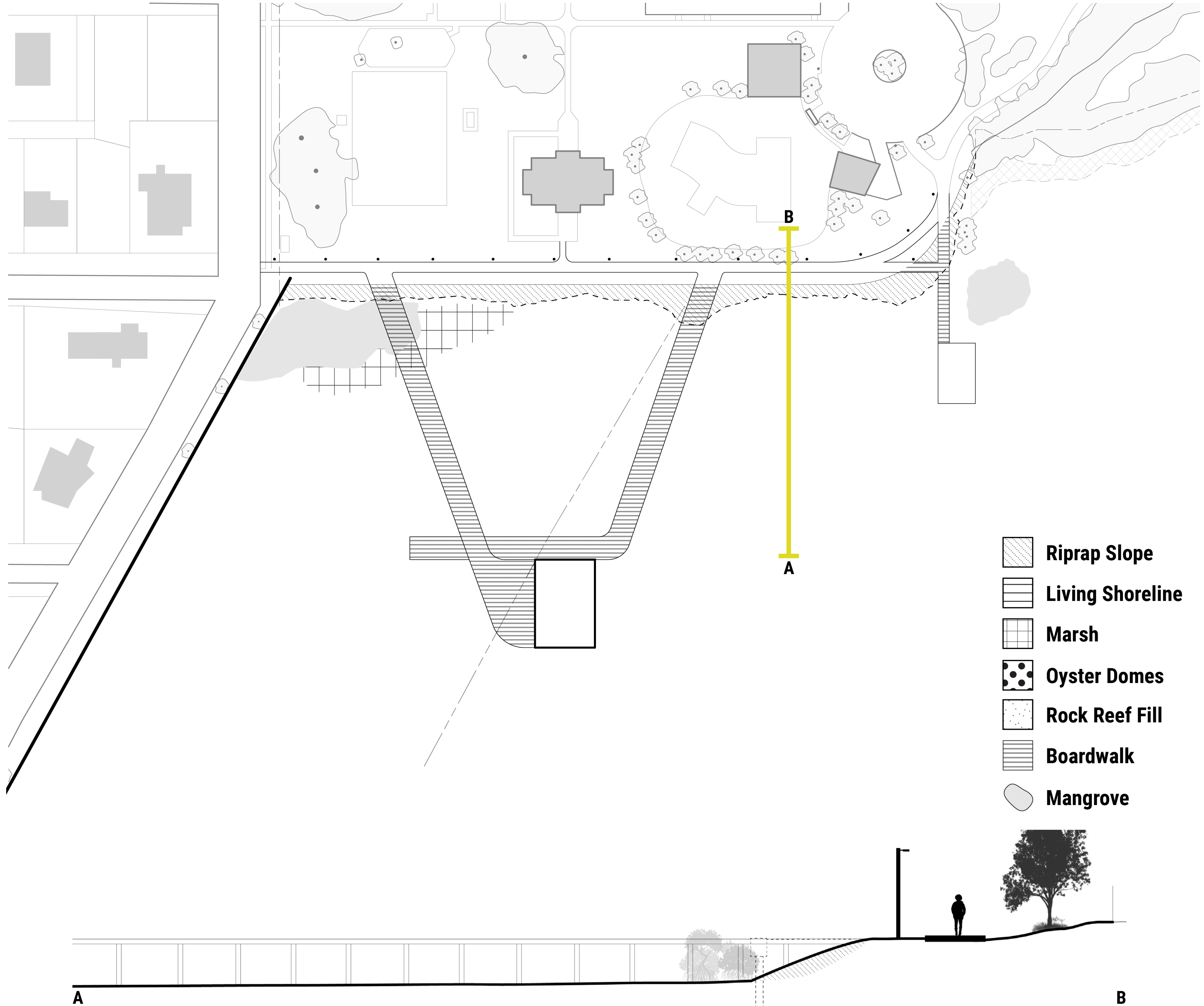
	ITEM/DESCRIPTION	PROJECT TAKEOFFS TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
PRE-CONSTRUCTION					
	TREE REMOVAL	6	EA	$2,000.00	$12,000
	CLEARING AND EXCAVATION	3,623	CY	$18.00	$65,214
	SEAWALL DEMO	1,300	LF	$106.50	$138,450
	SUB-TOTAL				**$215,664**
HARDSCAPE					
	OUTFALLS	1	EA	$10,000.00	$10,000
	NEW SEAWALL - CONCRETE SHEET PILING	1,664	LF	$164.00	$272,896
	NEW BULKHEAD CAP	39	CY	$1,000.00	$38,519
	REINFORCE STEEL - BULKHEAD	4,815	LB	$1.19	$5,730
	PRESTRESSED SOIL ANCHORS	22	EA	$7,017.00	$152,035
	PRESTRESSED SOIL ANCHORS, PERF TEST	2	EA	$1,100.00	$2,200
	RIP RAP	1,384	TN	$175.00	$242,162
	WOOD BOARDWALK	8,037	SF	$50.00	$401,850
	SIDEWALKS	625	LF	$229.17	$143,231
	FLOATING DOCK	1	EA	$100,000.00	$100,000
	SUB-TOTAL				**$1,368,622**
FURNISHINGS					
	WASTE RECEPTACLES	8	EA	$700.00	$5,600
	BENCHES	14	EA	$4,500.00	$63,000
	TABLES AND CHAIRS	4	EA	$4,000.00	$16,000
	SUB-TOTAL				**$84,600**
OFFSHORE INFRASTRUCTURE AND PLANTING					
	TREES	8	EA	$7,000.00	$56,000
	LITTORAL SHELF PLANTING (MARSH)	5,466	SF	$1.20	$6,559
	IRRIGATION	3,946	SF	$1.00	$3,946
	SOD	12,719	SF	$0.35	$4,452
	MANGROVE RESTORATION	976	EA	$30.00	$29,277
	TURBIDITY BARRIER	1,078	LF	$11.92	$12,850
	SUB-TOTAL				**$113,084**
ELECTRICAL & LIGHTING					
	PEDESTRIAN LIGHTING	6	EA	$7,000.00	$42,000
	SUB-TOTAL				**$42,000**
	TOTAL				**$1,823,970**
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			**8.00%**	**$145,918**
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			**15.00%**	**$273,595**
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			**8.00%**	**$145,918**
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			**15.00%**	**$273,595**
SOILS AND REMEDIATION				**5.00%**	**$91,198**
GEOTECHNICAL REPORTS					**$20,000**
OPINION OF PROBABLE COST	**GRAND TOTAL**				**$2,774,195**

Project 2 - Desoto Park Coastline

Concept: Rip Rap Coastline
Option 2

This design is the same as Option 1, except the boardwalk is altered to increase pedestrian circulation opportunities, addressing safety issues for the community. Two boardwalks are proposed, to create a loop connection. They meet at the existing pier island. The existing approach is removed.

Estimated Cost: $3,604,759



Project 2 Cost Estimates - Desoto Park

Concept: Rip Rap Coastline
Option 2

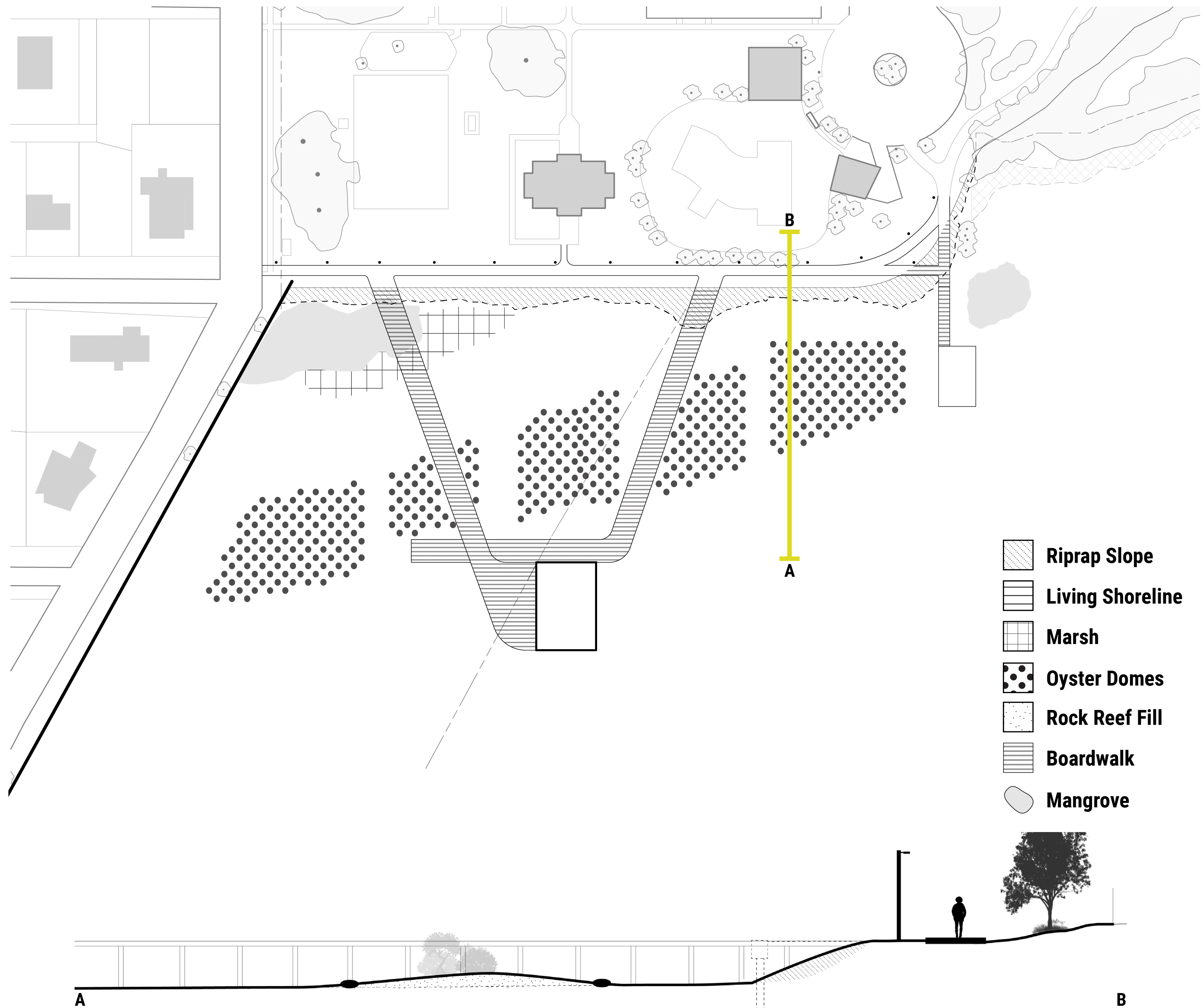
	ITEM/DESCRIPTION	PROJECT TAKEOFFS: TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
PRE-CONSTRUCTION					
	TREE REMOVAL	6	EA	$2,000.00	$12,000
	CLEARING AND EXCAVATION	3,623	CY	$18.00	$65,214
	SEAWALL DEMO	1,300	LF	$106.50	$138,450
	SUB-TOTAL				**$215,664**
HARDSCAPE					
	OUTFALLS	1	EA	$10,000.00	$10,000
	NEW SEAWALL - CONCRETE SHEET PILING	1,664	LF	$164.00	$272,896
	NEW BULKHEAD CAP	39	CY	$1,000.00	$38,519
	REINFORCE STEEL - BULKHEAD	4,815	LB	$1.19	$5,730
	PRESTRESSED SOIL ANCHORS	22	EA	$7,017.00	$152,035
	PRESTRESSED SOIL ANCHORS, PERF TEST	2	EA	$1,100.00	$2,200
	RIP RAP	1,384	TN	$175.00	$242,162
	WOOD BOARDWALK	19,019	SF	$50.00	$950,950
	SIDEWALKS	625	LF	$229.00	$143,125
	FLOATING DOCK	1	EA	$100,000.00	$100,000
	SUB-TOTAL				**$1,917,616**
FURNISHINGS					
	WASTE RECEPTACLES	8	EA	$700.00	$5,600
	BENCHES	14	EA	$4,500.00	$63,000
	TABLES AND CHAIRS	4	EA	$4,000.00	$16,000
	SUB-TOTAL				**$84,600**
OFFSHORE INFRASTRUCTURE AND PLANTING					
	TREES	8	EA	$7,000.00	$56,000
	LITTORAL SHELF PLANTING (MARSH)	5,466	SF	$1.20	$6,559
	IRRIGATION	3,946	SF	$1.00	$3,946
	SOD	12,719	SF	$0.35	$4,452
	MANGROVE RESTORATION	976	EA	$30.00	$29,277
	TURBIDITY BARRIER	1,166	LF	$11.92	$13,899
	SUB-TOTAL				**$114,133**
ELECTRICAL & LIGHTING					
	PEDESTRIAN LIGHTING	6	EA	$7,000.00	$42,000
	SUB-TOTAL				**$42,000**
	TOTAL				**$2,374,013**
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			**8.00%**	**$189,921**
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			**15.00%**	**$356,102**
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			**8.00%**	**$189,921**
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			**15.00%**	**$356,102**
SOILS AND REMEDIATION				**5.00%**	**$118,701**
GEOTECHNICAL REPORTS					**$20,000**
OPINION OF PROBABLE COST	**GRAND TOTAL**				**$3,604,759**

Project 2 - Desoto Park Coastline

Concept: Rip Rap Coastline
Option 3

This design builds upon Options 1 and 2 and adds concrete oyster dome or living reef structures to promote oyster growth and soil stabilization.

