NOTICE OF SHORELINE TASK FORCE REGULAR MEETING
CITY OF SOUTH PADRE ISLAND

TUESDAY, JANUARY 25, 2022

3:00 PM AT THE MUNICIPAL COMPLEX BUILDING
2ND FLOOR CITY COUNCIL CHAMBERS
4601 PADRE BOULEVARD SOUTH PADRE ISLAND, TX 78597

1. Call to Order

2. Pledge of Allegiance

3. Public Comments and Announcements
   This is an opportunity for citizens to speak to the board relating to agenda or non-agenda items. Speakers are required to address the Shoreline Task Force at the podium and give their name before addressing their concerns. [Note: State law will not permit the Shoreline Task Force to discuss, debate or consider items that are not on the agenda. Citizen comments may be referred to City Staff or may be placed on the agenda of a future Shoreline Task Force meeting]

4. Regular Agenda

   4.1. Discussion and action to appoint a chairperson and vice-chairperson for the Shoreline Task Force. (Boburka)

   4.2. Discussion and action to approve the minutes from the regular meeting on January 11, 2022. (Hughston)

   4.3. Update, discussion, and possible action on the Coastal Management Program (CMP)'s Cycle 24 beach and dune study. (Boburka)

   4.4. Committee member introductions and committee overview. (Boburka)

   4.5. Discussion and possible action on the Shoreline Task Force 2022 meeting calendar. (Boburka)

   4.6. Update on department projects (Boburka, Hughston):
   - Coastal Management Program (Cycles 24, 25, 26, 27)
   - RESTORE Act
   - Texas Parks and Wildlife Department's Planning Grant
   - National Fish and Wildlife Foundation's National Coastal Resiliency Fund
   - Wind and Water Sports Venue
   - Tompkins Channel
   - City's Dune Protection, Beach Renourishment, and Beach Access Plan

5. Adjourn

NOTE:

One or more members of the City of South Padre Island City Council may attend this meeting; if so, this statement satisfies the requirements of the OPEN MEETINGS ACT.

DATED JANUARY 21, 2022

Angelique Soto, City Secretary

I, THE UNDERSIGNED AUTHORITY, DO HEREBY CERTIFY THAT THE ABOVE NOTICE OF MEETING OF THE SHORELINE TASK FORCE OF THE CITY OF SOUTH PADRE ISLAND, TEXAS IS A TRUE AND CORRECT COPY OF SAID NOTICE AND THAT I POSTED A TRUE AND CORRECT COPY OF SAID NOTICE ON THE BULLETIN BOARD AT CITY HALL/MUNICIPAL BUILDING ON **JANUARY 21, 2022**, AT/OR BEFORE 3:00 PM AND REMAINED SO POSTED CONTINUOUSLY FOR AT LEAST 72 HOURS PRECEDING THE SCHEDULED TIME OF SAID MEETING.

Angelique Soto, City Secretary

THIS FACILITY IS WHEELCHAIR ACCESSIBLE, AND ACCESSIBLE PARKING SPACES ARE AVAILABLE. REQUESTS FOR ACCOMMODATIONS OR INTERPRETIVE SERVICES MUST BE MADE 48 HOURS PRIOR TO THIS MEETING. PLEASE CONTACT BUILDING OFFICIAL, GEORGE MARTINEZ AT (956)761-8103.

Item No. 4.1

CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE
AGENDA REQUEST FORM

MEETING DATE: January 25, 2022

NAME & TITLE: Kristina Boburka, Shoreline Director

DEPARTMENT: Shoreline Department

ITEM
Discussion and action to appoint a chairperson and vice-chairperson for the Shoreline Task Force. (Boburka)

ITEM BACKGROUND

BUDGET/FINANCIAL SUMMARY

COMPREHENSIVE PLAN GOAL

LEGAL REVIEW
Sent to Legal:
Approved by Legal:

RECOMMENDATIONS/COMMENTS:

Item No. 4.2

CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE
AGENDA REQUEST FORM

MEETING DATE: January 25, 2022

NAME & TITLE: Kristina Boburka, Shoreline Director

DEPARTMENT: Shoreline Department

ITEM
Discussion and action to approve the minutes from the regular meeting on January 11, 2022. (Hughston)

ITEM BACKGROUND
Meeting minutes from the regular meeting held on January 11, 2022.

BUDGET/FINANCIAL SUMMARY
N/A

COMPREHENSIVE PLAN GOAL
N/A

LEGAL REVIEW
Sent to Legal:
Approved by Legal:

RECOMMENDATIONS/COMMENTS:

MINUTES OF REGULAR MEETING
CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE

Tuesday, January 11th, 2021

I. CALL TO ORDER.

The Shoreline Task Force of the City of South Padre Island, Texas, held a regular meeting on Tuesday, January 11th, 2021, at the Municipal Complex Building, 2nd Floor, 4601 Padre Boulevard, South Padre Island, Texas. Chairman Virginia Guillot called the meeting to order at 3:00 p.m. A quorum was present with Task Force Chairman Virginia Guillot, Task Force Members Robert Nixon, Norma Trevino, Abbie Mahan, and Michael Sularz. Task Force Member with an excused absence Stormy Wall.

City Council members present were: Ken Medders and Kerry Schwartz. City staff members present were: City Manager Randy Smith, City Attorney Edmund Cyganiewicz, City Secretary Nikki Soto, City Public Information Coordinator Selena Trevino, Shoreline Director Kristina Boburka, and Coastal Coordinator Erika Hughston.

II. PLEDGE OF ALLEGIANCE.

Chairman Virginia Guillot led the Pledge of Allegiance.

III. PUBLIC COMMENTS AND ANNOUNCEMENTS:

Task Force Member Norma Trevino made a public comment inquiring about the parking at City Hall and what condition it related to beach access parking.

IV. REGULAR AGENDA

I. DISCUSSION AND ACTION TO APPROVE THE MINUTES FROM THE WORKSHOP ON DECEMBER 14TH, 2021. (HUGHSTON)

Task Force Member Nixon made a motion to approve the minutes, seconded by Task Force Member Trevino. Motion passed unanimously.

II. DISCUSSION AND ACTION TO APPROVE THE MINUTES FROM THE REGULAR MEETING ON December 14th, 2021. (BOBURKA)

Task Force Member Nixon made a motion to approve the minutes, seconded by Task Force Member Sularz. Motion passed unanimously.

III. DISCUSSION AND POSSIBLE ACTION TO PROVIDE RECOMMENDATIONS TO CITY COUNCIL REGARDING

VEHICLE AND TRAILER PARKING ALONG GULF BOULEVARD. (NIXON)

Shoreline Task Force Member Nixon reviewed that over the last few meeting the Task Force had discussed the implementation of beach access parking regulations. Task Force Member Nixon motioned to recommend to City Council the approval working alongside City Attorney Ed Cyganiewicz, to additionally include:

Recognizing and acknowledging the legal requirements to provide for public parking for beach access, and for public safety reasons, and to comply with any and all legal requirements, the parking, stopping, or standing of any type of trailer, attached or unattached to any vehicle, or any other type of vehicle, with or without trailers, or other attachments, that occupies or takes up any amount of space in excess of one designated standard parking space, or does not totally fit within one designated standard parking space, for any period of time, is prohibited on Gulf Boulevard, and in all designated City beach accesses. Overnight parking is prohibited on Gulf Boulevard and in all designated City beach accesses.

Motion was seconded by Task Force Member Sularz. Motion carried unanimously.

IV. DISCUSSION AND ACTION TO PROVIDE RECOMMENDATIONS TO CITY COUNCIL ON A BEACH AND DUNE PERMIT TO CONSTRUCT AN AT-GRADE BEACH ACCESS PATH FOR 4000 GULF BOULEVARD. (HUGHSTON, BOBURKA)

Shoreline Director Boburka opened discussion on the 4000 permit requesting an at-grade path for beach access. Permit applicant Michael Gorges explained their mitigation plan and intent to build the path west to east, replanting as they develop. Task Force Member Mahan made a motion to recommend the permit for approval to City Council, Task Force Member Sularz seconded the motion. Motion carried unanimously.

V. RECOGNITION OF CHAIRMAN VIRGINIA GUILLOT FOR HER TIME AND DEDICATION TO THE SHORELINE TASK FORCE. (BOBURKA)

Shoreline Director Boburka and Task Force Member Nixon recognized Chairman Guillot for her years of dedicated service to the Shoreline Task Force.

V. ADJOURNMENT.

There being no further business, Chairman Guillot adjourned the meeting at 3:16 p.m.

______________________________ ______________________________

Kristina Boburka, Shoreline Director Robert Nixon, Vice-Chairman

Item No. 4.3

CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE
AGENDA REQUEST FORM

MEETING DATE: January 25, 2022

NAME & TITLE: Kristina Boburka, Shoreline Director

DEPARTMENT: Shoreline Department

ITEM
Update, discussion, and possible action on the Coastal Management Program (CMP)'s Cycle 24 beach and dune study. (Boburka)

ITEM BACKGROUND
Cheryl Hapke will give an update on the project that is partially funded through the CMP Cycle 24 grant. We will also discuss the next steps of the project and a possible workshop in the coming months.

The Phase I and II reports are attached.

BUDGET/FINANCIAL SUMMARY
N/A

COMPREHENSIVE PLAN GOAL

LEGAL REVIEW
Sent to Legal:
Approved by Legal:

RECOMMENDATIONS/COMMENTS:

Integral Consulting Inc.
1790 Hughes Landing Blvd.
Suite 400
The Woodlands, TX 77380

telephone: 561.240.5094
www.integral-corp.com

July 12, 2021 Project No. C3027-0101

Kristina Boburka
City of South Padre Island
4601 Padre Boulevard
South Padre Island, TX 78597

Subject: **Phase 1 Report: Assessment and Investigation of the Beach and Dune Conditions at South Padre Island**

Dear Ms. Boburka:

Integral Consulting Inc. is pleased to deliver the project report for Phase 1 of the Assessment and Investigation of the beach and dune conditions of South Padre Island. The enclosed report includes a full characterization of the historical conditions and response by examining beach profiles and morphometrics extracted from the profiles for 25 locations within the City. The morphometrics are dune crest and toe elevation, beach width, and profile volume. The analysis also includes a long-term (90 year) and shorter-term (20 year) assessment of shoreline change and a very short-term (2 year) evaluation of 3-dimensional elevation change. Overall, the analysis concludes that with the exception of several specific locations, primarily in the northern portion of the study area, the beaches and dunes are robust, largely due to the regular beach nourishment and dune vegetation planting programs.

If you have any questions or require additional information, please contact Cheryl Hapke at 727.434.0024.

Sincerely,

Keith Brodock, P.E., P.P.
Project Manager | Managing Principal
kbrodock@integral-corp.com

Cheryl Hapke, Ph.D.
Project Lead | Senior Consultant
chapke@integral-corp.com

Enclosure

Assessment and Investigation of the Beach and Dune Conditions at South Padre Island

Phase 1 Report: Characterization of the Beach and Dune State

Prepared for
City of South Padre Island
ATTN: Kristina Boburka, Shoreline Director
4601 Padre Boulevard
South Padre Island, TX 78597

Prepared by
integral consulting inc.
1790 Hughes Landing Blvd.
Suite 400
The Woodlands, TX 77380

July 12, 2021

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ACRONYMS AND ABBREVIATIONS

ADAPT	Adaptation Decision and Planning Tool
CBI	Conrad Blucher Institute
ERP	Erosion Response Plan
EVA	Extreme Value Analysis
HDR	HDR Engineering, Inc.
Integral	Integral Consulting Inc.
Lidar	light detection and ranging
NOAA	National Oceanic and Atmospheric Administration
QA/QC	quality assurance and quality control
SPI	South Padre Island
SWAN	Simulating WAves Nearshore
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

1 INTRODUCTION

South Padre Island (SPI) is a narrow, low-relief barrier island along the south Texas coastline that is impacted frequently by erosive winter storm events and infrequent but extremely damaging major hurricanes. Additionally, relative rates of sea level rise are higher than global averages due to subsidence along the Texas coastline, which exacerbates flooding and increases the inland incursion of storm waves. The dune field that backs the beach along the City of SPI coastline from the Brazos-Santiago Pass to the northern end of the City limits is discontinuous due to numerous beach access points and removal of sand by beachfront property owners. The present dune system is composed of a semi-natural dune field that varies in elevation and width alongshore, and has an extensive vegetation-planting program that helps to provide some resistance to dune erosion.

Scarping of the beach and dune is common in the winter, particularly towards the northern, more erosive part of the beach system. Overall, the beach-dune system provides critical protection to the community of SPI from storm waves and elevated water levels. The beaches and dunes are nourished and planted on a regular basis, thus maintaining a first line of protection for the City and its infrastructure from storm events.

Integral Consulting Inc. (Integral) was awarded a contract with SPI in 2020 to assess and investigate the beach and dune conditions at SPI. The project is being undertaken in four phases (Figure 1-1) following an Integral-developed framework called Coastal ADAPT (Adaptation Decision and Planning Tool) that uses a variety of modeling approaches to examine adaptation options for increasing resilience to coastal hazards and sea level rise–related climate change risks. Phase 1, the focus of this report, includes a characterization of the beach-dune state, including its present morphology, and an assessment of the historical evolution of the system with respect to storm events and human activities. The final deliverable will be a set of recommendations to lay out a plan to increase the resiliency of SPI, and to enhance the "natural" coastal environment that makes it such a desirable location.

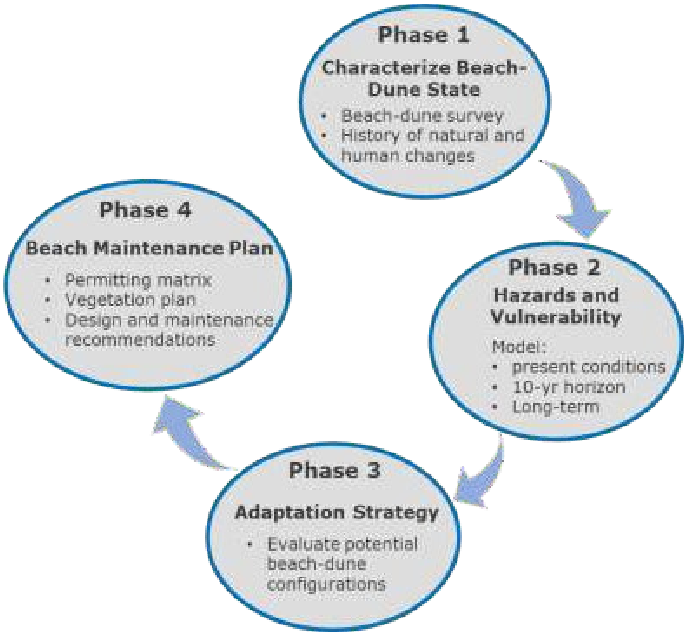


Figure 1-1. Workflow for informing a beach maintenance plan that includes multiple phases to achieve an actionable outcome

2 BACKGROUND

Studies and monitoring of the beach and dunes at SPI have occurred since an original 1993 beach and dune management plan was developed; the science, engineering, and geomorphological understanding of beaches and dunes and various approaches to improving community resiliency have evolved since then. A substantial amount of data exist for SPI, both in a long record of historical shorelines (1930s to 2019) and a variety of light detection and ranging (Lidar) topographic data and field-surveyed beach profiles. Our beach and dune assessment and investigation leverages the previous studies and utilizes existing data. An updated survey of the established beach profiles was collected in June 2021 on the 25 Conrad Blucher Institute [CBI] lines.