Estimated Cost: $5,775,051



Project 2 Cost Estimates - Desoto Park

Concept: Rip Rap Coastline

Option 3

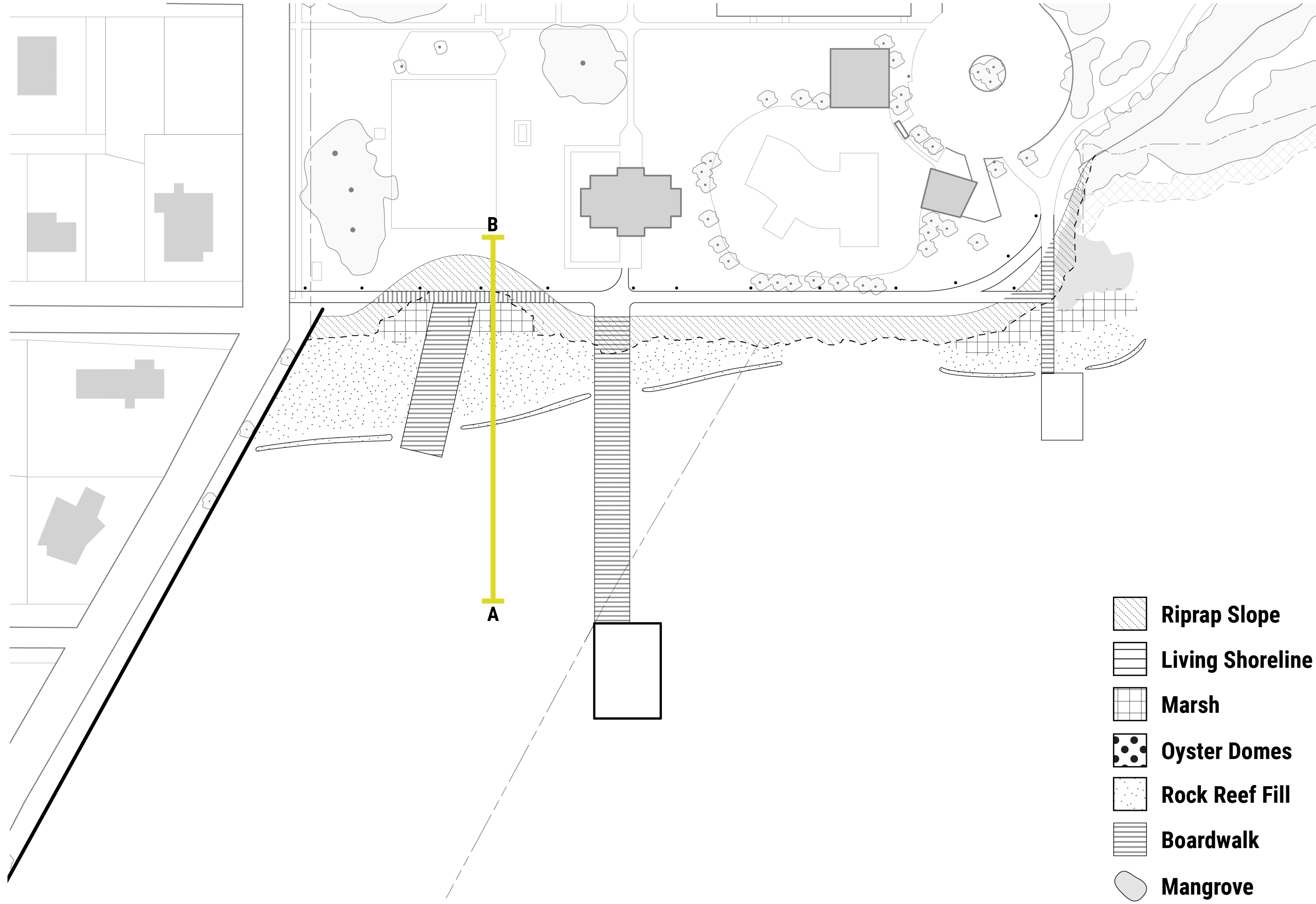
	ITEM/DESCRIPTION	PROJECT TAKEOFFS TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
PRE-CONSTRUCTION					
	TREE REMOVAL	6	EA	$2,000.00	$12,000
	CLEARING AND EXCAVATION	7,871	CY	$18.00	$141,678
	SEAWALL DEMO	700	LF	$106.50	$74,550
	SUB-TOTAL				$228,228
HARDSCAPE					
	OUTFALLS	1	EA	$10,000.00	$10,000
	NEW SEAWALL - CONCRETE SHEET PILING	1,664	LF	$164.00	$272,896
	NEW BULKHEAD CAP	39	CY	$1,000.00	$38,519
	REINFORCE STEEL - BULKHEAD	4,815	LB	$1.19	$5,730
	PRESTRESSED SOIL ANCHORS	22	EA	$7,017.00	$152,035
	PRESTRESSED SOIL ANCHORS, PERF TEST	2	EA	$1,100.00	$2,200
	SIDEWALKS	625	LF	$229.00	$143,125
	RIP RAP	1,384	TN	$175.00	$242,162
	WOOD BOARDWALK	19,019	SF	$50.00	$950,950
	FLOATING DOCK	1	EA	$100,000.00	$100,000
	SUB-TOTAL				$1,917,616
FURNISHINGS					
	WASTE RECEPTACLES	7	EA	$700.00	$4,900
	BENCHES	13	EA	$4,500.00	$58,500
	TABLES AND CHAIRS	4	EA	$4,000.00	$16,000
	SUB-TOTAL				$79,400
OFFSHORE INFRASTRUCTURE AND PLANTING					
	TREES	9	EA	$7,000.00	$63,000
	LITTORAL SHELF PLANTING (MARSH)	5,466	SF	$1.20	$6,559
	IRRIGATION	4,229	SF	$1.00	$4,229
	SOD	11,638	SF	$0.35	$4,073
	OYSTER DOMES	4,061	EA	$333.33	$1,353,667
	MANGROVE RESTORATION	976	EA	$30.00	$29,277
	TURBIDITY BARRIER	1,111	LF	$11.92	$13,243
	SUB-TOTAL				$1,474,048
ELECTRICAL & LIGHTING					
	PEDESTRIAN LIGHTING	16	EA	$7,000.00	$112,000
	SUB-TOTAL				$112,000
	TOTAL				$3,811,292
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			8.00%	$304,903
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			15.00%	$571,694
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			8.00%	$304,903
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			15.00%	$571,694
SOILS AND REMEDIATION				5.00%	$190,565
GEOTECHNICAL REPORTS					$20,000
OPINION OF PROBABLE COST	GRAND TOTAL				$5,775,051

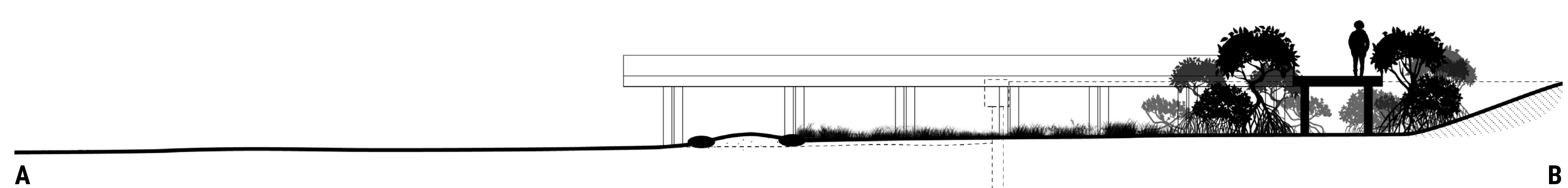
Project 2 - Desoto Park Coastline

Concept: Rip Rap Coastline
Option 4

This design brings a section from the existing coastline inland to create a marsh and mangrove walk-through space with boardwalk. An additional pier is proposed that would allow more access to the water and visibility to the end of the existing pier. The approach to the existing pier is removed and replaced with a boardwalk deck. Areas of hardened substrate and oyster-growing materials are also built up by the coast, contained by a line of oyster bags.