Previous investigations of the beach and dune system at SPI include evaluation and assessment of shoreline position and annual averaged rates of change, dune elevation and width, and dune vegetation reported in the 2012 Erosion Response Plan (ERP). The shoreline positions and rates of change in the ERP were obtained from the Texas Shoreline Change Project (https://www.beg.utexas.edu/research/programs/coastal/the-texas-shoreline-change-project). The ERP divides SPI into three areas—north, central, and south—and presents the averaged shoreline change rate within each area, as opposed to providing a detailed alongshore perspective. The dune elevations are reported as averages or ranges for each of the three areas. Lastly, the ERP provides descriptions of dune "depth" or how wide the dune field is in a cross-shore direction, and concludes and recommends that a 200-ft-wide dune field needs to be maintained to prevent the beaches and dunes from rapidly eroding, which would result in the loss of protection to community infrastructure. In addition to the largely qualitative 2012 ERP, a statewide shoreline change assessment by Paine and Caudle (2020) includes SPI and provides an update to the 2012 rates of change reported in the ERP.

In addition to the analyses presented in the ERP, HDR Engineering, Inc. (HDR) conducted the design and permitting of several beach-dune nourishment projects. As part of its effort, HDR established an annual monitoring program (2008–2015) to assess how the beach changed over time on profiles spaced approximately 1,000 ft apart at long-established survey control monuments. In addition to beach profile changes, shoreline positions were extracted from the profiles to evaluate shoreline change over the project period. The study included a wave modeling component to assess alongshore variability in wave forcing to provide insight for the variable alongshore rates of coastal change.

The current project presents a more quantitative assessment of the beach and dune system at SPI than the earlier studies, but is complementary and builds on the earlier work. This report describes the methodology and findings for seven analyses: hydrodynamics, beach and dune profile changes, shoreline change, 3-dimensional elevation change, morphometric change, vegetation line changes, and current state of the beach-dune system.

3 HYDRODYNAMIC ANALYSIS

Wave height, period, and direction are all important factors affecting how waves modify and erode coastal systems. In order to understand natural processes that are driving beach and dune changes at SPI, we examined wave data information from the closest wave buoy to SPI (NDBC 42020). Individual extreme storms were identified, as well as the return period of different wave characteristics using Extreme Value Analysis (EVA). We also examined water level data at a National Oceanic and Atmospheric Administration (NOAA) buoy located just inside of Santiago Brazos Pass, immediately south of SPI. This section discusses the hydrodynamic analysis of wave and water level data.

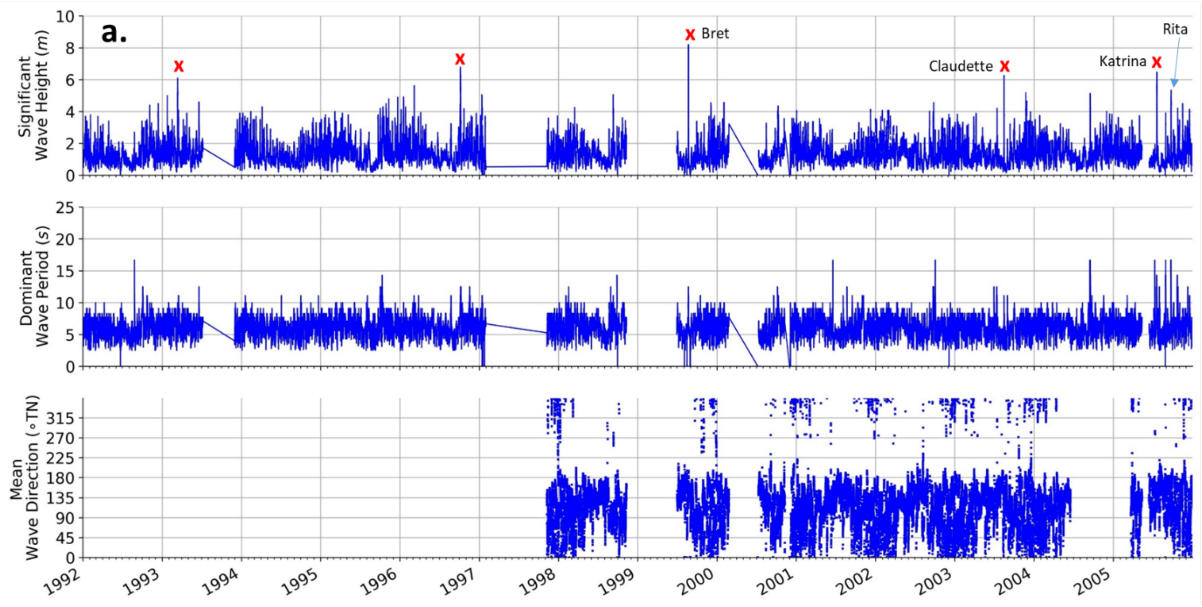
3.1 WAVE DATA

A time series of wave data from the closest directional wave buoy to SPI, NDBC 42020, located 57 nautical miles northeast from SPI (Figure 3-1) was used to conduct an EVA and investigate wave conditions associated with significant changes to the beach and dunes. The mean wave conditions at the selected NOAA wave buoy and the wave conditions offshore of SPI are not significantly different. The significant wave height, wave period, and wave directions are shown in Figure 3-2. Based on these data, there have been nine events (shown as red “x”s) during which significant wave heights at the offshore buoy exceeded 6 m (~20 ft), resulting in observed morphological changes to the beaches and dunes at SPI (Table 3-1). The impacts of these storms will be discussed further in Phase 2 reporting for the project.

To determine the impact of extreme storm events on the coastal resiliency on SPI, extreme values of wave height and wind speed were also computed and will be essential for the numerical wave and coastal erosion models to be conducted in Phase 2 of the project. The EVA of wave height and wind speed data provides the highest wave heights and wind speeds for various return periods (e.g., 1, 2, 5, 10, 100 years) from a 30-year data record.

Figure 3-1. Location map of SPI showing study area and locations of the NOAA wave buoy. The tide gauge is located within the Brazos-Santiago Pass, immediately adjacent to the southern boundary of the SPI study area.

NOAA NDBC 42020 Wave Data: 1992-2005



NOAA NDBC 42020 Wave Data: 2006-2020

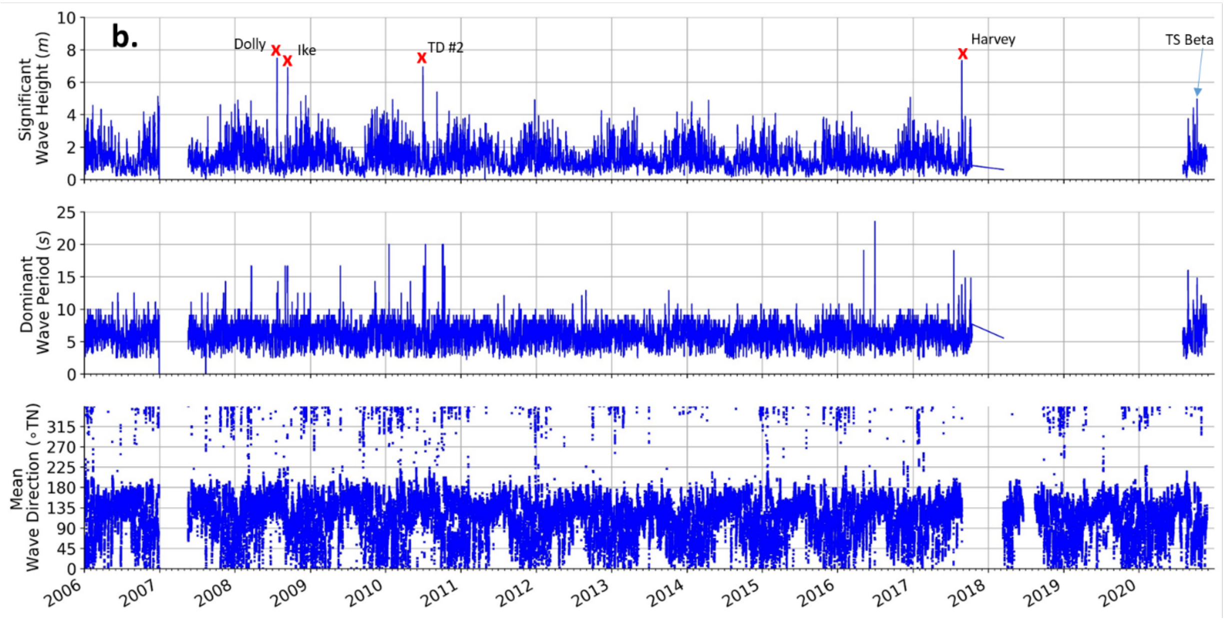


Figure 3-2. Wave data from the closest directional wave buoy to SPI. The time series is separated into two plots for 1992–2005 (a); and 2006–2020 (b) in order to better resolve individual events. The red "x"s indicate known, documented tropical storms that had impacts to SPI beaches and dunes, and will be discussed further in the Phase 2 reporting. Note the wave heights are reported in meters.

Table 3-1. Notable Documented Storms on Record That Impacted Beaches and Dunes at SPI

Landfall Date	Name	TS	HX	Cat	Landfall	Comments
1967-09-20	Beulah		Y	3	Just N of Rio Grande	Extensive damage to SPI
1999-08-23	Bret*		Y	3	Padre Island, between Brownsville and Corpus	
2003-07-15	Claudette*		Y	1	Matagorda	
2005-08-28	Katrina*		Y	3	New Orleans	Extensive erosion to City beaches
2005-09-24	Rita*		Y	3	Louisiana	Extensive erosion to City beaches
2008-07-23	Dolly*		Y	1	City of SPI	Extensive damage to SPI
2008-09-13	Ike*		Y	4	Galveston	Moderate damage to SPI/Extensive Erosion
2010-06-30	Alex		Y	2	Soto La Marina	Heavy rain
2010-07-08	TD 2*	-	-	-	South Padre Island	
2010-09-07	Hermine*	Y			NE Mexico	3.4 ft storm surge at Port Aransas
2011-06-30	Arlene	Y			Cabo Rojo	
2015-06-16	Bill	Y			Matagorda Island	
2017-08-25	Harvey*		Y	4	Rockport	Tidal surge
2020-07-25	Hanna		Y	1	Padre Island, Kennedy County	Minor
2020-09-22	Beta*	Y			Matagorda Peninsula, TX	Damage to dunes

Notes:

Shaded rows = Hurricanes
* = identifiable in wave record as red “x”s in Figure 3-2.
Cat = Category
HX = Hurricane
TS = Tropical Storm

To compute the EVA, the wave height and wind speed data records were loaded into Python and analyzed using an industry standard block maxima to determine the highest recorded values for each year of the 30-year record. These yearly maximum values were then fit to a generalized extreme value distribution and used to determine the return period values for wave height and wind speed.

The computed return period values will be used to provide boundary conditions to force a numerical wave and coastal erosion model in Phase 2 using the open source wave models SWAN (Simulating WAves Nearshore) and XBeach. SWAN is an industry-standard wave-modeling tool developed at the Delft University of Technology, Netherlands. It computes wave fields in coastal waters forced by wave conditions on the domain boundaries, ocean currents, and winds, and has been verified in nearshore and shallow water environments (Booij et al. 1999; Holthuijsen et al. 1993). SWAN uses a third-generation wave propagation technique that computes the sea state of random, short-crested waves as they travel over the ocean and disperse in the nearshore environment. Importantly for this project scope, SWAN can calculate the wave field due to prescribed wave conditions at the boundaries or due to the application of wind conditions over the ocean surface. XBeach is a 1- or 2-dimensional numerical wave model for predicting sediment transport and morphological dynamics in the nearshore and beach environment. XBeach is also industry-standard wave-modeling tool developed at the Delft University of Technology (https://oss.deltares.nl/web/xbeach/). XBeach was developed for simulating short time scales (e.g., storm events) over short lengths of coastline. It resolves short and long waves, which are important for dune erosion, an important concern of SPI.

Table 3-2. Wave Height and Wind Speed Return Period Values from EVA

Return Period (yrs)	Significant Wave Height (ft)	Wind Speed (kn)
1	9.5	27.6
2	16.1	34.6
5	19.7	39.3
10	23.0	43.9
100	41.7	73.4

3.2 WATER LEVEL DATA

In addition to the wave data analysis reported in the January 2021 progress report, we also analyzed water level data from NOAA tide gages in the region. We included this analysis because the offshore directional wave buoy available to assess historical wave data is located nearly 60 nautical miles northeast of SPI (Figure 3-1) and therefore may not always capture high water level events at SPI. The water level record from 2017 to 2021 captures a number of higher than average water levels in 2017–2019 that fall in October (Figure 3-3). These are not relatable to any known tropical storms and may represent astronomical yearly high tides, since they consistently occur in late October. The tide gage record does capture elevated water levels from storm surge associated with Hurricane Hanna and Tropical Storm Beta in 2020.