Estimated Cost: $3,729,640





Project 2 Cost Estimates - Desoto Park

Concept: Rip Rap Coastline

Option 4

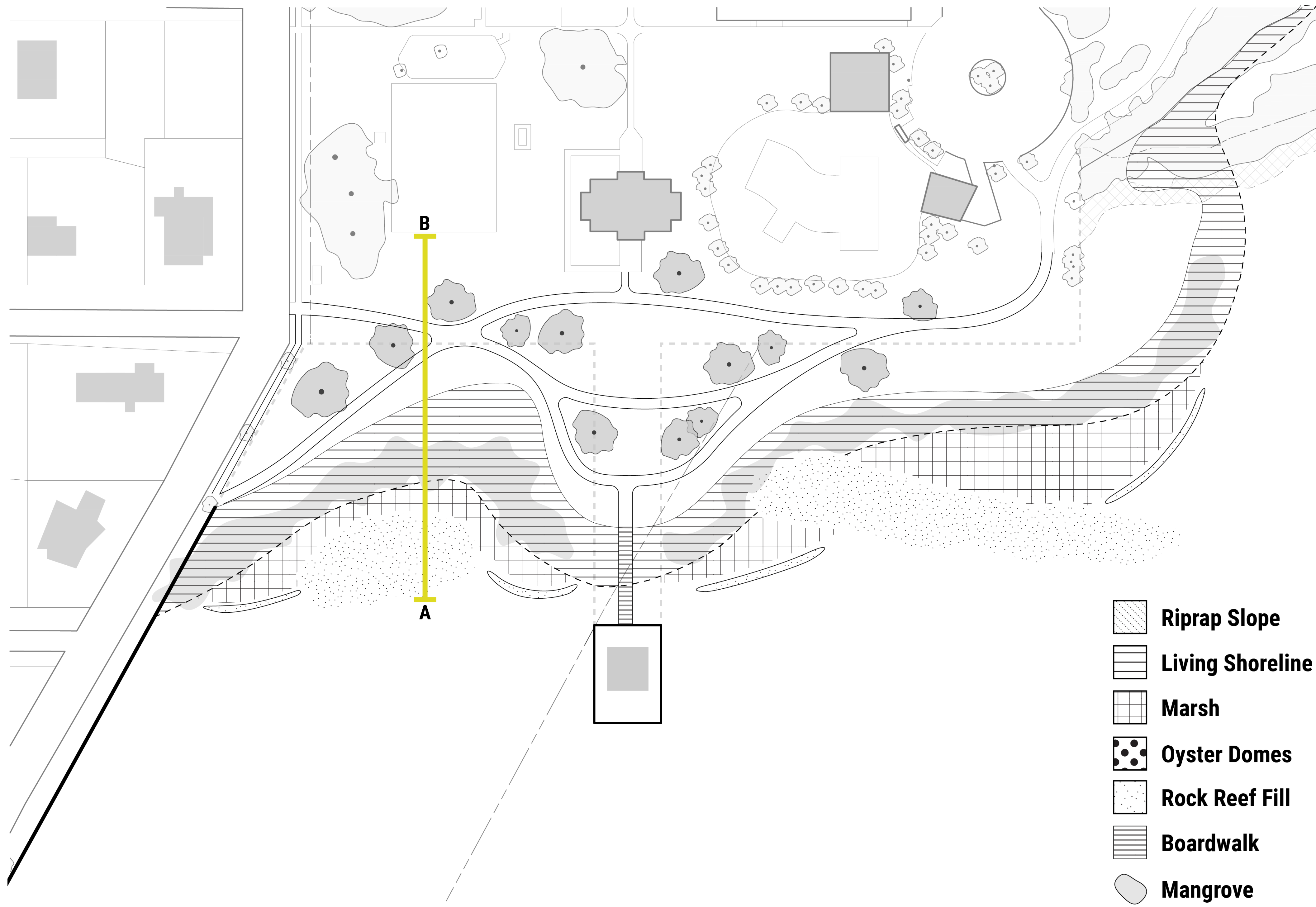
	ITEM/DESCRIPTION	PROJECT TAKEOFFS TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
PRE-CONSTRUCTION					
	TREE REMOVAL	6	EA	$2,000.00	$12,000
	CLEARING AND EXCAVATION	9,498	CY	$18.00	$170,964
	SEAWALL DEMO	1,500	LF	$106.50	$159,750
	SUB-TOTAL				**$342,714**
HARDSCAPE					
	OUTFALLS	1	EA	$10,000.00	$10,000
	NEW SEAWALL - CONCRETE SHEET PILING	2,432	LF	$164.00	$398,848
	NEW BULKHEAD CAP	56	CY	$1,000.00	$56,296
	REINFORCE STEEL - BULKHEAD	7,037	LB	$1.19	$8,374
	PRESTRESSED SOIL ANCHORS	32	EA	$7,017.00	$222,205
	PRESTRESSED SOIL ANCHORS, PERF TEST	3	EA	$1,100.00	$3,483
	SIDEWALKS	500	LF	$229.00	$114,500
	RIP RAP	1,443	TN	$175.00	$252,540
	WOOD BOARDWALK	13,190	SF	$50.00	$659,500
	FLOATING DOCK	1	EA	$100,000.00	$100,000
					$0
					$0
	SUB-TOTAL				**$1,825,747**
FURNISHINGS					
	WASTE RECEPTACLES	10	EA	$700.00	$7,000
	BENCHES	12	EA	$4,500.00	$54,000
	TABLES AND CHAIRS	4	EA	$4,000.00	$16,000
					$0
					$0
	SUB-TOTAL				**$77,000**
OFFSHORE INFRASTRUCTURE AND PLANTING					
	TREES	6	EA	$7,000.00	$42,000
	LITTORAL SHELF PLANTING (MARSH)	6,072	SF	$1.20	$7,286
	IRRIGATION	4,229	SF	$1.00	$4,229
	SOD	4,229	SF	$0.35	$1,480
	NEARSHORE OYSTER BAGS	460	LF	$20.00	$9,200
	ROCK REEF FILL	23,568	SF	$1.20	$28,282
	MANGROVE RESTORATION	272	EA	$30.00	$8,154
	TURBIDITY BARRIER	1,059	LF	$11.92	$12,623
	SUB-TOTAL				**$113,254**
ELECTRICAL & LIGHTING					
	PEDESTRIAN LIGHTING	14	EA	$7,000.00	$98,000
	SUB-TOTAL				**$98,000**
	TOTAL				**$2,456,715**
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			**8.00%**	**$196,537**
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			**15.00%**	**$368,507**
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			**8.00%**	**$196,537**
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			**15.00%**	**$368,507**
SOILS AND REMEDIATION				**5.00%**	**$122,836**
GEOTECHNICAL REPORTS					**$20,000**
OPINION OF PROBABLE COST	**GRAND TOTAL**				**$3,729,640**

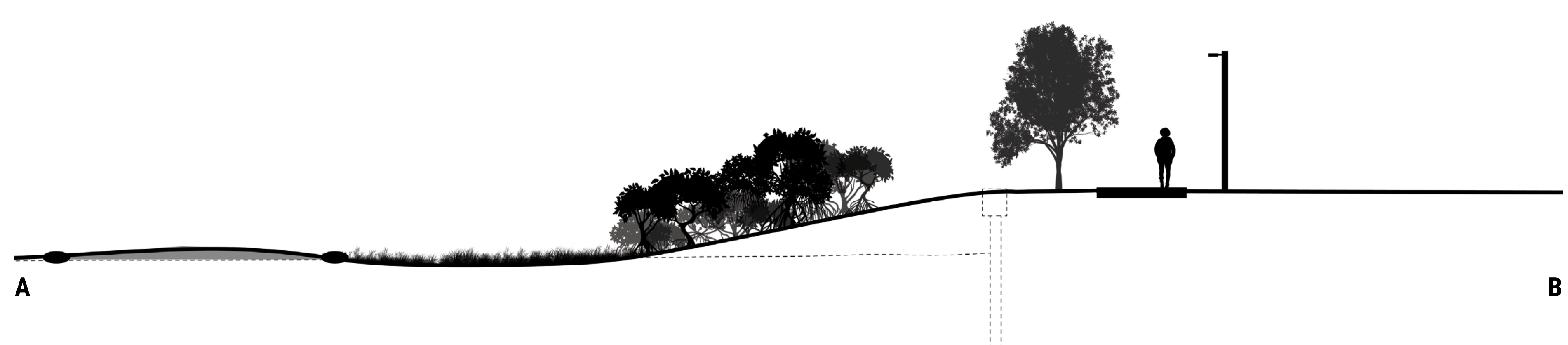
Project 2 - Desoto Park Coastline

Concept: Remove Seawall and Create a Natural Edge
Option 5

This design uses a significant amount of fill to create a new shoreline. The original seawall is removed and a new, gently sloped coastline is created in front, lined with marsh, mangrove, and oysters. The original pier is removed and replaced with a short boardwalk. The design creates dramatic change to the coastline with opportunities for native and wetland vegetation to fill in. Shortening the approach to the end of the pier increases safety.

Estimated Cost: $6,957,336





Project 2 Cost Estimates - Desoto Park

Concept: Remove Seawall and Create a Natural Edge

Option 5

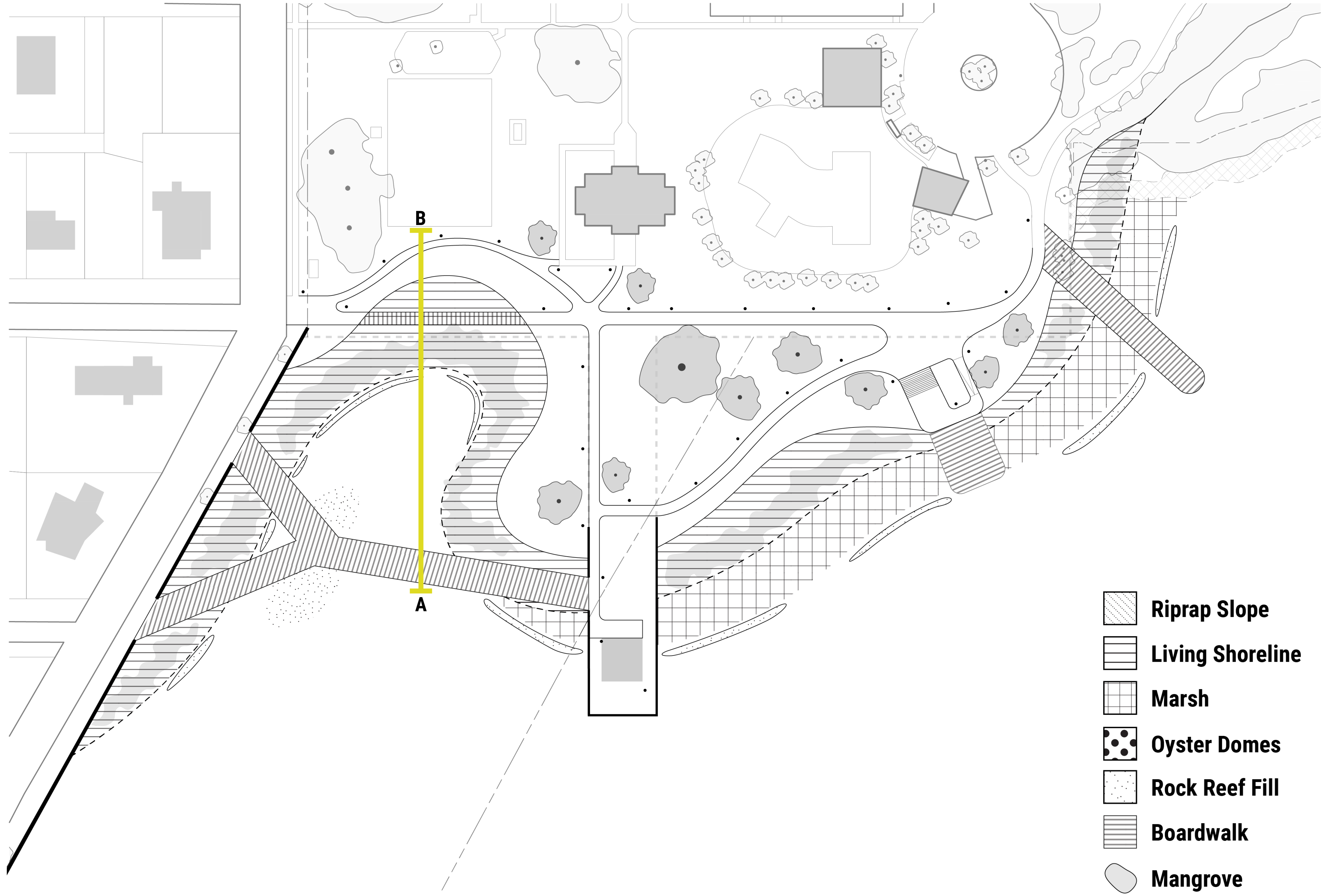
		PROJECT TAKEOFFS			
	ITEM/DESCRIPTION	TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
PRE-CONSTRUCTION					
	TREE REMOVAL	2	EA	$2,000.00	$4,000
	SEAWALL DEMO	1,500	LF	$106.50	$159,750
	CLEARING AND EXCAVATION	1,248	CY	$18.00	$22,464
	FILL	21,820	CY	$20.00	$436,397
	SUB-TOTAL				**$622,611**
HARDSCAPE					
	PIPES/CULVERTS	580	LF	$250.00	$145,000
	OUTFALLS	1	EA	$10,000.00	$10,000
	NEW SEAWALL - CONCRETE SHEET PILING	2,336	LF	$164.00	$383,104
	NEW BULKHEAD CAP	54	CY	$1,000.00	$54,074
	REINFORCE STEEL - BULKHEAD	6,759	LB	$1.19	$8,044
	PRESTRESSED SOIL ANCHORS	30	EA	$7,017.00	$213,434
	PRESTRESSED SOIL ANCHORS, PERF TEST	3	EA	$1,100.00	$3,346
	SIDEWALKS	1,712	LF	$229.00	$392,048
	WOOD BOARDWALK	841	SF	$50.00	$42,050
	SUB-TOTAL				**$1,251,099**
FURNISHINGS					
	WASTE RECEPTACLES	7	EA	$700.00	$4,900
	BENCHES	12	EA	$4,500.00	$54,000
	TABLES AND CHAIRS	4	EA	$4,000.00	$16,000
	SUB-TOTAL				**$74,900**
OFFSHORE INFRASTRUCTURE AND PLANTING					
	TREES	18	EA	$7,000.00	$126,000
	LITTORAL SHELF PLANTING (MARSH)	22,821	SF	$1.20	$27,385
	LIVING SHORELINE	1,113	LF	$2,000.00	$2,226,000
	IRRIGATION	57,450	SF	$1.00	$57,450
	SOD	57,450	SF	$0.35	$20,108
	NEARSHORE OYSTER BAGS	376	LF	$20.00	$7,520
	ROCK REEF FILL	20,839	SF	$1.20	$25,007
	MANGROVE RESTORATION	2,166	EA	$30.00	$64,986
	TURBIDITY BARRIER	1,191	LF	$11.92	$14,197
	SUB-TOTAL				**$2,568,652**
ELECTRICAL & LIGHTING					
	PEDESTRIAN LIGHTING	11	EA	$7,000.00	$77,000
	SUB-TOTAL				**$77,000**
	TOTAL				**$4,594,262**
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			**8.00%**	**$367,541**
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			**15.00%**	**$689,139**
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			**8.00%**	**$367,541**
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			**15.00%**	**$689,139**
SOILS AND REMEDIATION				**5.00%**	**$229,713**
GEOTECHNICAL REPORTS					**$20,000**
OPINION OF PROBABLE COST	**GRAND TOTAL**				**$6,957,336**