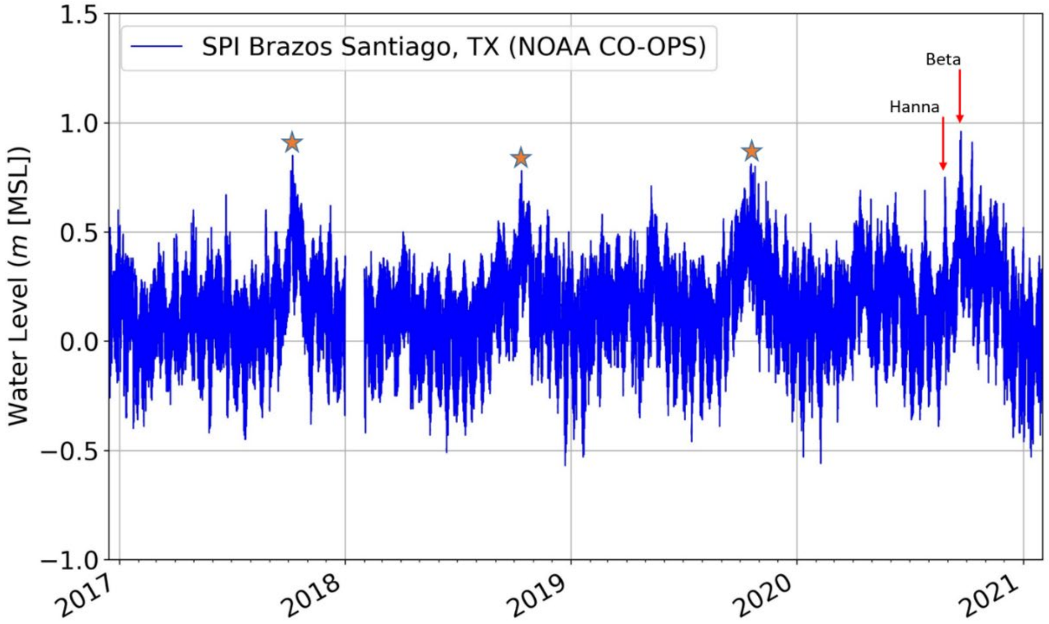


Figure 3-3. Water level data from a NOAA tide gage at Brazos Santiago Pass. The data time series appears to capture yearly astronomical high tides (orange stars) as well as storm surge from Hurricane Hanna and Tropical Storm Beta in 2020.

4 HISTORICAL BEACH AND DUNE PROFILES

Forty-five beach profile data sets spanning 27 years were downloaded and/or otherwise obtained for SPI from sources such as Shiner Moseley, the U.S. Army Corps of Engineers (USACE), Texas A&M, HDR, and Naismith. The beach profiles are perpendicular to the orientation of the shoreline (Figure 4-1), and extend across the primary dune, the beach, and offshore to water depths of 30–40 ft. All beach profile data sets were formatted for consistency, tested for quality assurance and quality control (QA/QC), and imported into ArcGIS for geospatial analysis. In analyzing the data, it became evident that the original surveys were conducted on a set of lines spaced approximately 1,000 ft (herein CBI profiles), located by a series of survey monuments, and repeated throughout the entire time series. However, in the mid-part of the time series, a new survey strategy was developed with more closely spaced profiles based on a linear distance from a starting point adjacent to Brazos Santiago Pass. Fortunately, the surveys also continued to include the CBI profiles, and this analysis focused on those 25 profiles that are consistent throughout the time series (Figure 4-1). In addition, as part of the present study, a survey conducted in June 2021 collected data on the 25 CBI profiles. In order to stay within the scope of the project, we filtered the data to analyze to nine survey dates, providing a time series of 25 years. Initially, we intended to include a June 2005 profile data set, but after detailed QA/QC, it was determined there were irreconcilable uncertainties in the data that suggested some type of offset or methodology error in the survey, and it was removed from the final analysis. The time series is provided in Table 4-1 and data were chosen to include historical representation (1995), and then approximately every 3–4 years unless a major storm occurred, in which we attempted to select data sets that would capture before- and after-storm conditions of the beaches and dunes. We also attempted to select surveys from approximately the same time of year so seasonal changes were less likely to bias the analysis.

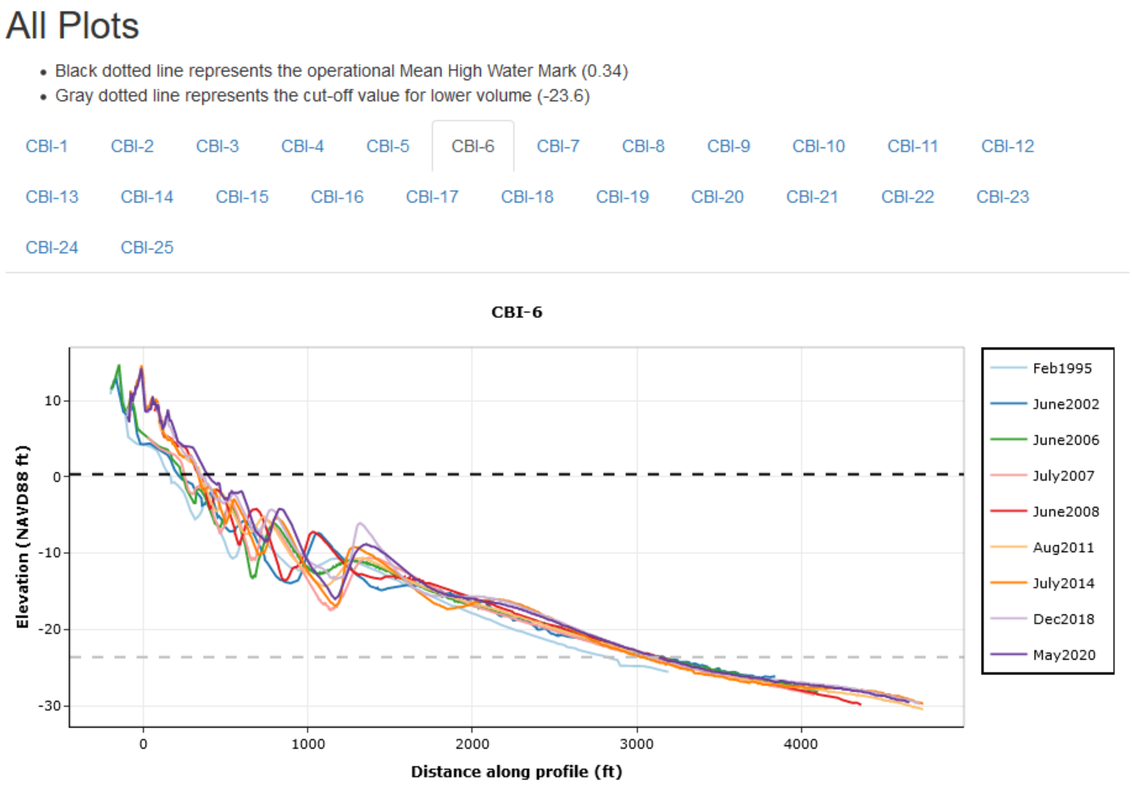
Table 4-1. Historical Beach Profile Data Obtained for Analysis

Survey Date	Surveyor
February 1995	Conrad Blucher Institute
June 2002	Texas A&M
~~June 2005~~	~~Shiner + Texas A&M~~
June 2006	HDR/Shiner Moseley/Frontier
July 2007	Terrasond
July 2008	Naismith
August 2011	Naismith
July 2014	Naismith
December 2018	Naismith
May 2020	Naismith

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 4-1. Location of 25 CBI profiles that were analyzed for the SPI beach and dune assessment project

To best view the profile data through time, an html-format viewer was created using code written in the statistical software package R, along with Plotly, which allows for visualization, analysis, and interpretation of the large data set (Figure 4-2). The viewer allows the user to visualize how the profiles change through both space and time by allowing each profile to be displayed individually or with other dates to see changes through time.



- Black dotted line represents the operational Mean High Water Mark (0.34)
- Gray dotted line represents the cut-off value for lower volume (-23.6)

Figure 4-2. Data viewer created based on beach profile time series for the 25 CBI profiles

An assessment of the overall morphology of the beach profiles at SPI reveals a relatively "typical" barrier island morphology—dunes and beaches are exposed sub-aerially and a well-formed and persistent offshore bar is present in the underwater portion of the beach profile. All beach profiles exhibit a double- or bar system with the exception of CBI-1 (Figure 4-3) and many have three offshore bars (Figure 4-4), the outermost of which is in water depths of 10 ft or greater, and varies considerably alongshore in its distance from the shoreline. The presence of multiple offshore bars is generally indicative of an ample sediment supply, although more commonly occurs in coastal systems with wide, dissipative beaches (Splinter et al. 2018), which does not describe SPI.

Analysis of the long-term (February 1995–May 2020; 25 year) beach profile change identifies that there is a dominant accretional trend in the 1-dimensional beach and dune profiles. Of the 25 profiles analyzed, only two are substantially farther landward in 2020 than they were in 1995: CBI-1 and CBI-2 at the very southern end of the island (Figure 4-3). This portion of the island has been substantially altered by human activities, associated with recreational facilities at Isla Blanca Park. The majority of the 25 profiles have shifted seaward (Figure 4-4) or exhibit negligible change over the 25 years covered by the study.

In general, the profile morphology tends to be much more highly variable through time and along the coast on the subaerial and shallow water (<15 ft) portion of the beach as the beaches and dunes are reworked by water, wind, and people (Figure 4-2).

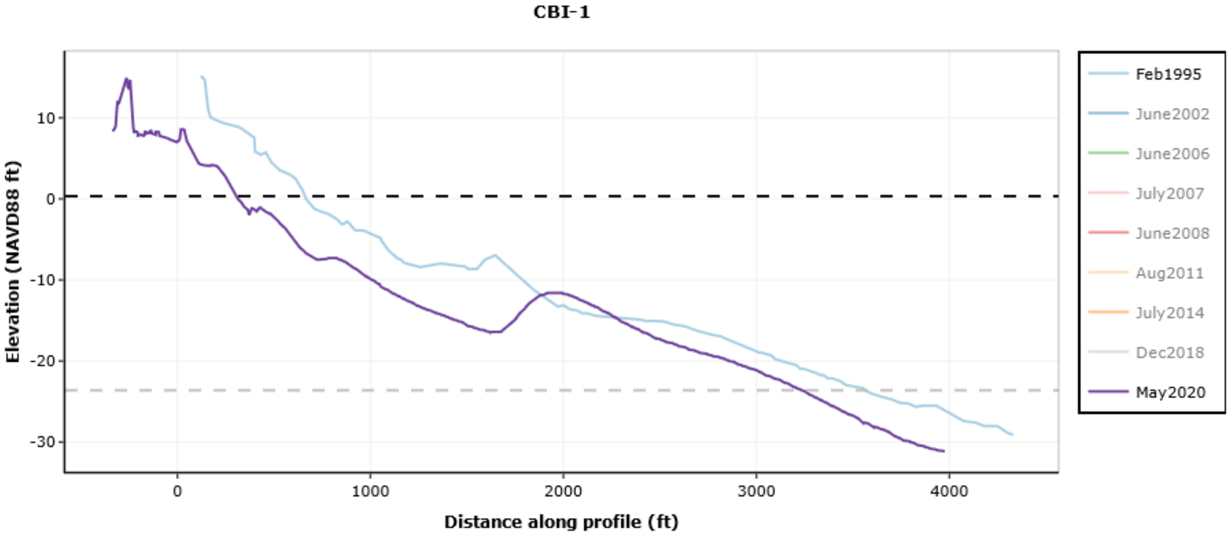


Figure 4-3. Profile change from 1995 to 2020 at profile CBI-1. This was one of 2 profiles that experienced systemic retreat, or landward movement.

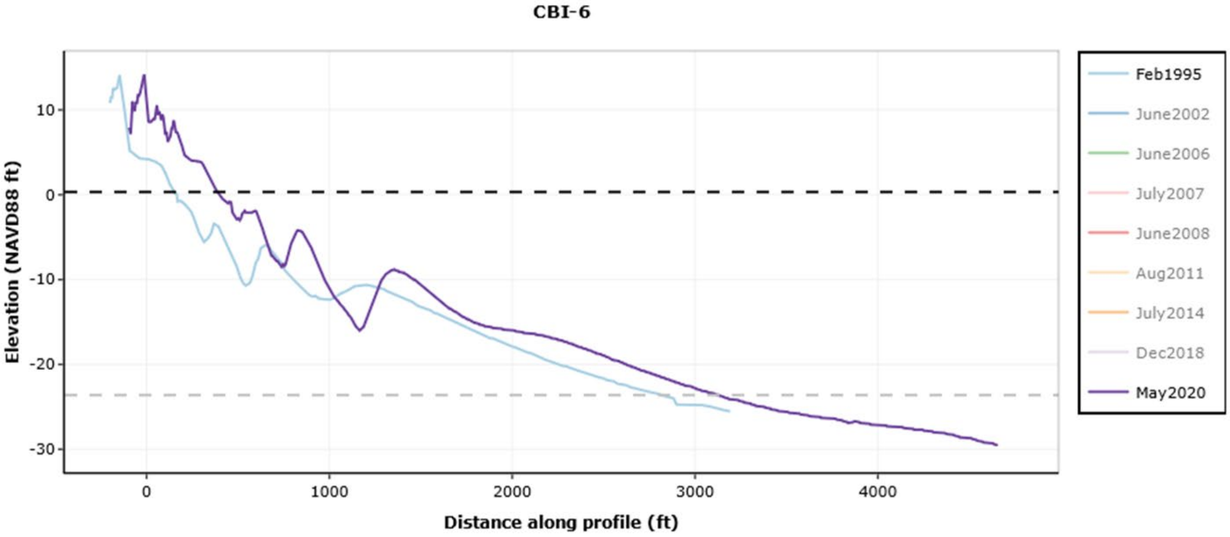


Figure 4-4. Morphologic change between 1995 and 2020 typical of the majority of profiles showing seawards progradation of the profile

5 SHORELINE CHANGE

Long-term shoreline change data were obtained from the Texas General Land Office Bureau of Economic Geology that were generated as part of an updated shoreline change assessment for the entire Texas coast from 1930–2019 (Paine and Caudle 2020). The rates were calculated using a long time series of shorelines dating from the 1930s, when they were digitized from historical maps, and include shorelines digitized from aerial imagery from a number of periods from the 1960s–2007. The most recent shorelines used in the study (2012 and 2019) were derived from airborne Lidar data. The analysis for this project refines the previous study by focusing in on patterns and trends of change only within the boundaries of the study area (the City of SPI), and rates were calculated on shore perpendicular transects spaced 164 ft (50 m) using a linear regression method. Figures 5-1 and 5-2 show the results for the entire study area for two time periods (1930s–2019 and 2000–2019) to provide a perspective on both long- and short-term shoreline change (CBI profile locations shown for reference, only). Larger-scale maps showing more detail of the results are provided in Appendices A and B.

The findings of the long-term (1930s–2019) shoreline change analysis (Figure 5-1) identify a distinct pattern, previously described by Morton (1993), of high rates of erosion in the northern portion of the study area (CBI profiles 17–25), generally stable in the central portion (CBI profiles 13–16), and primarily accretional in the southern section (CBI profiles 1–12; Figure 5-1). The averaged rate of shoreline change for the long-term (90 year) time period, across the entire study area, was accretional, +0.6 ft/year.

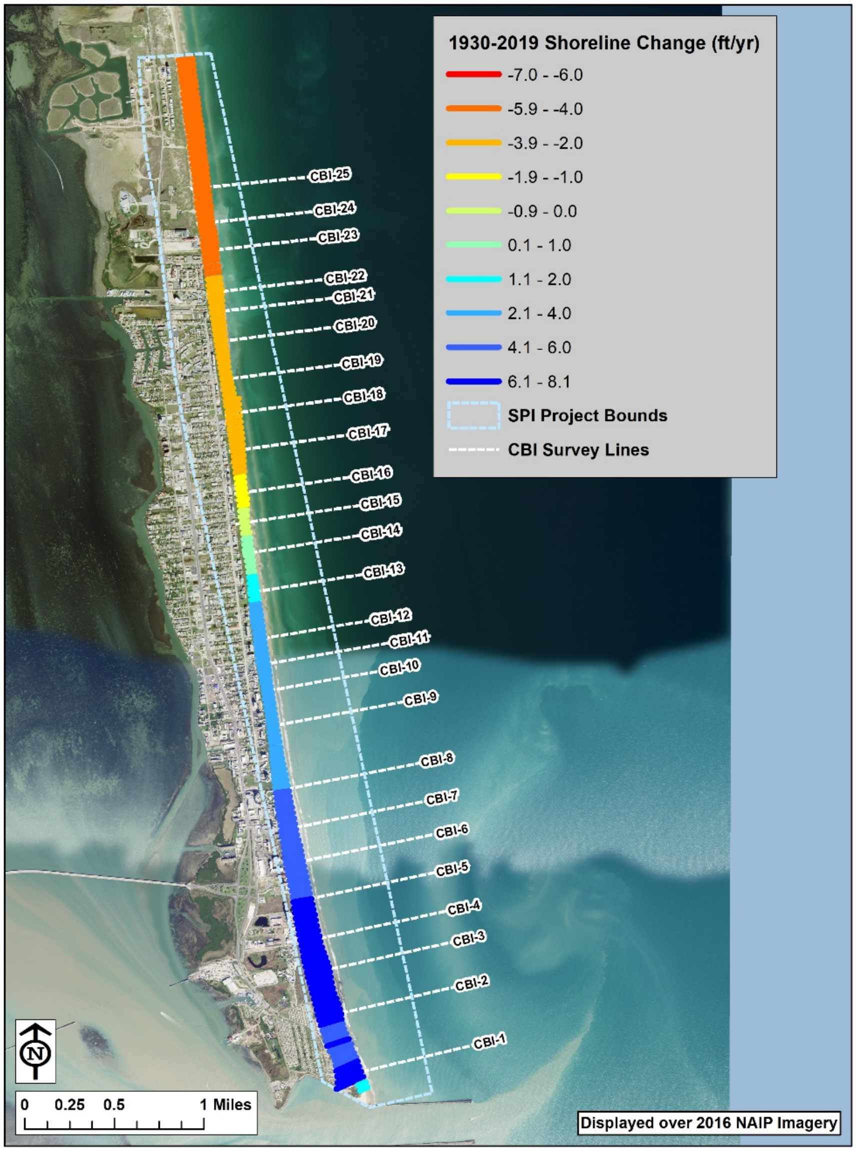


Figure 5-1. Long-term rates of shoreline change in feet/year from the 1930s to 2019

In the most recent two decades (2000–2019), the rates of change varied substantially more along coast (Figure 5-2 and Appendix B) compared to the long-term analysis. This difference in the shoreline change trends is a function of a number of factors: shorter-term data sets contain more noise, which is caused by changes from storm events, tides, seasonality, and human activities, such as beach nourishment. The occurrences, while present in longer-term data sets, tends to be smoothed over long periods of time. Between 2000-2019 at SPI there is no distinct pattern along coast; there is an erosion hotspot in the very northern portion of the study area (beyond the extent of the CBI profiles), where rates of retreat are as high as 6–7 ft/year in one location. Change rates modulate between erosion or accretion along much of the central portion of the island (CBI-9 to CBI-25) and an area of moderate erosion (-0.4 to -1.4 ft/year) occurs along the coast from CBI-5 to CBI-9. South of this erosional zone, the shoreline becomes primarily accretional to the inlet jetty.

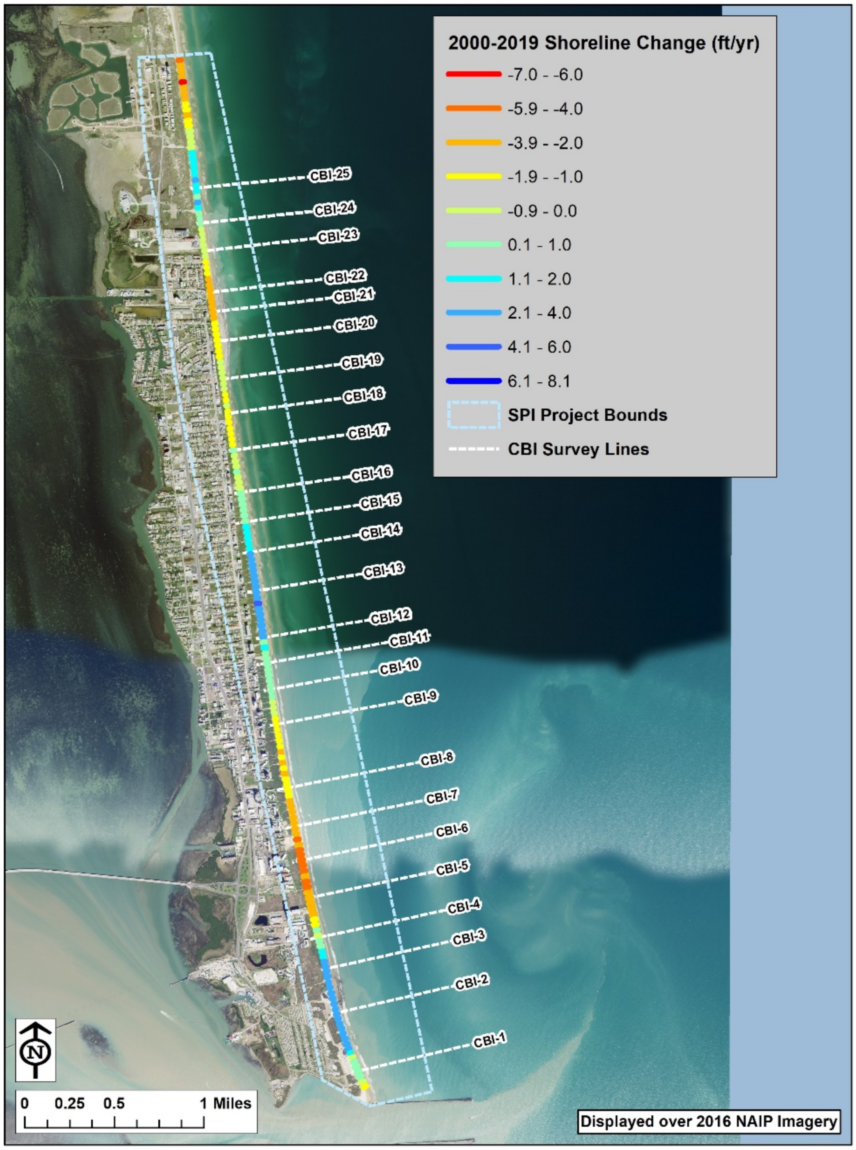


Figure 5-2. Short-term rates of shoreline change from 2000–2019

6 3-DIMENSIONAL ELEVATION CHANGE

To analyze very short-term changes to the topography of the entire beach-dune system, we obtained two Lidar data sets from 2016 and 2018. Both raster data sets have a cell size resolution of 3.28 ft (1 m), and were downloaded from NOAA's Digital Coast website (https://coast.noaa.gov/digitalcoast/data/). The USACE, as part of its National Coastal Mapping Program, collected the 2016 data and the 2018 data were contracted by the U.S. Geological Survey (USGS). The data were imported into ArcGIS and a standard raster subtraction was applied to create a map of the changes in elevation between the two time periods.

Along the length of the island, the pattern of change is generally vertical accretion of the dunes, especially at the seaward edge of the dune field, and appears to be related dune construction associated with beach nourishment (Figures 6-1 to 6-3 and Appendix C). There was onshore placement of sand in October 2016, several months following the 2016 Lidar data collection, which increased the sediment volume of the beach and dune system. The consistent elevation increase across the dune field could be attributable to a number of factors, including aeolian transport of sand from the beaches to the dunes (the persistent wind direction at SPI is out of the east-southeast), and increases in vegetation canopy height if the Lidar data did not reach bare earth. The fact that the constructed dunes are still largely intact two years after the beach nourishment project is testament that nourishment is successful in maintaining a healthy dune system. The established dune vegetation-planting program also helps to maintain the dunes.

Also persistent along much of the study area is elevation loss of the lower beach, with evidence of scarping at or near the swash zone, shown by the abrupt change from blue (accretion) to red (erosion) (e.g., CBI-23 and CBI-24; Figure 6-1). The beach erosion is persistently higher in the northern section of the island (Figure 6-1) from CBI profiles 21 to 25 and the area north of CBI-25. The severity of the beach erosion decreases to the south (Figures 6-2 and 6-3), and there are a few locations where the beach experienced some accretion, such as CBI-2 and CBI-5 (Figure 6-3), and CBI profiles 13–15, and 19 (Figure 6-2). The extreme values of some of the high erosion areas, as much as 6 ft of vertical loss, is suggestive of extreme storm erosion and scarping, and likely represents the erosion caused by Hurricane Harvey, which occurred in late August of 2017, approximately six months prior to the date the 2018 Lidar data were collected (March 2018). Slow recovery of a beach system from a major storm event is also exacerbated by regular winter storms, which would be expected in the months prior to the March 2018 data collection.

There is indication of increased elevation of the mid- and upper portion of the beach, which is consistent with some landward deposition of sediment on the upper beach during storm events. The highest areas of accretion occur at the toe of the dunes (e.g., CBI-14), and could be the result of landward transportation and deposition of material from the lower to the upper beach during storms, aeolian transport, or beach nourishment.

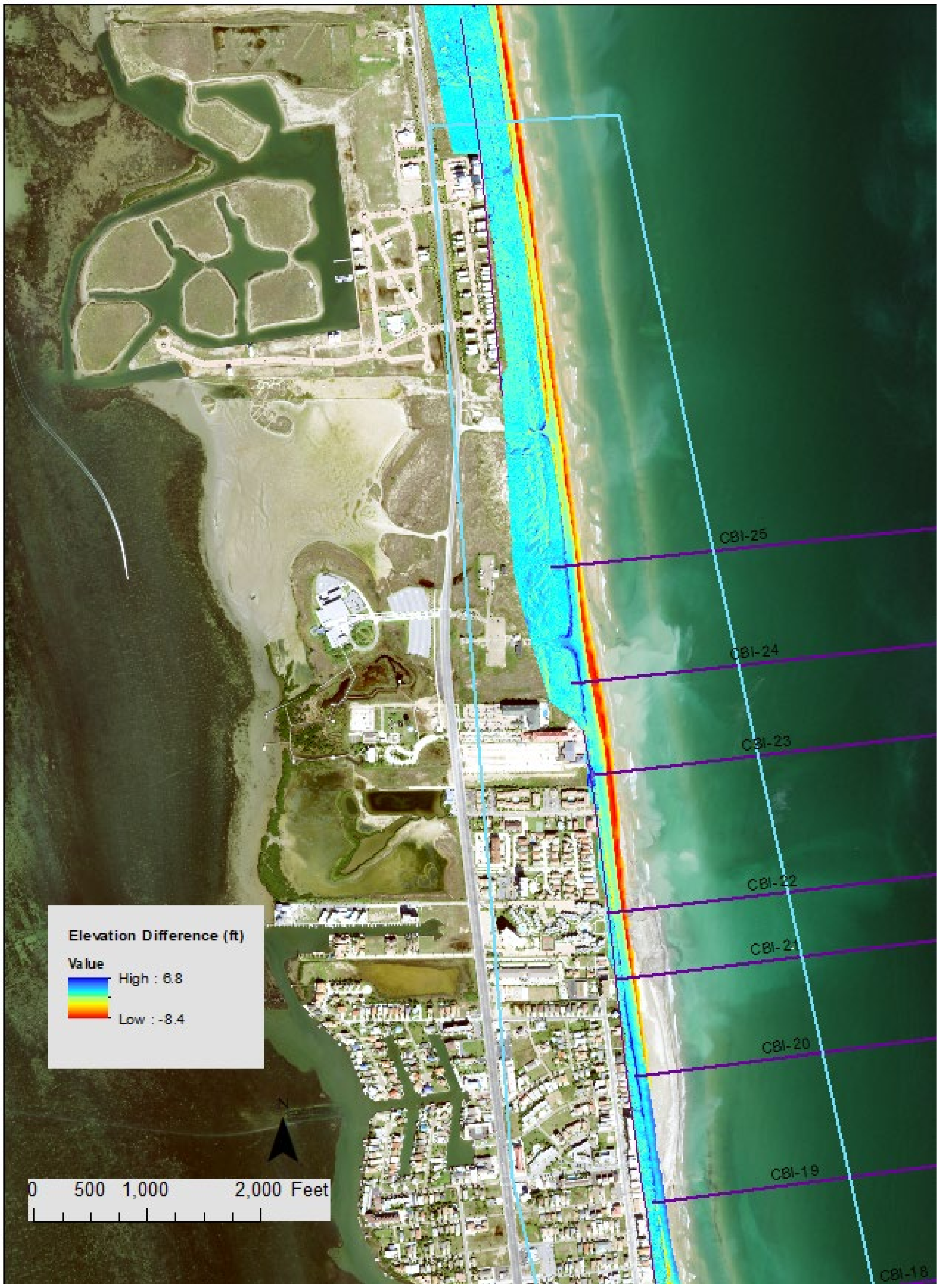


Figure 6-1. Topographic difference map between 2016 and 2018 of the northern portion of the study area including the locations of the CBI profiles for reference