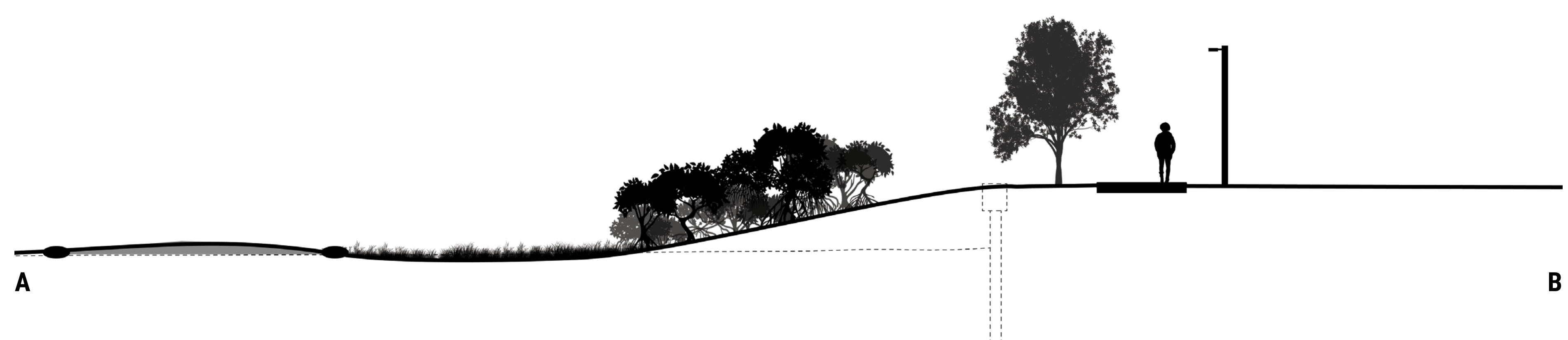
Project 2 - Desoto Park Coastline

Concept: Remove Seawall and Create a Natural Edge
Option 6

This design is similar to Option 5, but it includes the addition of new piers and outlook locations. The pier seawall is replaced with a new seawall, and a small, paved plaza area is added near the pool, with steps and ramp to the water's edge.

Estimated Cost: $10,413,245





Project 2 Cost Estimates - Desoto Park

Concept: Remove Seawall and Create a Natural Edge
Option 6

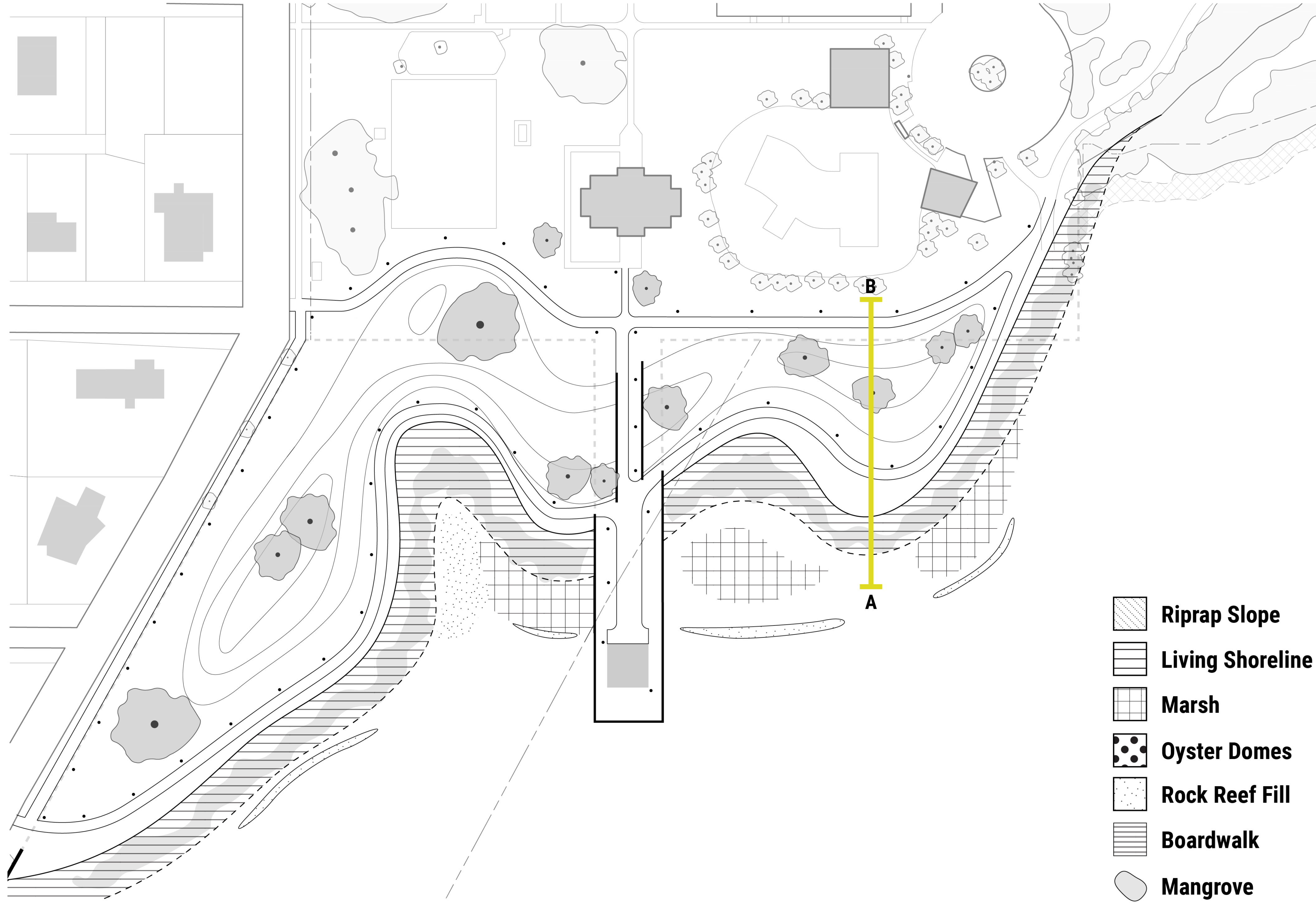
	ITEM/DESCRIPTION	PROJECT TAKEOFFS TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
PRE-CONSTRUCTION					
	TREE REMOVAL	6	EA	$2,000.00	$12,000
	CLEARING AND EXCAVATION	1,487	CY	$18.00	$26,766
	SEAWALL DEMO	1,755	LF	$106.50	$186,908
	FILL	18,646	CY	$20.00	$372,920
	SUB-TOTAL				**$598,594**
HARDSCAPE					
	PIPES/CULVERTS	580	LF	$250.00	$145,000
	OUTFALLS	1	EA	$10,000.00	$10,000
	NEW SEAWALL - CONCRETE SHEET PILING	5,837	LF	$164.00	$957,235
	NEW BULKHEAD CAP	135	CY	$1,000.00	$135,111
	REINFORCE STEEL - BULKHEAD	16,889	LB	$1.19	$20,098
	PRESTRESSED SOIL ANCHORS	76	EA	$7,017.00	$533,292
	PRESTRESSED SOIL ANCHORS, PERF TEST	8	EA	$1,100.00	$8,360
	SIDEWALKS	1,510	LF	$229.00	$345,790
	WOOD BOARDWALK	20,465	SF	$50.00	$1,023,250
					$0
					$0
	SUB-TOTAL				**$3,178,136**
FURNISHINGS					
	WASTE RECEPTACLES	10	EA	$700.00	$7,000
	BENCHES	16	EA	$4,500.00	$72,000
	TABLES AND CHAIRS	4	EA	$4,000.00	$16,000
					$0
					$0
	SUB-TOTAL				**$95,000**
OFFSHORE INFRASTRUCTURE AND PLANTING					
	TREES	8	EA	$7,000.00	$56,000
	LIVING SHORELINE	1,308	LF	$2,000.00	$2,616,000
	LITTORAL SHELF PLANTING (MARSH)	24,398	SF	$1.20	$29,278
	IRRIGATION	44,890	SF	$1.00	$44,890
	SOD	44,890	SF	$0.35	$15,712
	NEARSHORE OYSTER BAGS	720	LF	$20.00	$14,400
	ROCK REEF FILL	4,776	SF	$1.20	$5,731
	MANGROVE RESTORATION	2,030	EA	$30.00	$60,900
	TURBIDITY BARRIER	1,200	LF	$11.92	$14,304
	SUB-TOTAL				**$2,857,214**
ELECTRICAL & LIGHTING					
	PEDESTRIAN LIGHTING	22	EA	$7,000.00	$154,000
	SUB-TOTAL				**$154,000**
	TOTAL				**$6,882,944**
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			**8.00%**	**$550,636**
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			**15.00%**	**$1,032,442**
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			**8.00%**	**$550,636**
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			**15.00%**	**$1,032,442**
SOILS AND REMEDIATION				**5.00%**	**$344,147**
GEOTECHNICAL REPORTS					**$20,000**
OPINION OF PROBABLE COST	**GRAND TOTAL**				**$10,413,245**

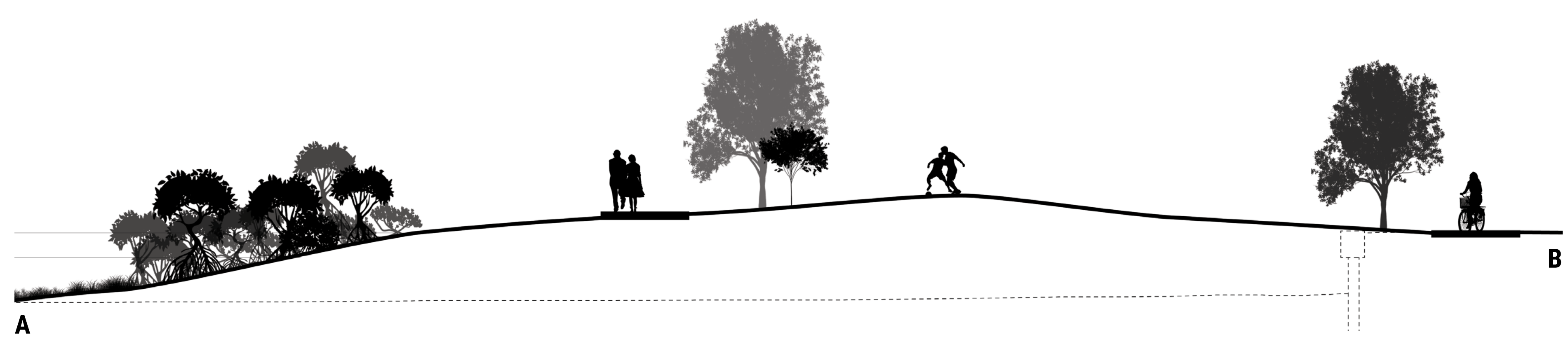
Project 2 - Desoto Park Coastline

Concept: Remove Seawall and Create a Natural Edge Option 7

This design creates a sweeping naturalized edge. Behind it, a berm provides space for an overlook, to see above coastal mangroves, and to provide coastal protection. Walls are added to cut through the berm and create a connection to the replaced pier.

Estimated Cost: $8,708,798





Project 2 Cost Estimates - Desoto Park

Concept: Remove Seawall and Create a Natural Edge

Option 7

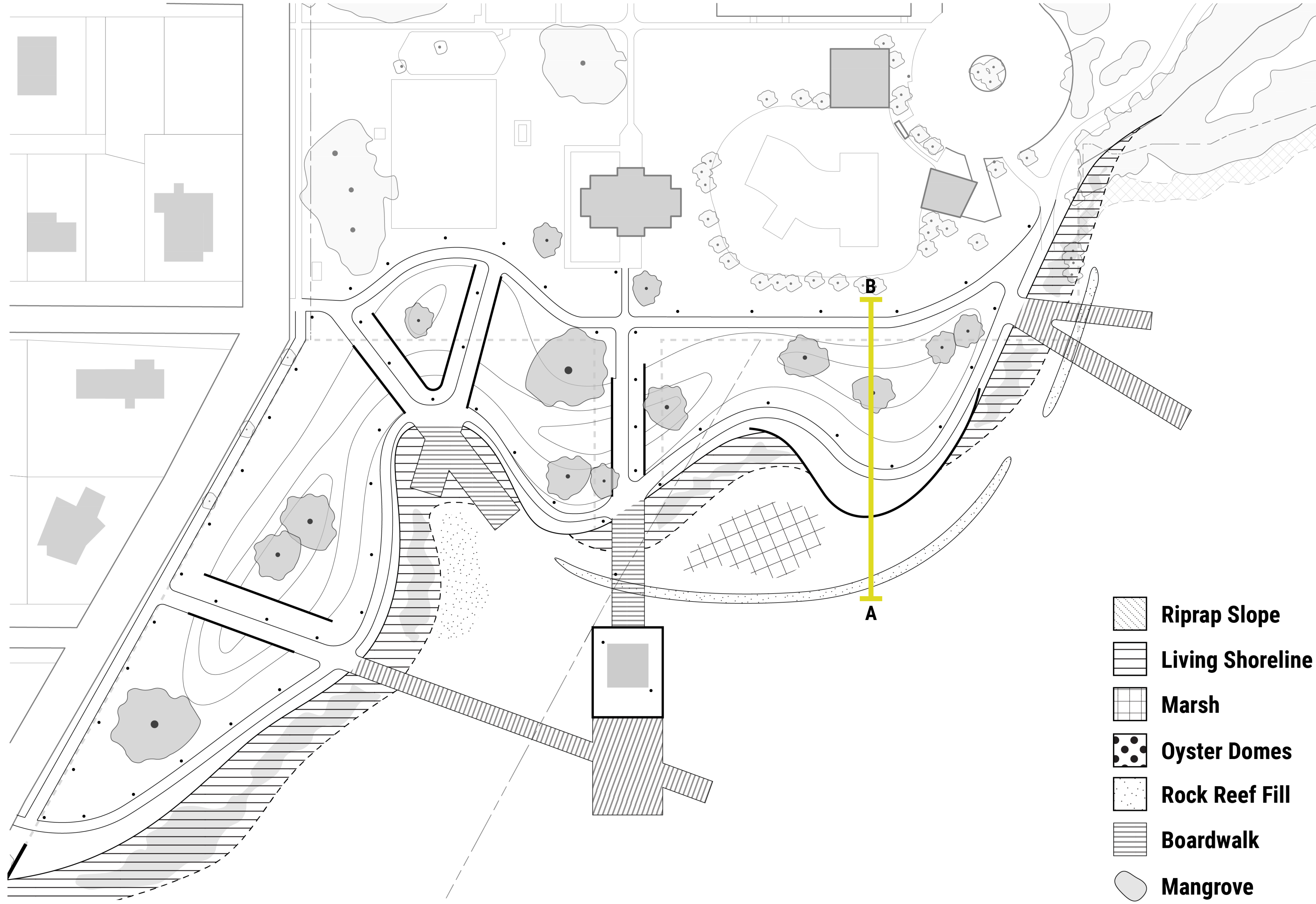
	ITEM/DESCRIPTION	PROJECT TAKEOFFS TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
PRE-CONSTRUCTION					
	TREE REMOVAL	6	EA	$2,000.00	$12,000
	CLEARING AND EXCAVATION	438	CY	$15.00	$6,570
	SEAWALL DEMO	1,834	LF	$106.50	$195,321
	FILL	29,073	CY	$20.00	$581,460
	SUB-TOTAL				$795,351
HARDSCAPE					
	PIPES/CULVERTS	580	LF	$250.00	$145,000
	OUTFALLS	1	EA	$10,000.00	$10,000
	CONCRETE RETAINING WALLS	200	LF	$1,500.00	$300,000
	NEW SEAWALL - CONCRETE SHEET PILING	2,637	LF	$164.00	$432,435
	NEW BULKHEAD CAP	61	CY	$1,000.00	$61,037
	REINFORCE STEEL - BULKHEAD	7,630	LB	$1.19	$9,079
	PRESTRESSED SOIL ANCHORS	34	EA	$7,017.00	$240,917
	PRESTRESSED SOIL ANCHORS, PERF TEST	3	EA	$1,100.00	$3,777
	SIDEWALKS	2,581	LF	$229.00	$591,049
	SUB-TOTAL				$1,793,294
FURNISHINGS					
	WASTE RECEPTACLES	11	EA	$700.00	$7,700
	BENCHES	16	EA	$4,500.00	$72,000
	TABLES AND CHAIRS	10	EA	$4,000.00	$40,000
	SUB-TOTAL				$119,700
OFFSHORE INFRASTRUCTURE AND PLANTING					
	TREES	17	EA	$7,000.00	$119,000
	LIVING SHORELINE	1,278	LF	$2,000.00	$2,556,000
	LITTORAL SHELF PLANTING (MARSH)	13,052	SF	$1.20	$15,662
	IRRIGATION	78,797	SF	$1.00	$78,797
	SOD	78,797	SF	$0.35	$27,579
	NEARSHORE OYSTER BAGS	421	LF	$20.00	$8,420
	ROCK REEF FILL	3,670	SF	$1.20	$4,404
	MANGROVE RESTORATION	2,034	EA	$30.00	$61,017
	TURBIDITY BARRIER	1,170	LF	$11.92	$13,946
	SUB-TOTAL				$2,884,826
ELECTRICAL & LIGHTING					
	PEDESTRIAN LIGHTING	23	EA	$7,000.00	$161,000
	SUB-TOTAL				$161,000
	TOTAL				$5,754,171
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			8.00%	$460,334
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			15.00%	$863,126
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			8.00%	$460,334
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			15.00%	$863,126
SOILS AND REMEDIATION				5.00%	$287,709
GEOTECHNICAL REPORTS					$20,000
OPINION OF PROBABLE COST	GRAND TOTAL				$8,708,798

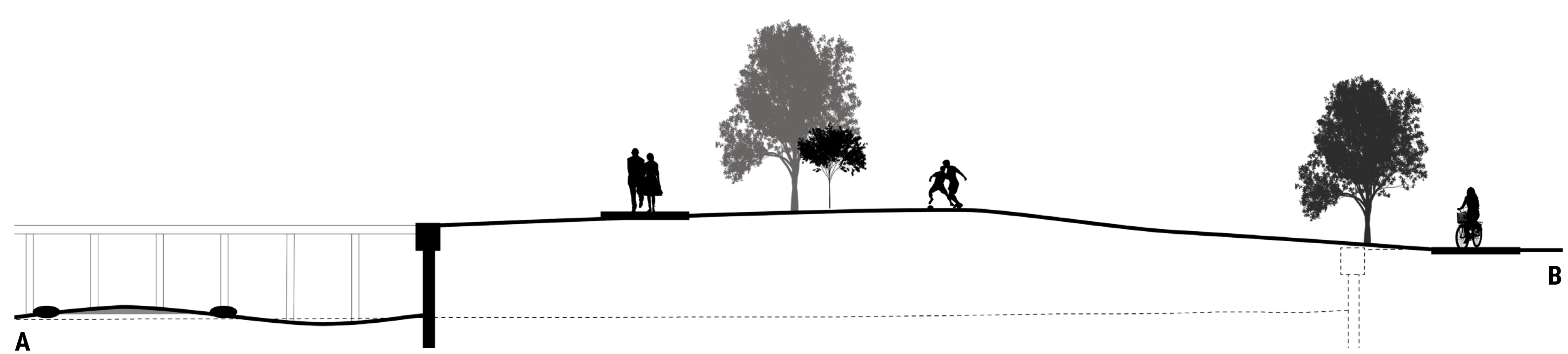
Project 2 - Desoto Park Coastline

Concept: Remove Seawall and Create a Natural Edge
Option 8

This design is similar to Option 7, with the addition of more piers. Seawalls are also added to create viewpoints and minimize mangrove growth. The existing pier is replaced by a boardwalk and an added point of access is provided from Bermuda Boulevard, where there is a higher density of residential population.

Estimated Cost: $11,018,702





Project 2 Cost Estimates - Desoto Park

Concept: Remove Seawall and Create a Natural Edge

Option 8

	ITEM/DESCRIPTION	PROJECT TAKEOFFS TAKEOFF QUANTITY	 UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
PRE-CONSTRUCTION					
	TREE REMOVAL	6	EA	$2,000.00	$12,000
	CLEARING AND EXCAVATION	1,966	CY	$15.00	$29,490
	SEAWALL DEMO	1,834	LF	$106.50	$195,321
	FILL	29,073	CY	$20.00	$581,460
	SUB-TOTAL				**$818,271**
HARDSCAPE					
	PIPES/CULVERTS	580	LF	$250.00	$145,000
	OUTFALLS	1	EA	$10,000.00	$10,000
	CONCRETE RETAINING WALLS	760	LF	$1,500.00	$1,140,000
	NEW SEAWALL - CONCRETE SHEET PILING	3,366	LF	$164.00	$552,090
	NEW BULKHEAD CAP	78	CY	$1,000.00	$77,926
	REINFORCE STEEL - BULKHEAD	9,741	LB	$1.19	$11,591
	PRESTRESSED SOIL ANCHORS	44	EA	$7,017.00	$307,579
	PRESTRESSED SOIL ANCHORS, PERF TEST	4	EA	$1,100.00	$4,822
	SIDEWALKS	2,981	LF	$229.00	$682,649
	WOOD BOARDWALK	17,670	SF	$50.00	$883,500
	SUB-TOTAL				**$3,815,156**
FURNISHINGS					
	WASTE RECEPTACLES	11	EA	$700.00	$7,700
	BENCHES	16	EA	$4,500.00	$72,000
	TABLES AND CHAIRS	10	EA	$4,000.00	$40,000
	SUB-TOTAL				**$119,700**
OFFSHORE INFRASTRUCTURE AND PLANTING					
	TREES	17	EA	$7,000.00	$119,000
	LIVING SHORELINE	1,037	LF	$2,000.00	$2,074,000
	LITTORAL SHELF PLANTING (MARSH)	4,775	SF	$1.20	$5,730
	IRRIGATION	78,797	SF	$1.00	$78,797
	SOD	78,797	SF	$0.35	$27,579
	NEARSHORE OYSTER BAGS	533	LF	$20.00	$10,660
	ROCK REEF FILL	3,670	SF	$1.20	$4,404
	MANGROVE RESTORATION	1,135	EA	$30.00	$34,056
	TURBIDITY BARRIER	1,305	LF	$11.92	$15,556
	SUB-TOTAL				**$2,369,782**
ELECTRICAL & LIGHTING					
	PEDESTRIAN LIGHTING	23	EA	$7,000.00	$161,000
	SUB-TOTAL				**$161,000**
	TOTAL				**$7,283,909**
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			**8.00%**	**$582,713**
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			**15.00%**	**$1,092,586**
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			**8.00%**	**$582,713**
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			**15.00%**	**$1,092,586**
SOILS AND REMEDIATION				**5.00%**	**$364,195**
GEOTECHNICAL REPORTS					**$20,000**
OPINION OF PROBABLE COST	**GRAND TOTAL**				**$11,018,702**

Project 3 - Bermuda Boulevard Coastline and Piers

Bermuda Boulevard is at the water's edge in Palmetto Beach's. The street is fronted by houses and there is limited vehicular access along this corridor. The right of way is mostly used by automobile traffic, there is a sidewalk on the west side of the street, but not on the east, near the water. This project does not address street improvements - its focus is on the addition of multiple piers over the water, where the City owns submerged properties. Living infrastructure components are included to reduce erosion and wave energy while providing opportunities for habitat colonization. Currently the soil structure is a major problem in this area, it is extremely muddy.

This project creates wave dampening and soil stabilization - protection for the coastal edge - while also providing a valuable public amenity where neighborhood residents can associate with the bay.