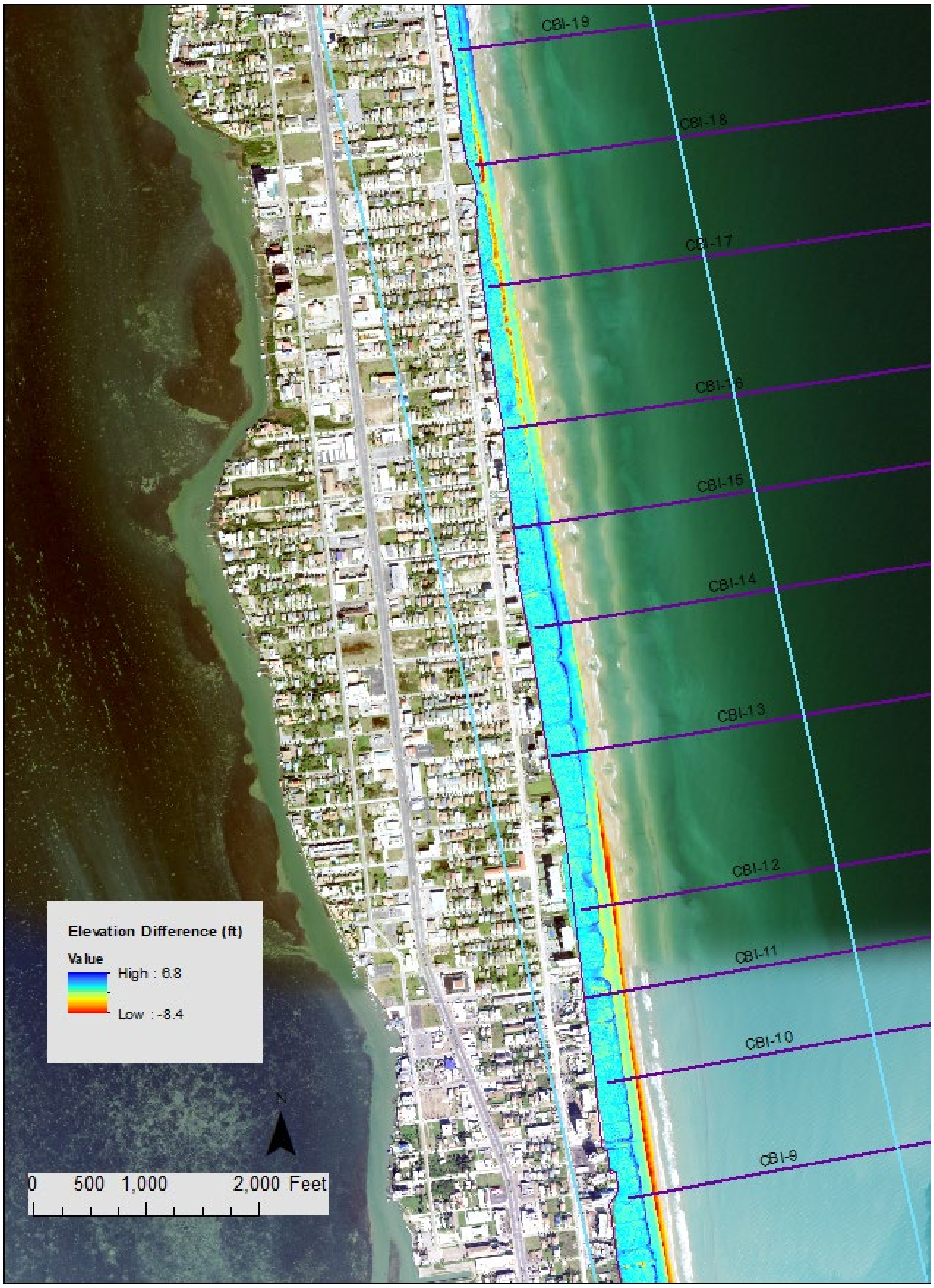


Figure 6-2. Topographic difference map between 2016 and 2018 of the central portion of the study area including the locations of the CBI profiles for reference

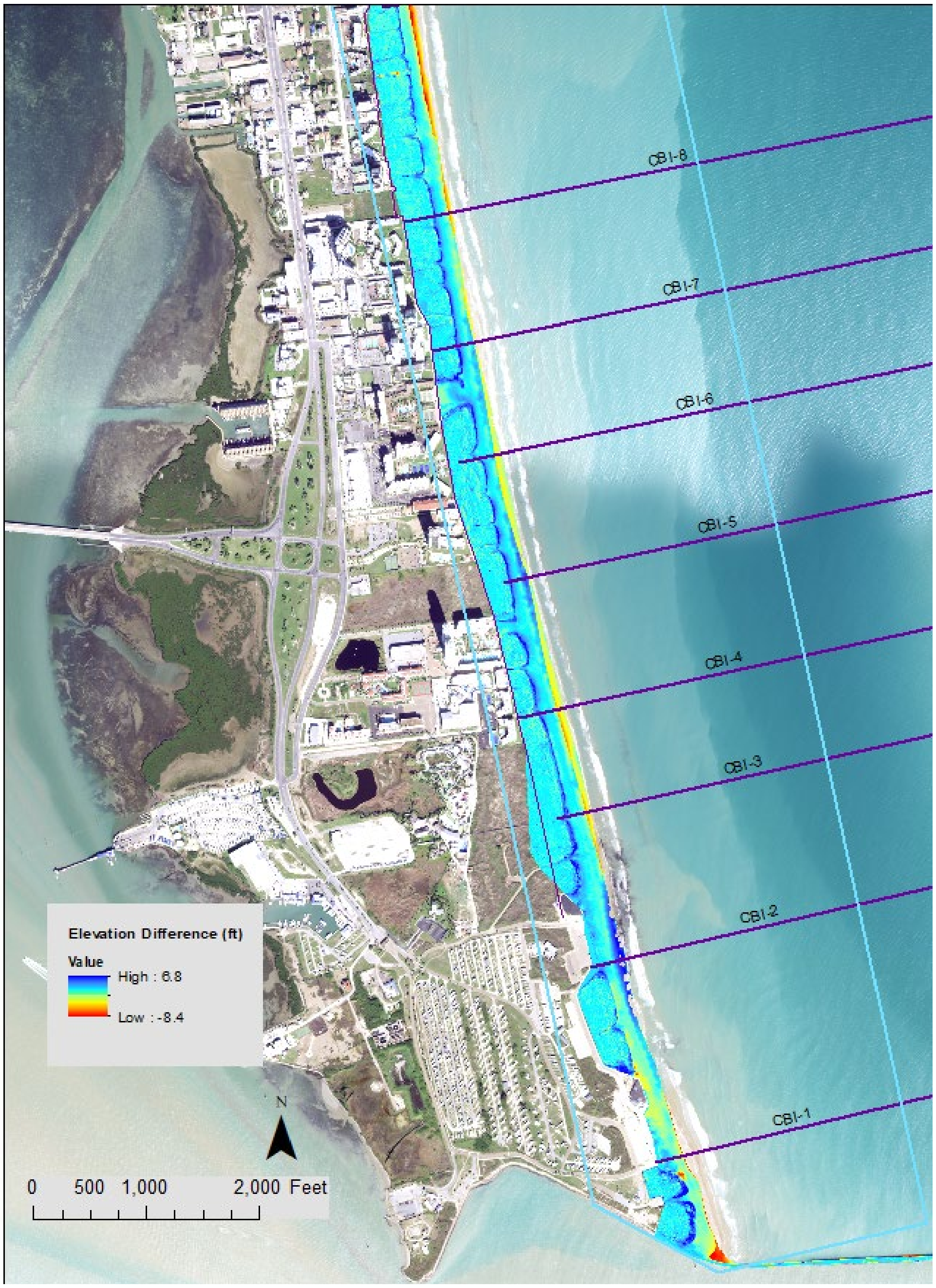
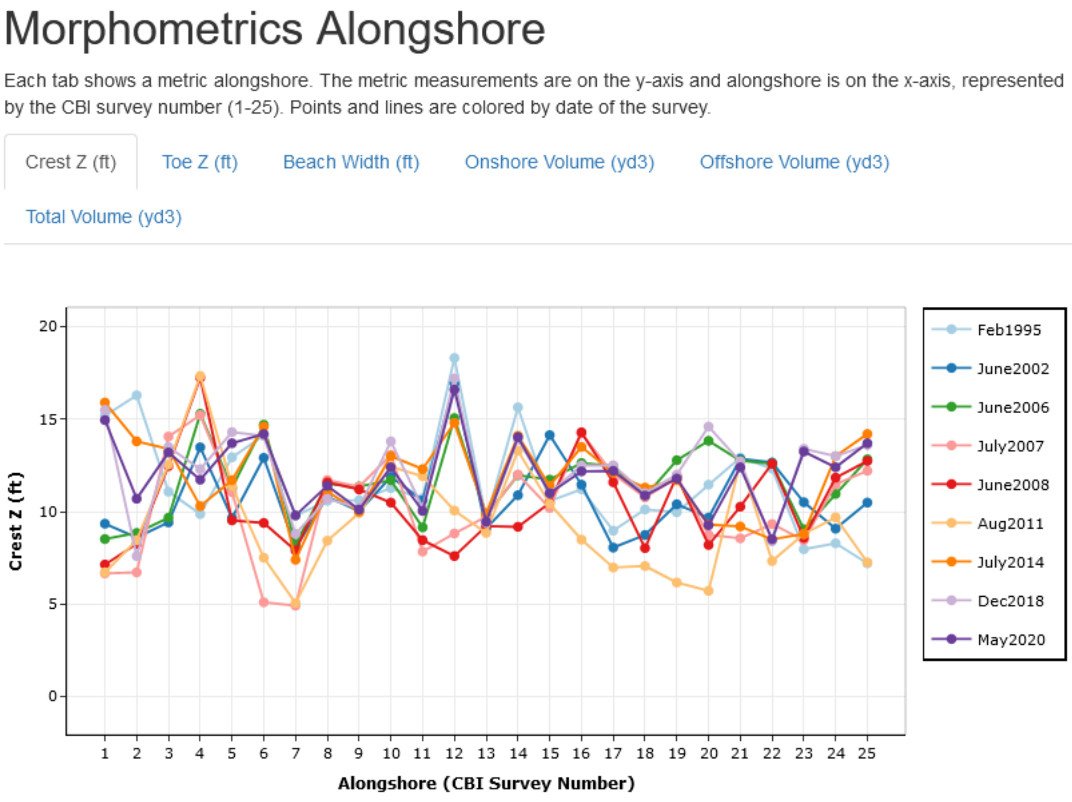


Figure 6-3. Topographic difference map between 2016 and 2018 of the southern portion of the study area including the locations of the CBI profiles for reference

7 MORPHOMETRIC CHANGES

A variety of metrics that describe changes to the morphology of the beach and dunes through both time and space were identified and extracted from the time series of the 25 CBI profiles. Metrics include dune crest and dune toe elevations, beach width, and profile volumes. The open-source tool, PyBeach (https://github.com/TomasBeuzen/pybeach), was run on the entire time series to extract the dune crest, dune toe, and a shoreline position. The beach width was subsequently calculated in Excel by determining the distance between the shoreline and the dune toe. The beach volumes (onshore, offshore, and total) were calculated using a trapezoid method available in the Python numerical library, Numpy (https://numpy.org/doc/stable/reference/generated/numpy.trapz.html).

Similar to the profile data visualization, an html-format viewer was created using code written using the statistical software package R, along with Plotly, to allow for visualization, analysis and interpretation of the morphometric data set (Figure 7-1 shows the dune crest elevation).



Morphometrics Alongshore

Each tab shows a metric alongshore. The metric measurements are on the y-axis and alongshore is on the x-axis, represented by the CBI survey number (1-25). Points and lines are colored by date of the survey.

Figure 7-1. Data viewer created based on morphometrics extracted from the 25 CBI profiles for the nine survey dates selected for analysis

7.1 DUNE CREST

The first part of the analysis focuses on how the dune crest changes during the earlier portion of the time series, from 1995 to 2007. Figure 7-2 shows the alongshore variation in the dune crest elevations over 12 years. Although variable in space and time as expected on a dynamic beach-dune system, the elevations followed similar trends from 1995–2006, but in 2007 there was overall more sustained elevation loss. The exception in general consistency from 1995 to 2006 are several profile locations in the southern portion of the study area (Figure 7-1; CBI-1 and CBI-2) when there are large, sustained losses post-1995. This can be attributed to human activities associated with facilities at Isla Blanca Park. In general, the crest elevations are lower in 2011 than in the previous time periods, with an alongshore average elevation of 9.4 ft. Over the rest of the time series the averaged dune elevations ranged from 10.3 – 12.4 ft. The overall loss in 2007 does not appear to correlate with significant storm events, but could be remnants of overall system sediment losses from the back-to-back major storms, Hurricanes Katrina and Rita, in 2005. This is not atypical in other investigations of frequent, extreme storms disrupting barrier island equilibrium (Hapke et al. 2016) where it can take as much of a decade for the system to fully recover.. The storm impacts are not reflected in the 2006 survey however, which may be due to nourishment following the events.

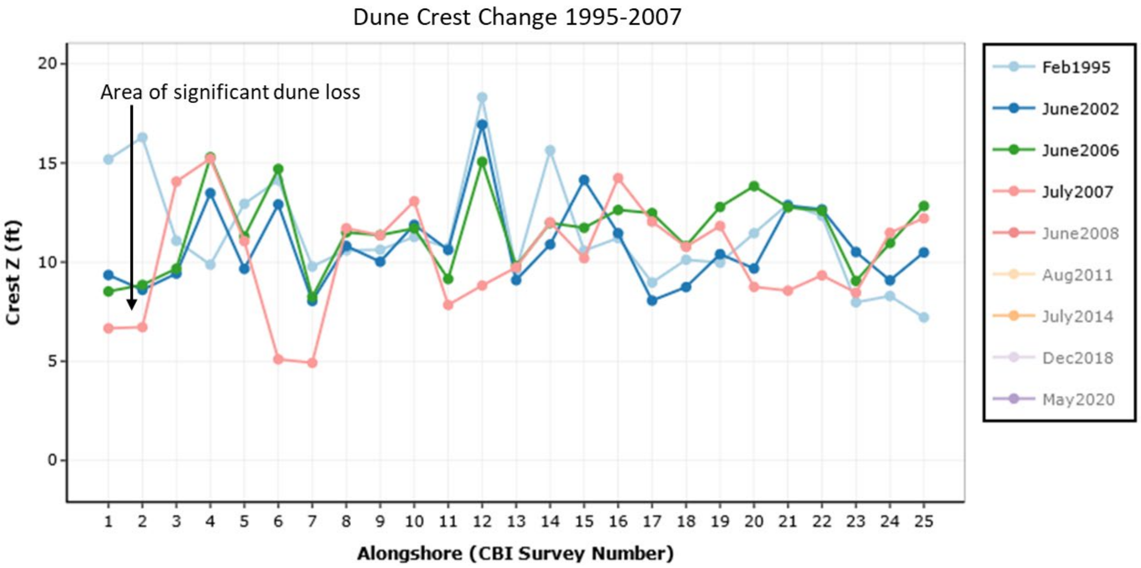


Figure 7-2. Dune crest elevations for the earlier portion of the time series from 1995–2007

In the latter part of the time series, the dune crest elevations are generally lower in the earlier two years (Figure 7-3), with 2011 being the lowest average crest elevation of the entire time series (average 9.4 ft). Figure 7-3 does not include all data from 2007 to 2020 for clarity. A number of tropical storms occurred between 2008 and 2011, including Dolly and Ike in 2008.