Estimated Cost of Piers and Sidewalks Only: $10,093,049

Estimated Cost of Reef Only: $5,075,133

Estimated Cost of Full Seawall Replacement Only: $9,938,545

Image: Pier 26 at Hudson River Park in New York City

Project 3 Cost Estimates - Bermuda Boulevard Coastline and Piers

Piers and Sidewalks Only

	ITEM/DESCRIPTION	PROJECT TAKEOFFS: TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
PIERS AND SIDEWALKS					
	WOOD BOARDWALK	106,591	SF	$50.00	$5,329,550
	SIDEWALKS	3,258	LF	$229.00	$746,082
	WASTE RECEPTACLES	20	EA	$700.00	$14,000
	BENCHES	36	EA	$4,500.00	$162,000
	PEDESTRIAN LIGHTING	40	EA	$7,000.00	$280,000
	TREES	10	EA	$7,000.00	$70,000
	SOD	45,313	SF	$0.35	$15,860
	TURBIDITY BARRIER	4,480	LF	$11.92	$53,402
	SUB-TOTAL				$6,670,893
	TOTAL				$6,670,893
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			8.00%	$533,671
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			15.00%	$1,000,634
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			8.00%	$533,671
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			15.00%	$1,000,634
SOILS AND REMEDIATION				5.00%	$333,545
GEOTECHNICAL REPORTS					$20,000
OPINION OF PROBABLE COST	GRAND TOTAL				$10,093,049

Full Seawall Replacement Only

	ITEM/DESCRIPTION	PROJECT TAKEOFFS: TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
SEAWALL REPLACEMENT					
	SEAWALL DEMO	3,374	LF	$106.50	$359,331
	OUTFALLS	12	EA	$10,000.00	$120,000
	TIDAL GATE VALVES	12	EA	$40,000.00	$480,000
	NEW SEAWALL - CONCRETE SHEET PILING	21,594	LF	$164.00	$3,541,350
	NEW BULKHEAD CAP	500	CY	$1,000.00	$499,850
	REINFORCED STEEL - BULKHEAD	62,481	LB	$1.19	$74,353
	PRESTRESSED SOIL ANCHORS	260	EA	$7,017.00	$1,824,420
	PREST. SOIL ANCHOR, PERF TEST	26	EA	$1,100.00	$28,600
	SUB-TOTAL				$6,568,573
	TOTAL				$6,568,573
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			8.00%	$525,486
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			15.00%	$985,286
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			8.00%	$525,486
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			15.00%	$985,286
SOILS AND REMEDIATION				5.00%	$328,429
GEOTECHNICAL REPORTS					$20,000
OPINION OF PROBABLE COST	GRAND TOTAL				$9,938,545

Reef Only

	ITEM/DESCRIPTION	PROJECT TAKEOFFS: TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
REEF CONSTRUCTION					
	RIP RAP REEF	17,279	TON	$175.00	$3,023,770
	SOIL MAT	18,000	SY	$18.00	$324,000
	SUB-TOTAL				$3,347,770
	TOTAL				$3,347,770
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			8.00%	$267,822
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			15.00%	$502,165
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			8.00%	$267,822
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			15.00%	$502,165
SOILS AND REMEDIATION				5.00%	$167,388
GEOTECHNICAL REPORTS					$20,000
OPINION OF PROBABLE COST	GRAND TOTAL				$5,075,133

Project 4 - Storm Drains and Outfalls

The results of sediment sampling and analysis indicate that stormwater discharge from seawall outfalls may be directly related to high mud content in the soil. The inlets and pipes connected to those outfalls are also responsible for draining low elevation streets, some as low as 3' NAVD. Existing 1-year stillwater elevation is 2' NAVD, and sea levels are expected to increase 14"-18" in the next 30 years. To prepare for the future, and to reduce pollution into the bay, this design proposes to cluster and connect existing inlet locations through a manifold system of pipes. This allows for reduced point of discharge with concentrated pipe flow. Each discharge pipe would include a baffle box and/or sediment drop-out structure and tidal gate valve to prevent backflow into the system from the sea. Currently, each inlet location discharges directly to the bay, resulting in 12 outfall locations. This design reduces that number to 4.

Estimated Cost of Stormwater Pipe Replacement Only: $5,044,872

Estimated Cost of Full Seawall Replacement Only: $9,938,545

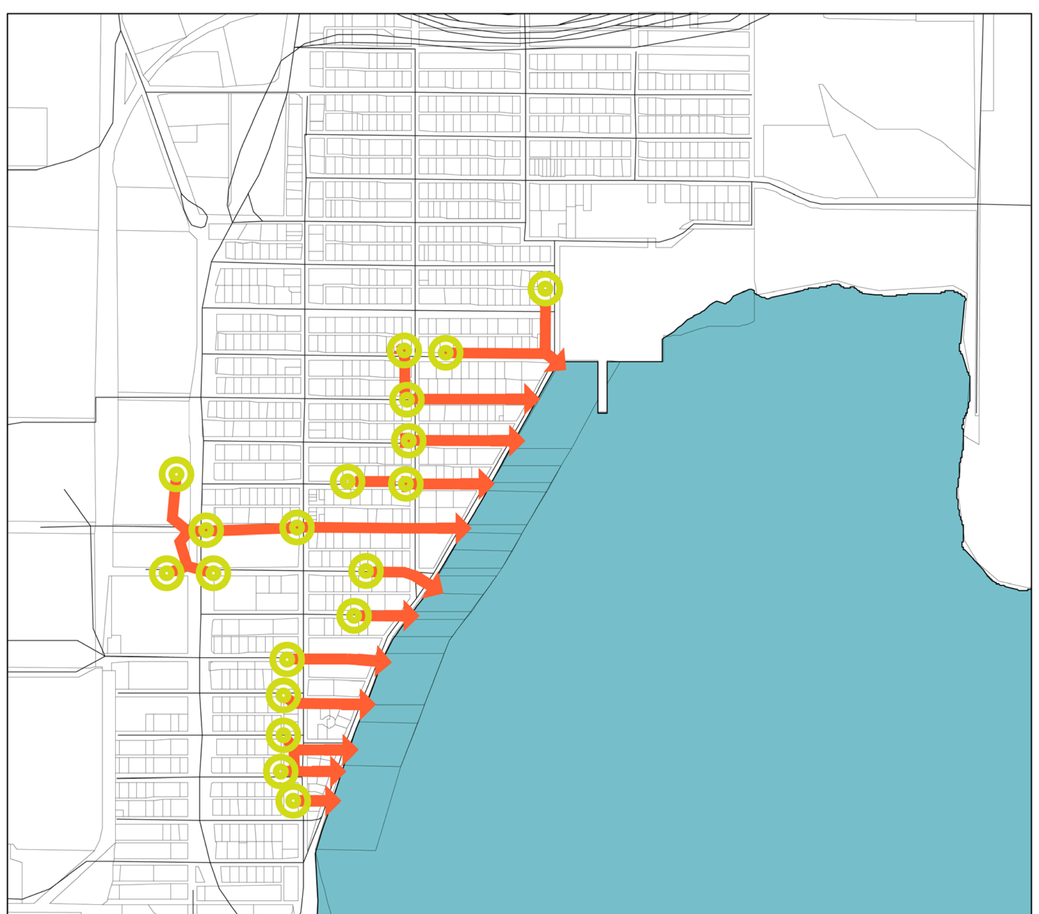


Image: Existing storm drains and outfalls

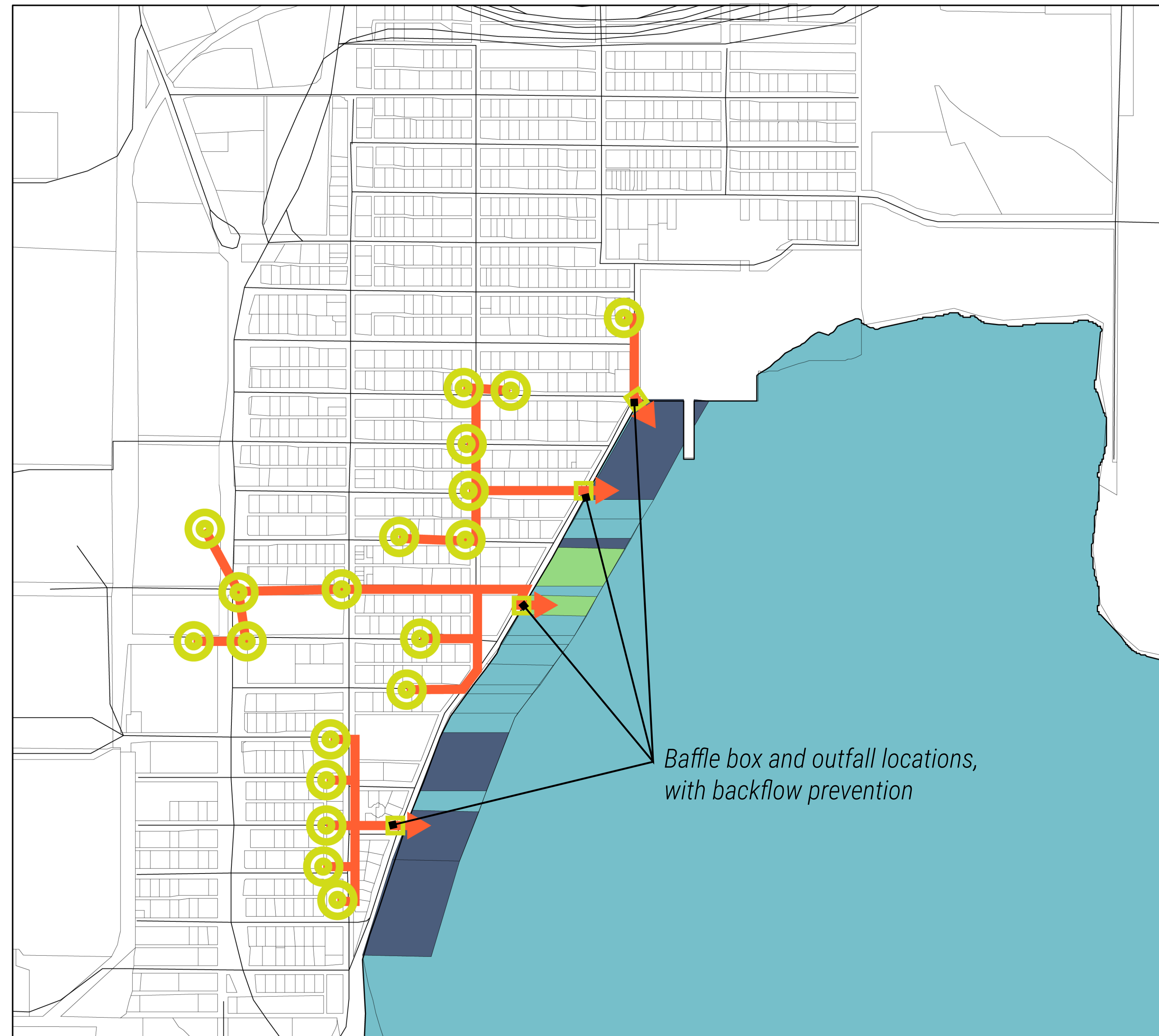


Image: Proposed storm drains and baffle boxes

Stormwater Pipe Replacement Only

	ITEM/DESCRIPTION	PROJECT TAKEOFFS: TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
STORMWATER PIPES					
	SEAWALL DEMO	160	LF	$106.50	$17,040
	ROADWAY DEMO/EXCAVATION	13,136	CY	$18.00	$236,448
	ROAD CLOSURES	N/A	DAY	$300.00	
	PIPE DEMO/EXCAVATION	9,387	CY	$25.00	$234,667
	PIPES/CULVERTS	7,960	LF	$250.00	$1,990,000
	SEAWALL - AT OUTFALLS	160	LF	$1,500.00	$240,000
	BAFFLE BOXES	4	EA	$100,000.00	$400,000
	TURBIDITY BARRIERS	3,776	LF	$11.92	$45,010
	OUTFALLS	4	EA	$10,000.00	$40,000
	INLETS	19	EA	$10,000.00	$190,000
	TIDAL GATE VALVES	4	EA	$40,000.00	$160,000
	ROAD REPAVING	6,568	SY	$40.00	$262,720
	SUB-TOTAL				**$3,327,730**
	TOTAL				**$3,327,730**
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			**8.00%**	**$266,218**
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			**15.00%**	**$499,159**
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			**8.00%**	**$266,218**
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			**15.00%**	**$499,159**
SOILS AND REMEDIATION				**5.00%**	**$166,386**
GEOTECHNICAL REPORTS					**$20,000**
OPINION OF PROBABLE COST	**GRAND TOTAL**				**$5,044,872**

Full Seawall Replacement Only

	ITEM/DESCRIPTION	PROJECT TAKEOFFS: TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
SEAWALL REPLACEMENT					
	SEAWALL DEMO	3,374	LF	$106.50	$359,331
	NEW SEAWALL - CONCRETE SHEET PILING	21,594	LF	$164.00	$3,541,350
	CONCRETE CLASS IV, NEW BULKHEAD CAP	500	CY	$1,000.00	$499,850
	REINFORCED STEEL - BULKHEAD	62,481	LB	$1.19	$74,353
	PRESTRESSED SOIL ANCHORS	260	EA	$7,017.00	$1,824,420
	PREST. SOIL ANCHOR, PERF TEST	26	EA	$1,100.00	$28,600
	OUTFALLS	12	EA	$10,000.00	$120,000
	TIDAL GATE VALVES	12	EA	$40,000.00	$480,000
	SUB-TOTAL				**$6,568,573**
	TOTAL				**$6,568,573**
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			**8.00%**	**$525,486**
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			**15.00%**	**$985,286**
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			**8.00%**	**$525,486**
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			**15.00%**	**$985,286**
SOILS AND REMEDIATION				**5.00%**	**$328,429**
GEOTECHNICAL REPORTS					**$20,000**
OPINION OF PROBABLE COST	**GRAND TOTAL**				**$9,938,545**

Project 5 - Brazilian Pepper Removal at Desoto Park

Brazilian pepper is an exotic species that thrives in coastal environments such as mangrove and marsh habitat. This project would remove existing Brazilian Pepper plants while filling open areas with appropriate mangrove species. The project could include community participation, and there are organizations, such as Mang, that provide mangrove saplings, which could reduce costs.

The area shown for treatment is a waterfront segment of Desoto Park, however there are other areas within Palmetto Beach and McKay Bay that could use Brazilian Pepper removal.

Estimated Cost: $332,251

		PROJECT TAKEOFFS			
	ITEM/DESCRIPTION	TAKEOFF QUANTITY	UNIT MEASUREMENT	UNIT PRICE	TOTAL COST
BRAZILIAN PEPPER REMOVAL AND RESTORATION					
	EXOTIC PLANT REMOVAL	2.26	ACRE	$20,000.00	$45,200
	MANGROVE RESTORATION	5053	EA	$30.00	$151,589
	COMMUNITY PLANTING EVENT	1	EA	$10,000.00	$10,000
	SUB-TOTAL				$206,789
	TOTAL				$206,789
GENERAL CONDITIONS	(SITE REQUIREMENTS, CONSTRUCTION ADMINISTRATION, WEEKLY CLEAN, ETC.)			8.00%	$16,543
DESIGN CONTINGENCY	(UNFORSEEN DETAILING AND DESIGN RESOLUTION)			15.00%	$31,018
CONSTRUCTION CONTINGENCY	(NEEDED FOR UNFORSEEN PROJECT COSTS)			8.00%	$16,543
GENERAL CONTRACTING SERVICES	(SITE CONSTRUCTION SUPERVISION, PROJECT MANAGER, ETC.)			15.00%	$31,018
SOILS AND REMEDIATION				5.00%	$10,339
GEOTECHNICAL REPORTS					$20,000
OPINION OF PROBABLE COST	GRAND TOTAL				$332,251

TASK 7

ECONOMIC ANALYSIS

Economic Analysis Report

Project Costs and Economic Analysis

Project costs were identified in Task 6: Preliminary Project Designs. This includes details for materials, import vs. export of fill, and opinion of probably costs.

Funding Strategies

Project costs can be supported by a number of federally sponsored grant funding programs. Generally, funding opportunities can be separated into two, possibly three, categories: Habitat projects, Risk Mitigation projects, and Roadway and Mobility projects. Understanding the purpose and intent of granting agencies is important for matching appropriate projects. For example, BRIC grants are meant to support risk mitigation and so require a benefit/cost analysis (BCA), which would describe the financial value for the project. This is somewhat different than a habitat project, which would be supported by organizations such as the National Oceanic and Atmospheric Administration (NOAA), the Environmental Protection Agency (EPA), and the National Fish and Wildlife Foundation (NFWF).

Potential grants for the projects in this study include:

- The National Fish and Wildlife National (NFWF) Coastal Resilience Fund [Habitat]
- The National Oceanic and Atmospheric Administrations (NOAA) Climate Resilience Regional Challenge [Habitat and Risk Mitigation]
- The EPA's Nonpoint Source (NPS) Pollution Program [Habitat]
- The Building Resilient Infrastructure and Communities (BRIC) grant program [Risk Mitigation]
- The Hazard Mitigation Grant Program (HMGP), for areas in a federally declared area of emergency [Risk Mitigation]
- Other BRIC and HMGP associated grant programs, such as the Legislative Predisaster Mitigation (LPDM) grant program [Risk Mitigation]
- The United States (US) Department of Transportation (DOT) Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation Program (PROTECT) [Mobility and Risk Mitigation]
- The US DOT Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grant [Mobility]

The State of Florida also has grant opportunities, such as:

- The Resilient Florida Grant Program [Risk Mitigation]
- The Water Management District Cooperative Funding Program (this has not supported resilience projects recently) [Risk Mitigation]

Locally, funds are available from:

- Tampa Bay Estuary Program (TBEP), Tampa Bay Environmental Restoration Fund (TBERF) [Habitat]

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APPENDIX

Modeling the Effect of Project 2 Design Alternatives On Inundation During a Major Hurricane

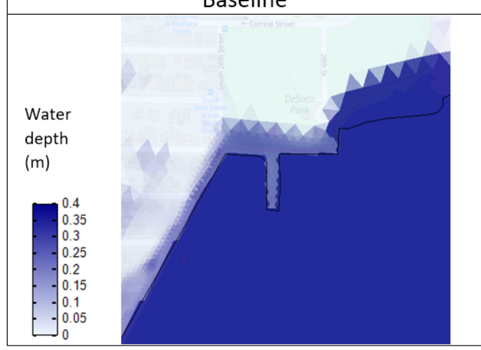
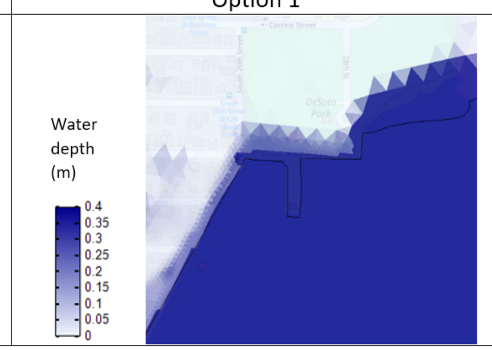
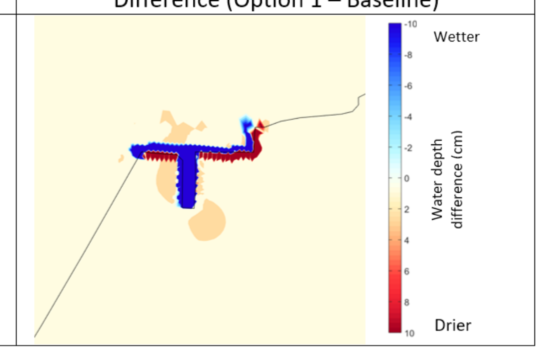
Work completed by Mauricio Arias, PhD., PE and Megan Kramer

Computer modeling software (Delft3d) was used to simulate the effects of proposed design alternatives, for the modification of the Desoto Park Coastline (aka., Project 2). Model results reveal inundation patterns at the peak of a major hurricane, with half the storm surge of what was recorded during hurricane Ian in Ft. Myers. For each of the 8 options below, the first (left) frames represent inundation patterns under a hurricane with current infrastructure conditions, middle frames represent the water levels after each of the design options are implemented, and the right frames represent the difference in water levels between current infrastructure conditions and concept implementation (in centimeters). In the right frames, red means the new design options cause a reduction in flooding as compared to the existing condition. The blue indicates an increase in water depth.

Concept: Rip Rap Coastline, Option 1

Replacement of the seawall with rip rap causes changes in water levels (up to 10 cm or about 4 inches) in the area immediately adjacent to the riprap barrier. Increases in flooding are clear and expected where the pier is to be removed and the fringe of the park where the riprap would be placed.

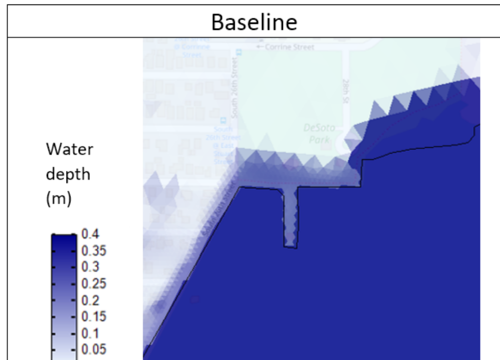
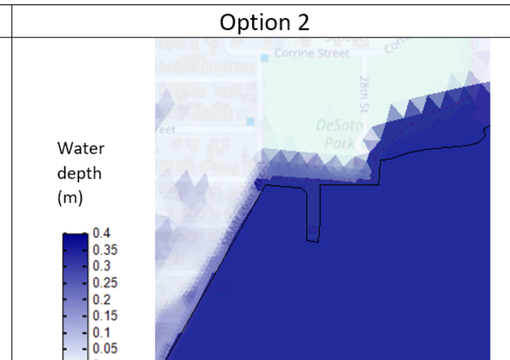
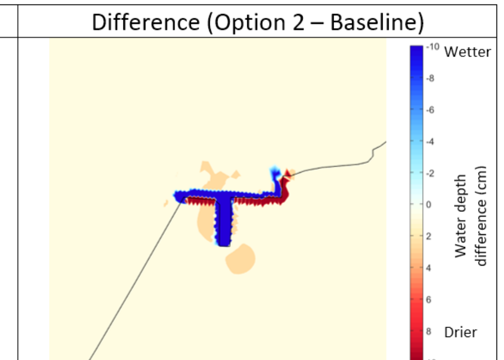
Table 1: Water depth at peak storm surge, Rip Rap Coastline, Option 1

Baseline	Option 1	Difference (Option 1 – Baseline)
		

Concept: Rip Rap Coastline, Option 2

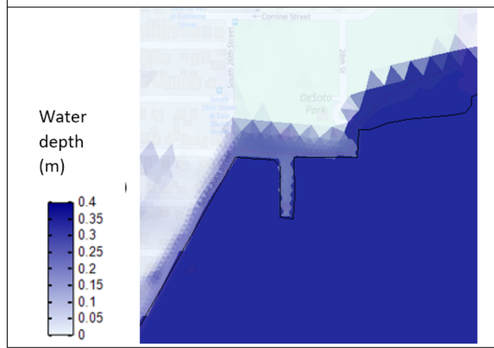
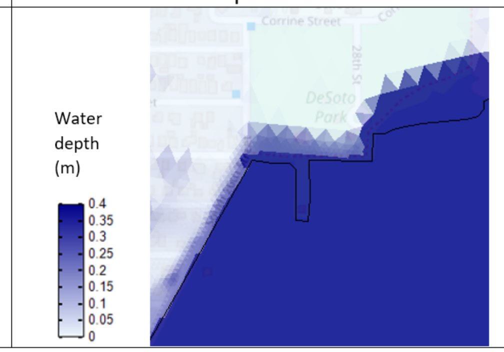
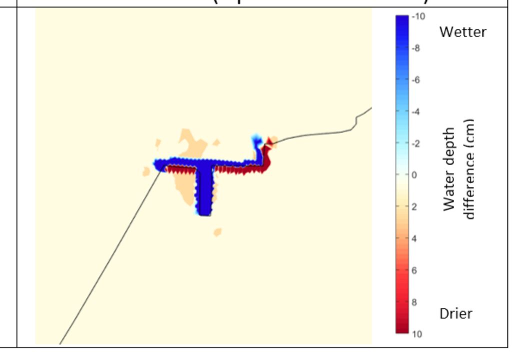
This design option would cause very similar outputs as Option 1.