Both Dolly and Ike occurred after the 2008 survey was collected, so storm impacts would not be expected to be reflected in the 2008 data set.

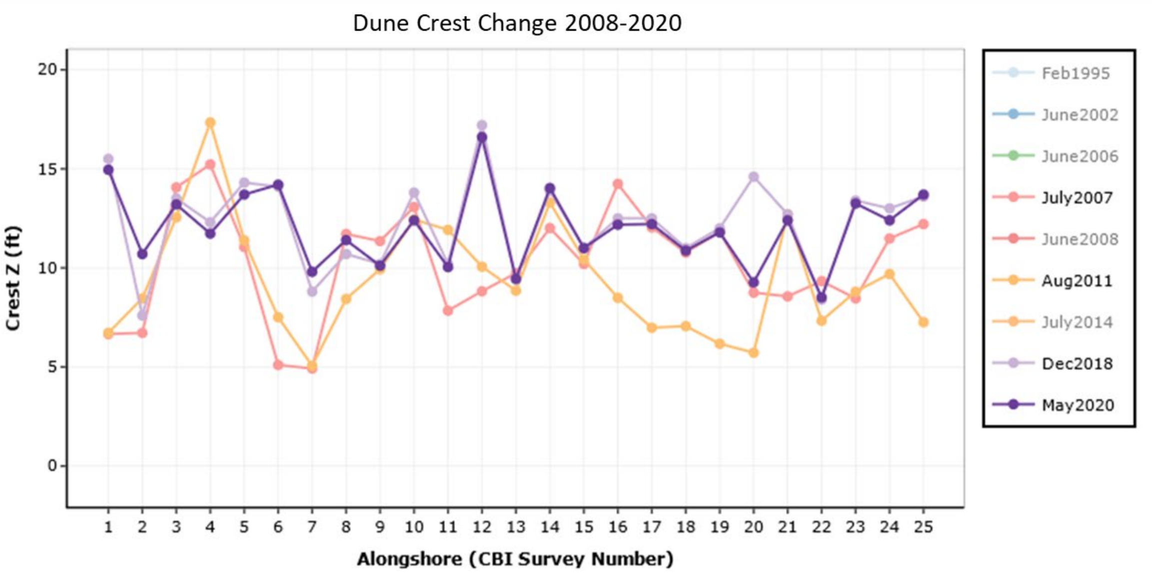


Figure 7-3. Dune crest elevations for the earlier portion of the time series from 2007–2020. The 2008 and 2014 data are not shown for clarity of the data trends.

7.2 DUNE TOE

The dune toe elevation is variable alongshore, and a comparison of the elevation for the earliest and most recent dates, 1995 and 2020, underscores the alongshore variability. However, outside of several outliers, the dune toe elevation over time is relatively stable (Figure 7-4) with a mean of 7 ft. The lowest overall elevation in the time series occurred in 2008 when the averaged alongshore elevation dropped to 5.8 ft.

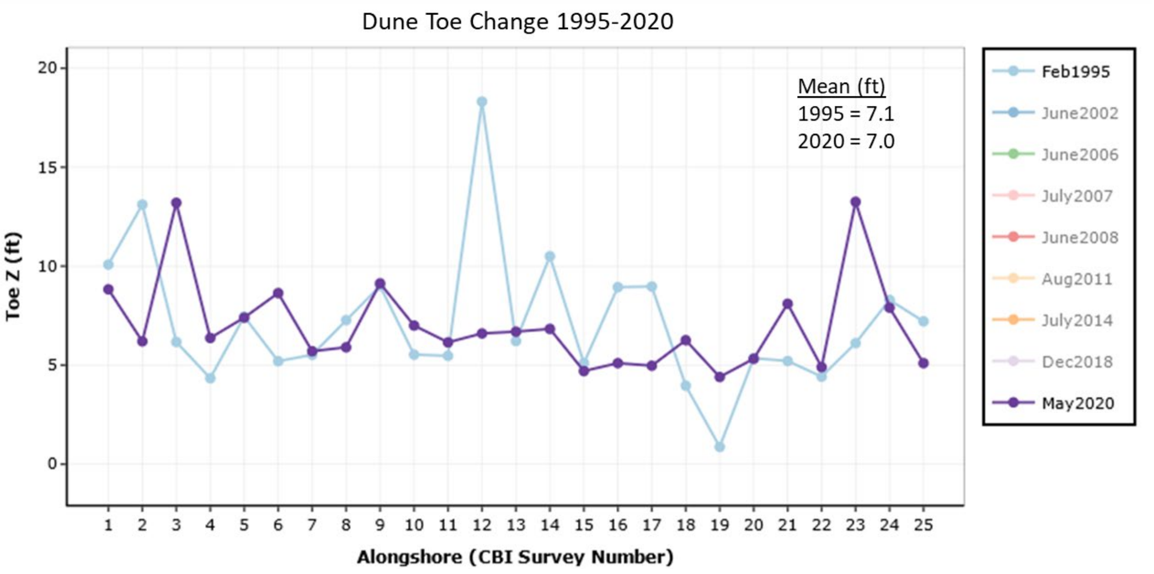


Figure 7-4. Alongshore dune toe elevations for 1995 and 2020

7.3 BEACH WIDTH

Beach width and dune crest elevation are the two metrics most likely to influence how resilient a system will be to impact from event-driven change. Beach width is perhaps the most highly variable morphometric because it is the portion of the beach regularly affected by waves, tides, currents, seasonality, and human activities. For beach width at SPI, three dates of the time series are shown to highlight the substantial alongshore variation (Figure 7-5). In some cases, there is a reverse correlation wherein profiles with wide beaches in 2002 had narrow beaches in 2020 (e.g., CBI-7 and CBI-8). In other locations, the widths are similar for all three time periods. Large variations like these can be attributed to natural processes, sometimes in the formation of beach cusps in which the beach forms regularly spaced embayments and promontories in the alongshore directions, as well as human activities such as beach nourishment. Statistically, the average alongshore beach width captured in the time series was largest in 1995, and remained closer to 200 ft through 2002–2020.

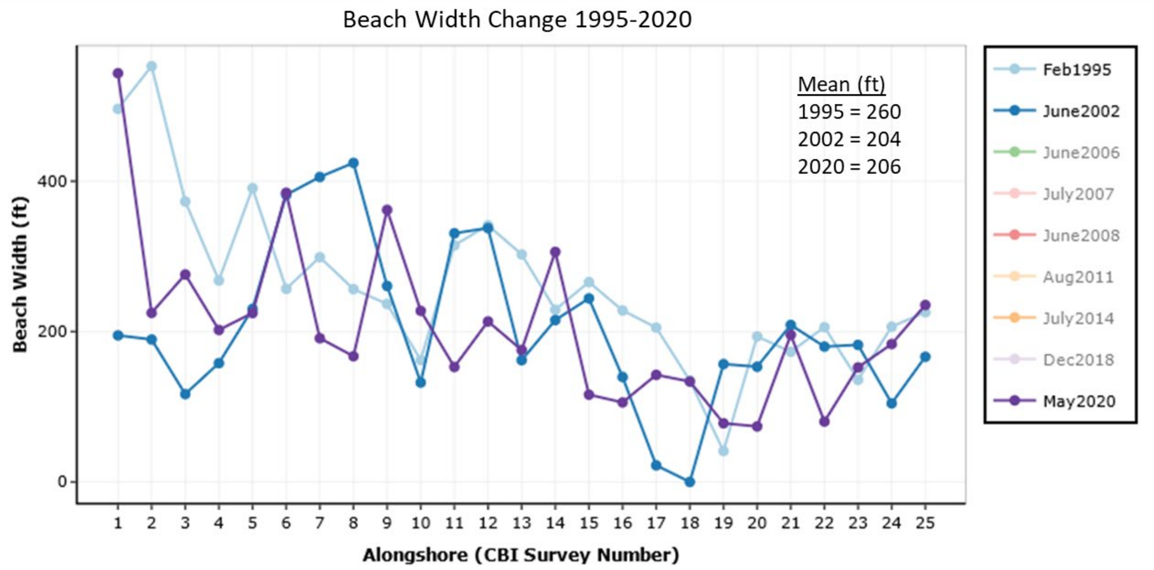


Figure 7-5. Beach width variations alongshore and over time

7.4 PROFILE VOLUMES

The final metrics examined for the characterization of the beach-dune system at SPI are the profile volumes. Volumes were quantified for the total profile volume and separately for the onshore and offshore portions of each profile. A baseline elevation offshore was established for the measurement of volume (Figure 7-6) and is the depth to which all profiles in the time series were surveyed. Many profiles extended deeper, but the baseline elevation was used to maintain consistency in the volumetric calculations. The offshore volume was calculated as the square-foot area beneath the profile, above the baseline elevation and to the vertical extension of the operational mean high water times a standard width of 1 ft. The operational mean high water is a datum established by the USGS (Weber et al. 2005), which represents a locally determined mean high water for the region that includes SPI. The onshore volume is calculated as the square-foot area beneath the profile, above the operational mean high water to the building line established by the City of SPI times the standard 1-ft width (Figure 7-6). The resulting volumes (in cubic feet) were then converted to cubic yards to align with industry standard reporting.

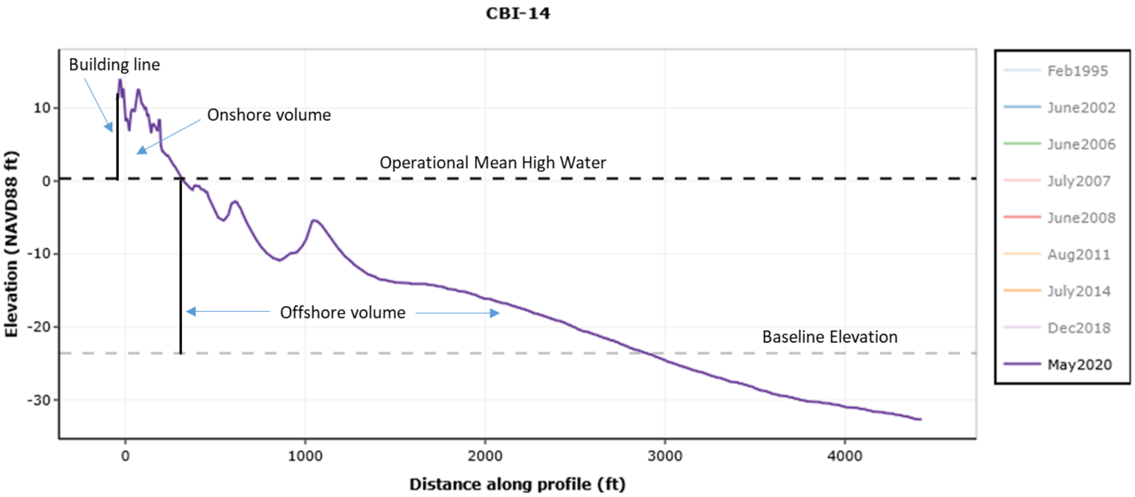


Figure 7-6. Example profile with explanation of how the onshore and offshore profile volumes were determined

The volume profiles do not include CBI-1, CBI-2, CBI-24, and CBI-25 because there is no building line in these areas (Isla Blanca Park and the undeveloped northernmost section of the study area). As with the majority of the morphometrics, the profile volumes are highly variable (Figure 7-7). Note that the vertical axes are different in the two profiles shown in Figures 7-7, and that the offshore profiles have much higher volumes than the onshore profiles. This is a function of the larger area measured for the offshore volumes. The onshore profile volumes have some consistent patterns (Figure 7-7a): greater sustained volumes in the south and central portions of the profile, and a distinct shift to increased volume in more recent times, beginning in 2014. The offshore volumes do not have a consistent temporal trend (Figure 7-7b), but there is a trend towards lower volumes in the central portion of the study area (~CBI-10 to CBI-16).