Table 2: Water depth at peak storm surge, Rip Rap Coastline, Option 2

Baseline	Option 2	Difference (Option 2 – Baseline)
		

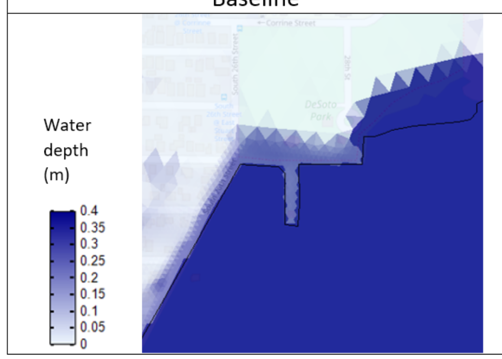
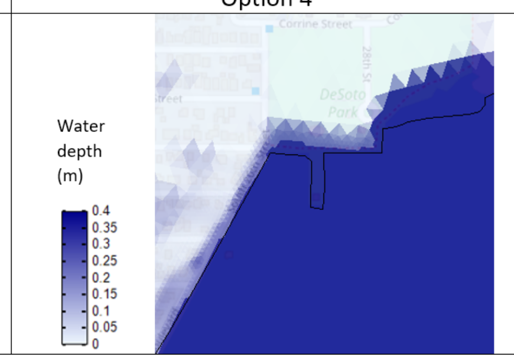
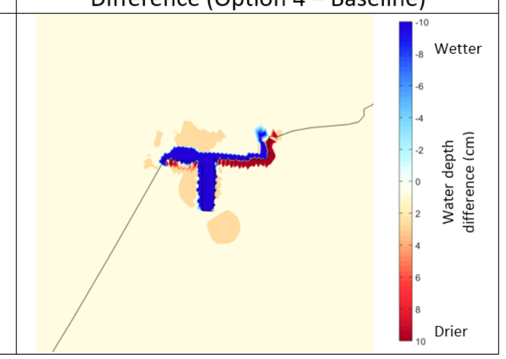
Concept: Rip Rap Coastline, Option 3
Again, this design option would cause very similar outputs as Option 1.

Table 3: Water depth at peak storm surge, Rip Rap Coastline, Option 3

Baseline	Option 3	Difference (Option 3 – Baseline)
		

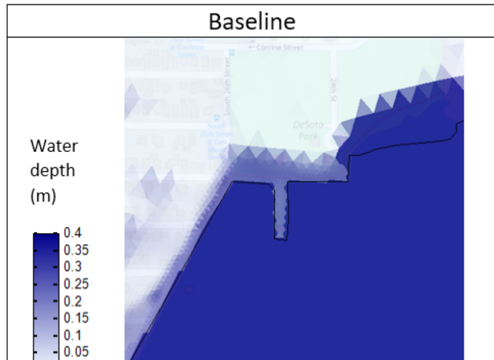
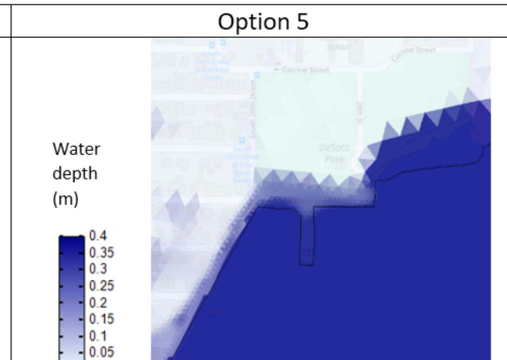
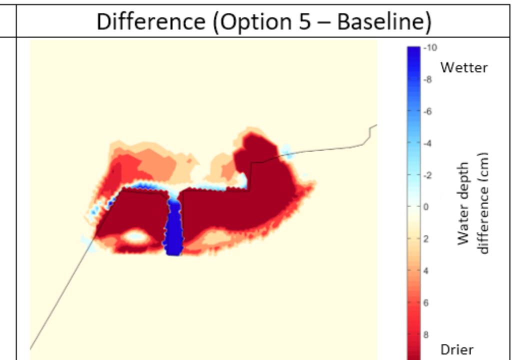
Concept: Rip Rap Coastline, Option 4
This design option would cause similar outputs as Option 1, but with an increase in flooding inland nearby the area where the new pier is proposed.

Table 4: Water depth at peak storm surge, Rip Rap Coastline, Option 4

Baseline	Option 4	Difference (Option 4 – Baseline)
		

Concept: Remove Seawall and Create Natural Edge, Option 5
This design option would cause widespread decrease in flooding (up to 4 inches) in the DeSoto Park waterfront.

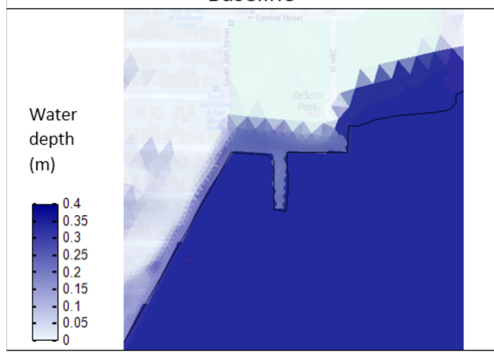
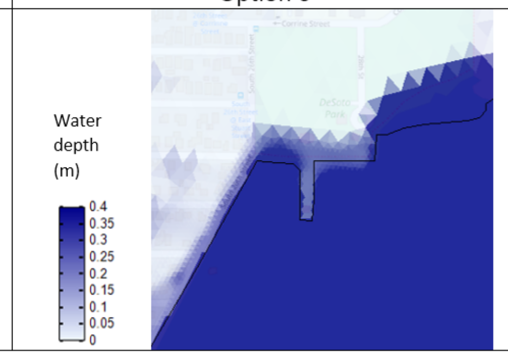
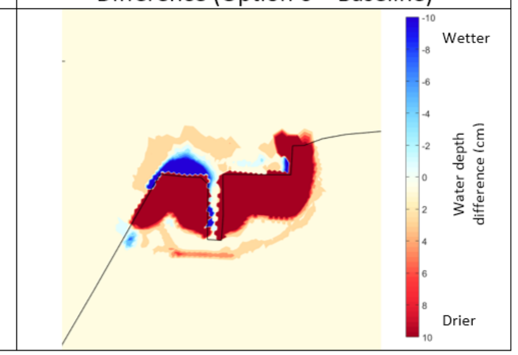
Table 5: Water depth at peak storm surge, Remove Seawall and Create Natural Edge, Option 5

Baseline	Option 5	Difference (Option 5 – Baseline)
		

Concept: Remove Seawall and Create Natural Edge, Option 6

The extent of drier conditions would extend a bit offshore from Option 2, but an increase in flood depth would be expected west of the old pier.

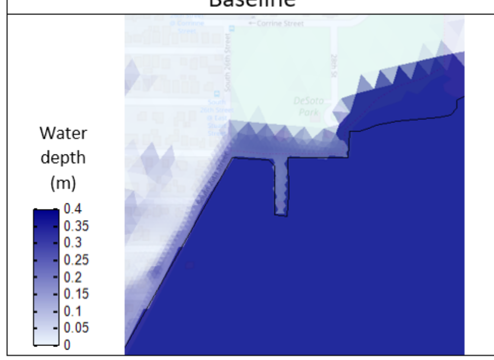
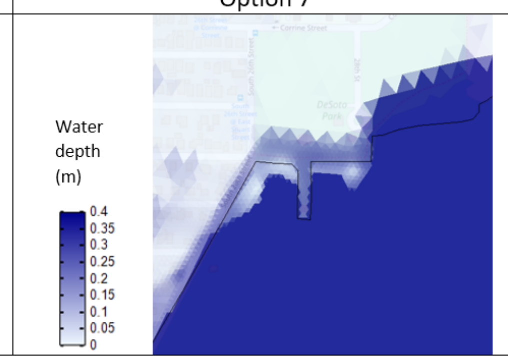
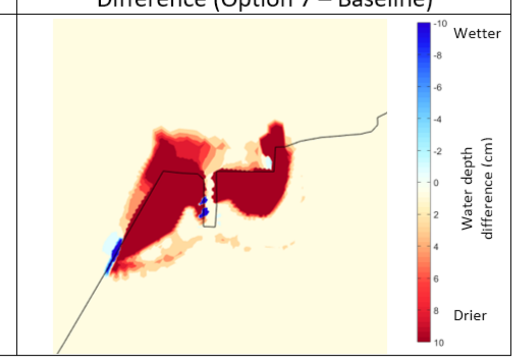
Table 6: Water depth at peak storm surge, Remove Seawall and Create Natural Edge, Option 6

Baseline	Option 6	Difference (Option 6 – Baseline)
		

Concept: Remove Seawall and Create Natural Edge, Option 7

Drier conditions are expected not only offshore from the park, but also in the area around the proposed vegetated edge.

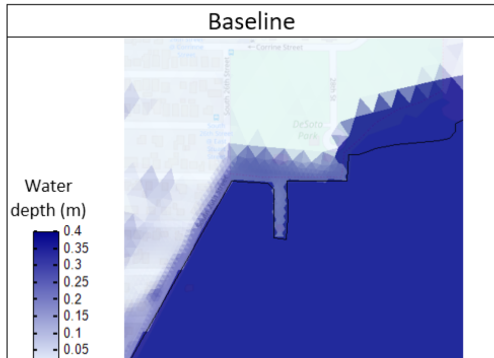
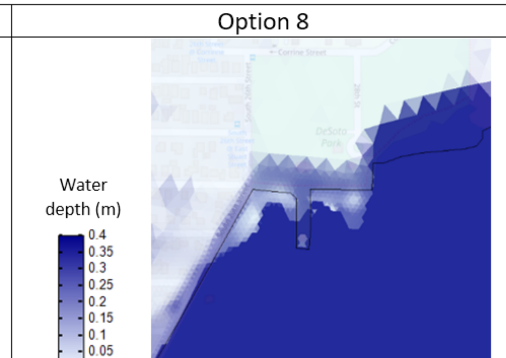
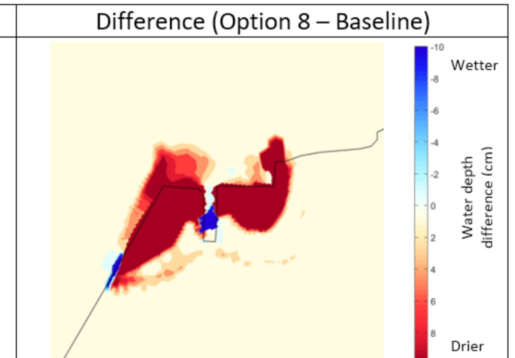
Table 7: Water depth at peak storm surge, Remove Seawall and Create Natural Edge, Option 7

Baseline	Option 7	Difference (Option 7 – Baseline)
		

Concept: Remove Seawall and Create Natural Edge, Option 8

Very similar conditions to those expected for Option 7.

Table 8: Water depth at peak storm surge, Remove Seawall and Create Natural Edge, Option 8

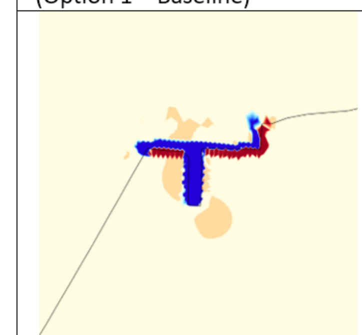
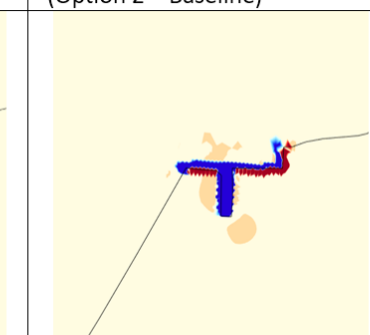
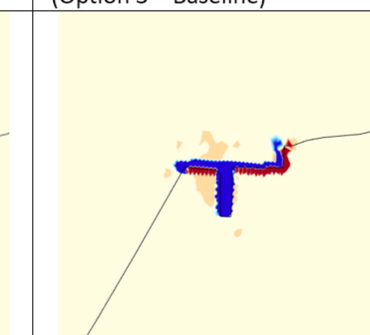
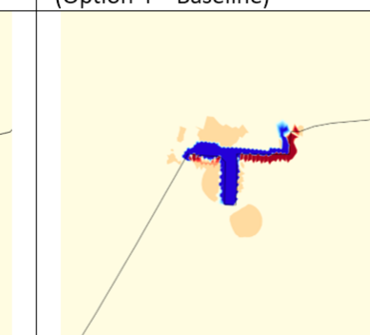
Baseline	Option 8	Difference (Option 8 – Baseline)
		

Summary

In each design option, there is not much more than 4” of difference shown in surge elevation modeling. This is not dramatic, but could be the difference in flooding or not for low-lying houses, streets, and drainage systems.

In options one through four, additional water is shown in the area, which would be expected when removing fill and replacement with a boardwalk pier. Opposite, options five through eight show decrease in water presence because of fill replacing open water. However, options 5, 7, and 8 show additional benefits that protect the intersection of 22nd and Linsey streets at the northwest corner of McKay Bay, with option 7 providing the most protection.

Table 9: Water depth comparison for all options.

(Option 1 – Baseline)	(Option 2 – Baseline)	(Option 3 – Baseline)	(Option 4 – Baseline)
			
(Option 5 – Baseline)	(Option 6 – Baseline)	(Option 7 – Baseline)	(Option 8 – Baseline)