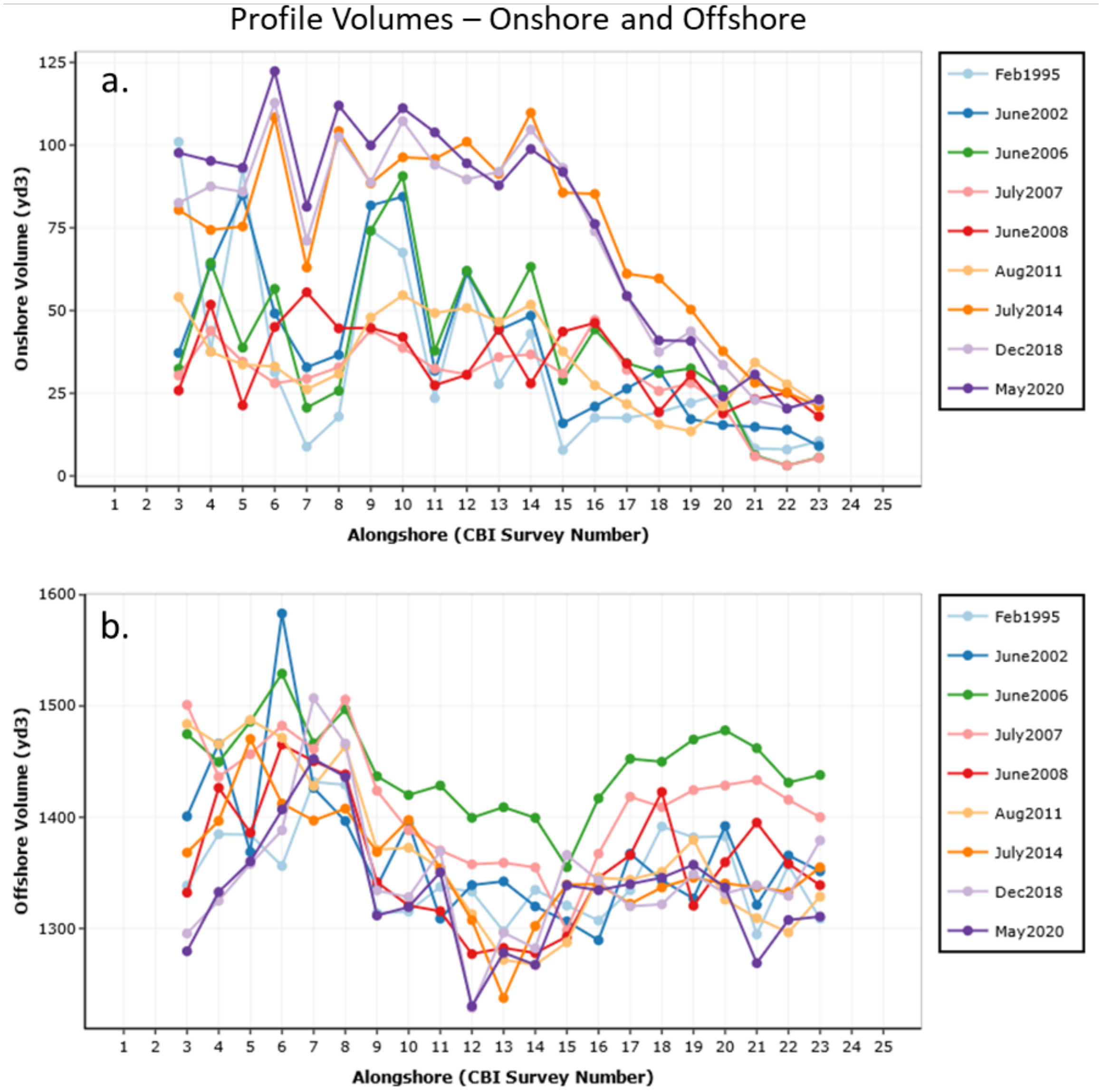


Figure 7-7. Full time series of volumes alongshore for the onshore (a) and offshore (b) portions of the CBI profiles

To gain perspective on historical change and present state of the profile volumes, the data for only the long term, 1995 and 2020, were evaluated (Figure 7-8). As was noted for the full time series discussion, the onshore profile volumes (Figure 7-8a) have a sustained greater volume in 2020 than in the earlier period, likely due to the robust beach nourishment, and dune building and planting programs. The trend towards low volumes to the north is persistent and as a result, this portion of SPI is more vulnerable to coastal hazards. The offshore volume, while spatially variable, has remained relatively stable over the 25-year period of the analysis.

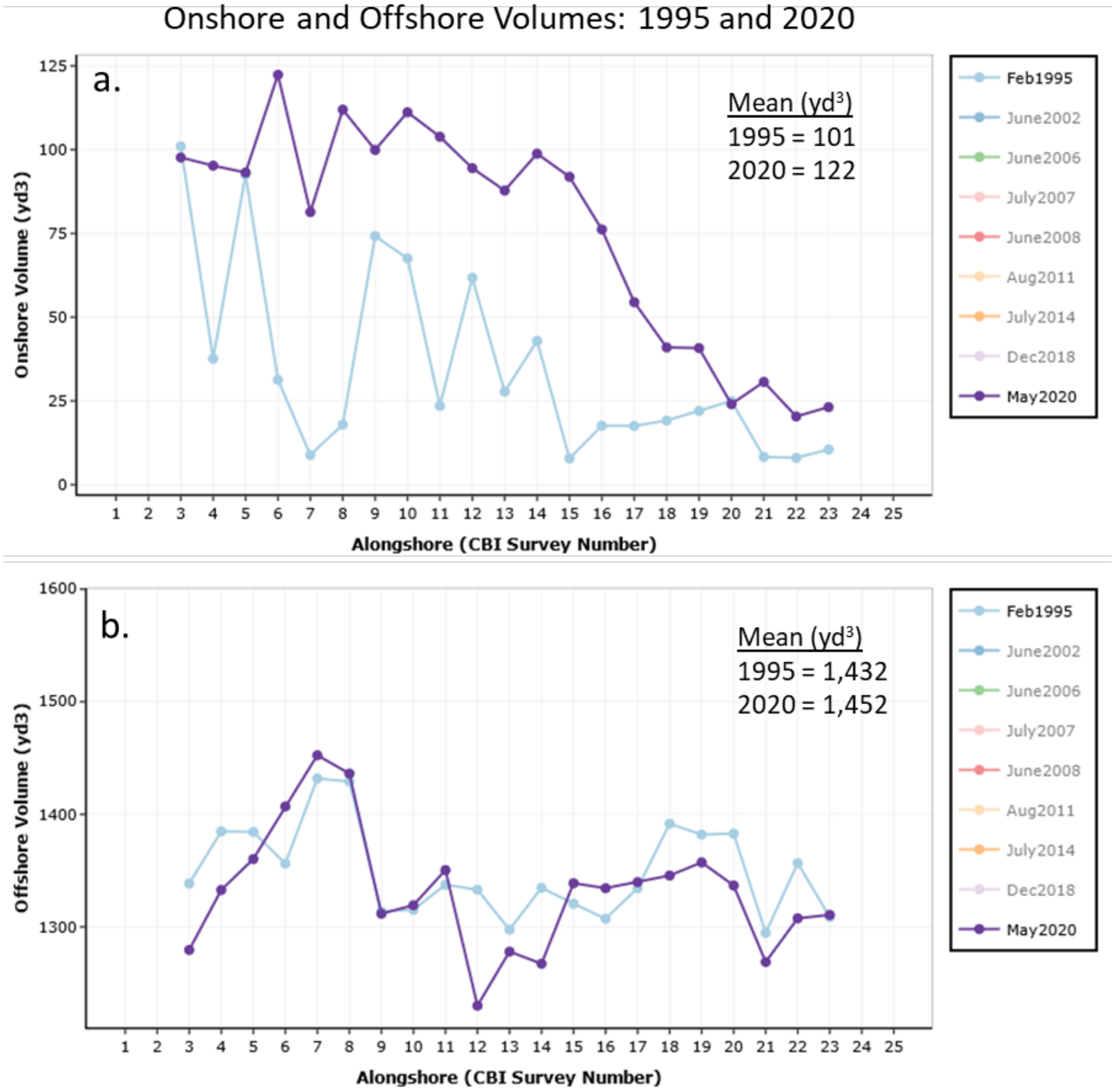


Figure 7-8. Alongshore volumes for 1995 and 2020 for the onshore (a) and offshore (b) portions of the profiles

8 VEGETATION LINE

Vegetation lines were digitized from 2002, 2007, 2016, and 2020 from available aerial photography. The 2020 line only extends along the southern and central portions of the study area to between CBI-17 and CBI-18 (Figure 8-1) due to the limited extent of the 2020 aerial imagery. The remaining three dates cover the entirety of SPI, providing a time series of 14 years. The vegetation lines were visually interpreted as the seaward-most boundary between identifiable dune vegetation and sand. Large-scale spatial series of the vegetation line maps for the entire study are provided in Appendix D for a more detailed perspective of the changes, and several key findings are discussed below.

In 2002, the vegetation line is consistently landward as compared to the later years; thus, the vegetated dune area is much narrower and closer to the building line than in the more recent years. In some locations, for example between CBI-18 to CBI--20, the vegetation line is right up against the buildings or is nonexistent (Figure 8-1). Between 2002 and 2007, the vegetation line propagated significantly seaward, resulting in a more robust, wider vegetated dune field. The vegetated dune width from 2002 to 2020 was measured as the distance from the building line to the vegetation line, in areas where they both exist (e.g., at certain CBIs, no vegetation was present) (Figure 8-2). The dune field width on average doubled over that time period due to a substantial effort after the 2008 Hurricanes Dolly and Ike to not only build and protect the beach and dunes, but to develop a rigorous planting effort, adding thousands of specialty native dune plants to help stabilize the dune field (City of South Padre Island 2012). These efforts have clearly had a major impact in holding the dune line and providing the City and oceanfront property added protection in the form of a healthy, wide dune field.

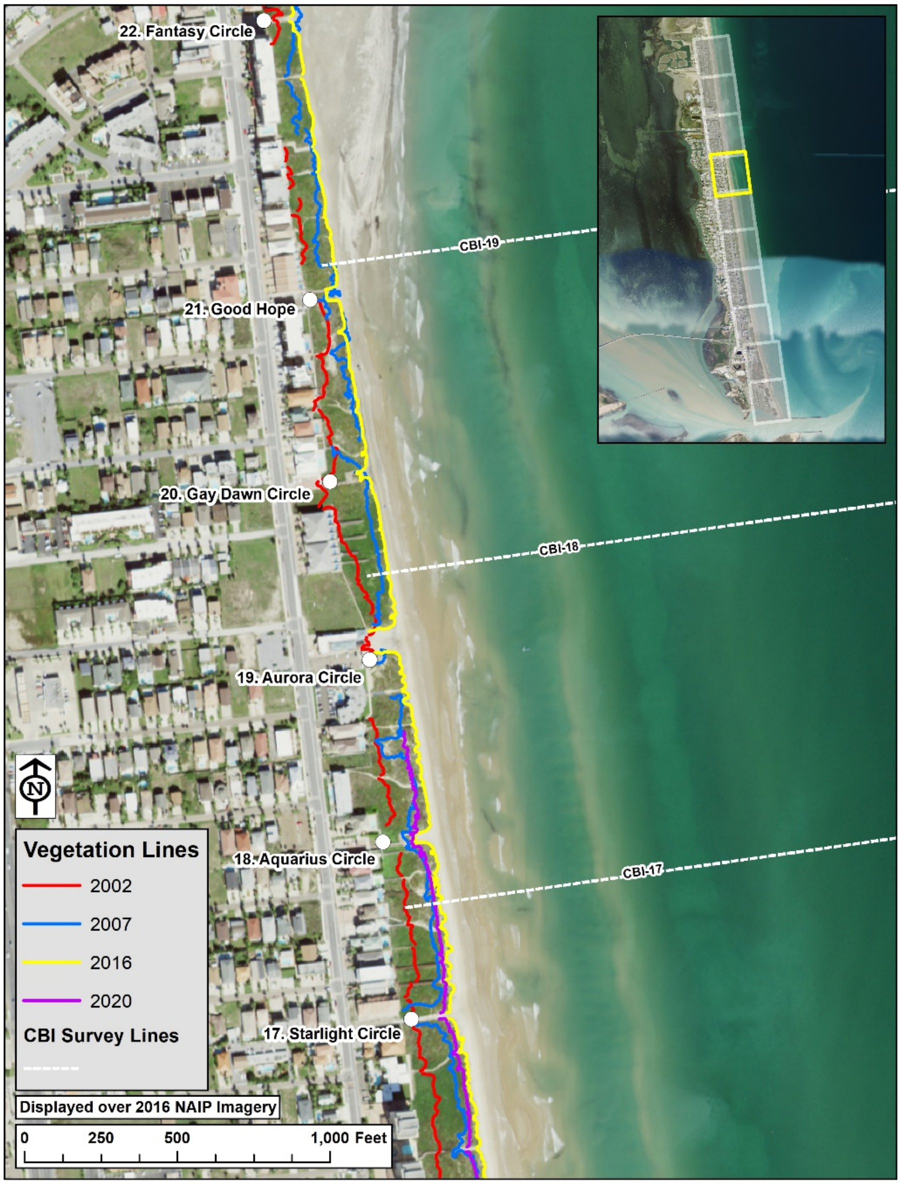


Figure 8-1. A north-central section map showing vegetation lines from 2002–2020. Note the 2020 line ends between CBI-17 and CBI-18. This map is also provided at full scale in Appendix D. The dots and numbered place names are the names of beach access locations at SPI.

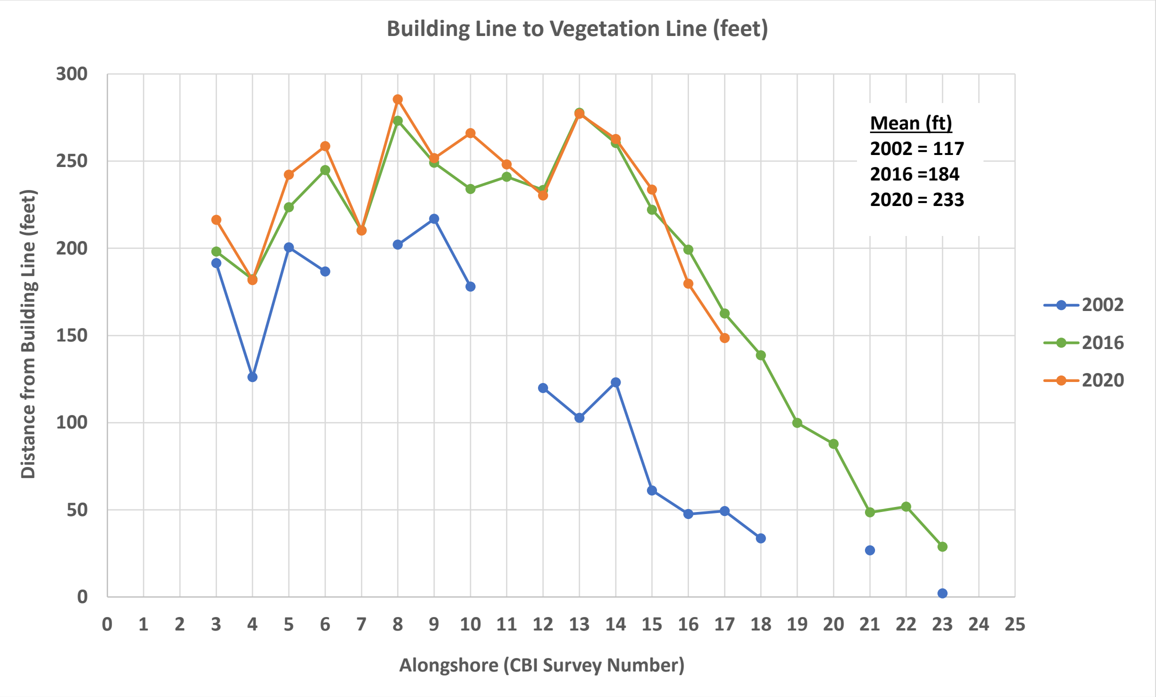


Figure 8-2. Alongshore width of dune field as measured between the vegetation line and the SPI building line for 2002, 2016, and 2020

9 SUMMARY AND CURRENT STATE

One of the primary objectives of Phase 1 of the beaches and dunes project is to present an evaluation of the current state of the coastal system. To accomplish this objective, plots of summary statistics of the various morphometrics through time were created to show the current state relative to the historical. The analysis considers not only the current state based on the morphometrics, but also includes the shoreline, vegetation, and elevation change components of the study.

The average dune crest and toe changes through time are shown in Figure 9-1. The crest and toe do vary through time, but overall oscillate only slightly. There is a general trend of elevation increase in the more recent time periods starting in 2014. Although there is a slight decrease in both metrics between 2018 and 2020, overall the frontal dune appears relatively robust and the summer 2021 nourishment will provide material to sustain the dunes. In addition to the frontal dune elevation, the width of the dune field is important in considering the resiliency of the system. The alongshore vegetation line series in Appendix D shows much of the dune field has gained substantially in width in the time period between 2002 and 2020 due to an earnest dune rebuilding and replanting program by the City of SPI. There are locations, however, especially concentrated in the northern section of the study area, where the dune field is very narrow or non-existent. These areas, as well as the numerous beach access points, are highly vulnerable to storm waves, which further exacerbate existing erosion issues.

The dune crest elevation, dune field width, and beach width are the three metrics most likely to influence how resilient a system will be to impact from event-driven change. The current (2020) width of the beach is healthy compared to the extreme low in 2007, although it has narrowed slightly since 2018 (Figure 9-2). As with the dunes, the summer 2021 beach nourishment project will likely help keep the beach width stabilized.

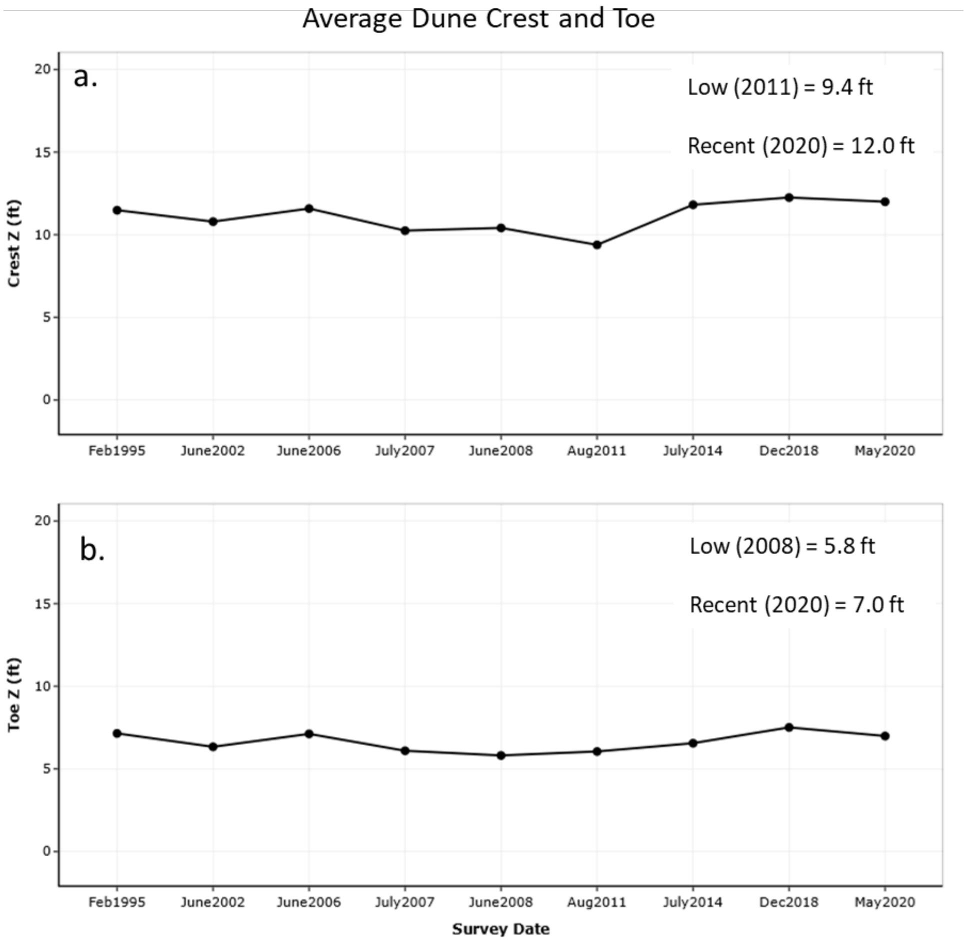


Figure 9-1. Averaged dune crest (a) and dune toe (b) elevations through time showing both the time series (averaged) low and the current state of each feature

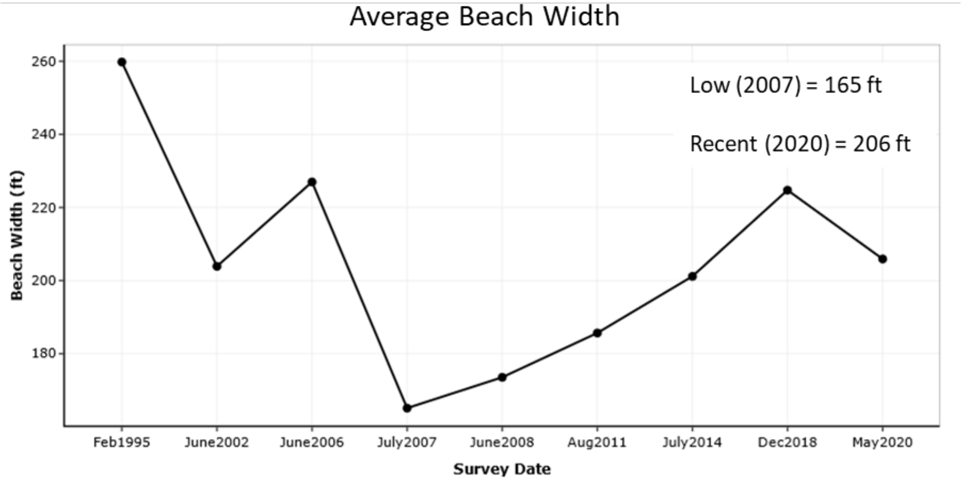


Figure 9-2. Averaged beach width through time showing both the time series (averaged) low and the current state of the beach

The shoreline change analysis shows that in more recent times the shoreline is fluctuating both spatially and temporally (Appendices A and B). Continued regular beach nourishment will likely address localized erosion hotspots when they occur and the shoreline position should remain, although it will always be impacted by wave events. The elevation difference maps of the short-term (2 year) indicate that storm influences include significant scarping of the beach. However, if the beach width and dune elevations are maintained, sustained erosion can be limited for the most part to the lower beach, except in response to yearly winter storms, from which the profile generally recovers.

Changes to the volume of a beach system reflect variations in sediment availability that influence beach and dune changes over longer time periods than changes to the dunes, shoreline, and beach width. The onshore versus offshore volume changes through time are interestingly opposite through time (Figure 9-3). The onshore volume was low until 2014 where it increased significantly, and then even further in 2020. The increase can likely be attributed to the regular nourishment program, but the beach also may be experiencing influx from the offshore, given that despite offshore sand placements in 2018, 2019, and 2020, the volume of the offshore profile has been decreasing, and is currently (2020) in its lowest state in the time series. Further investigation and monitoring of this phenomenon is recommended to evaluate where and why the loss of sediment in the offshore is occurring.

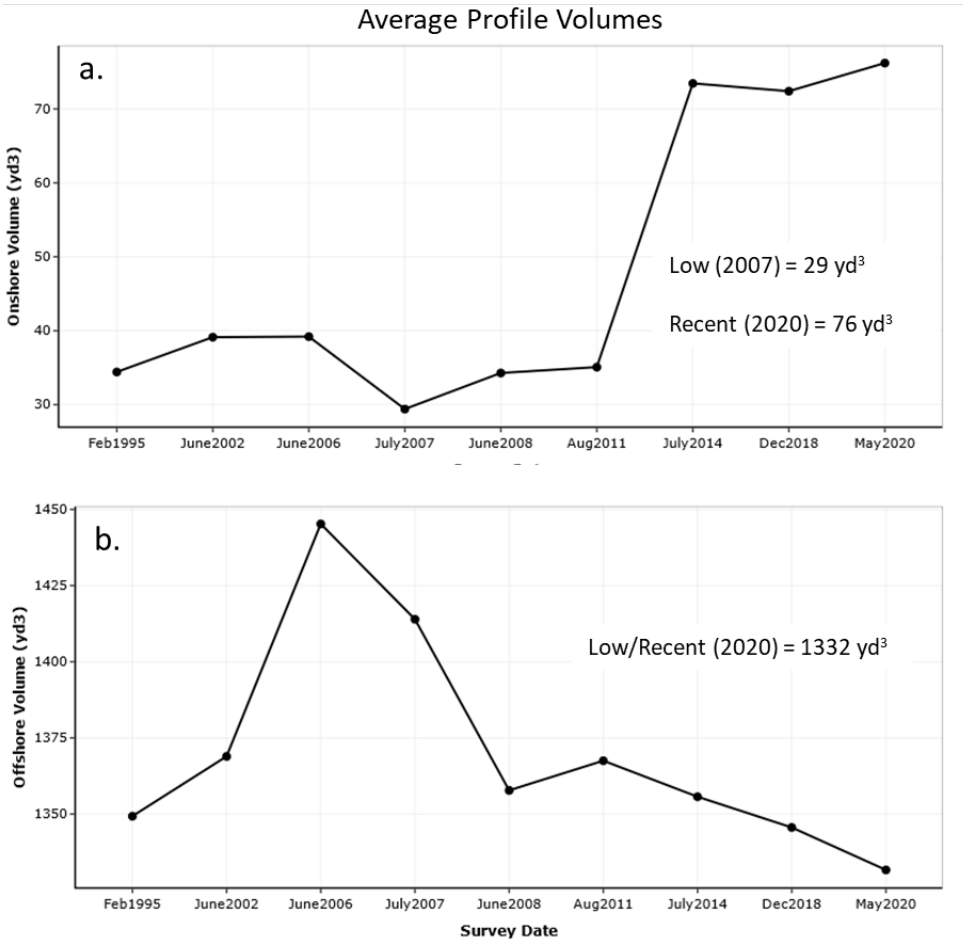


Figure 9-3. Averaged onshore (a) and offshore (b) profile volumes through time showing both the time series low and the current state of each feature

10 REFERENCES

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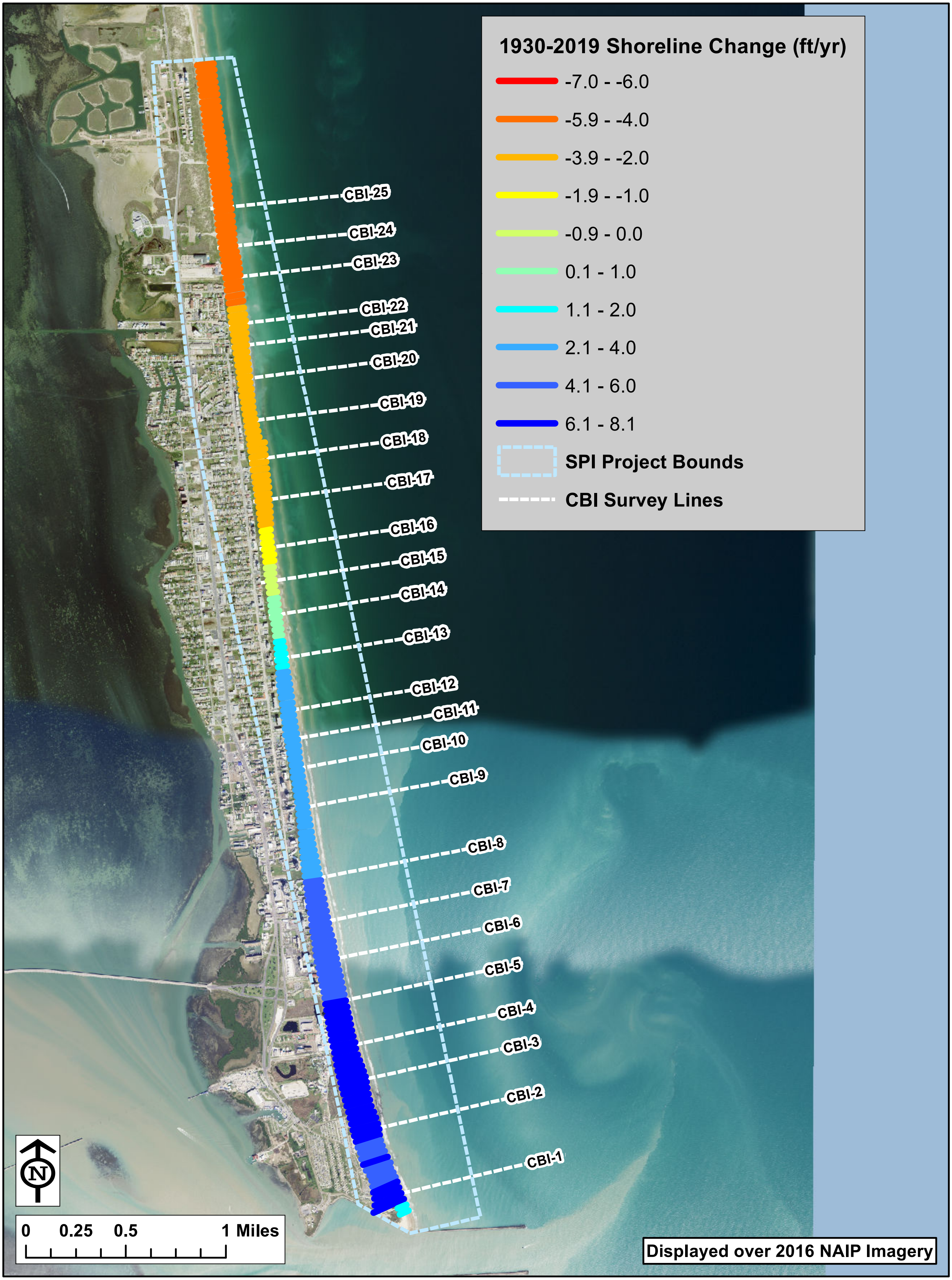
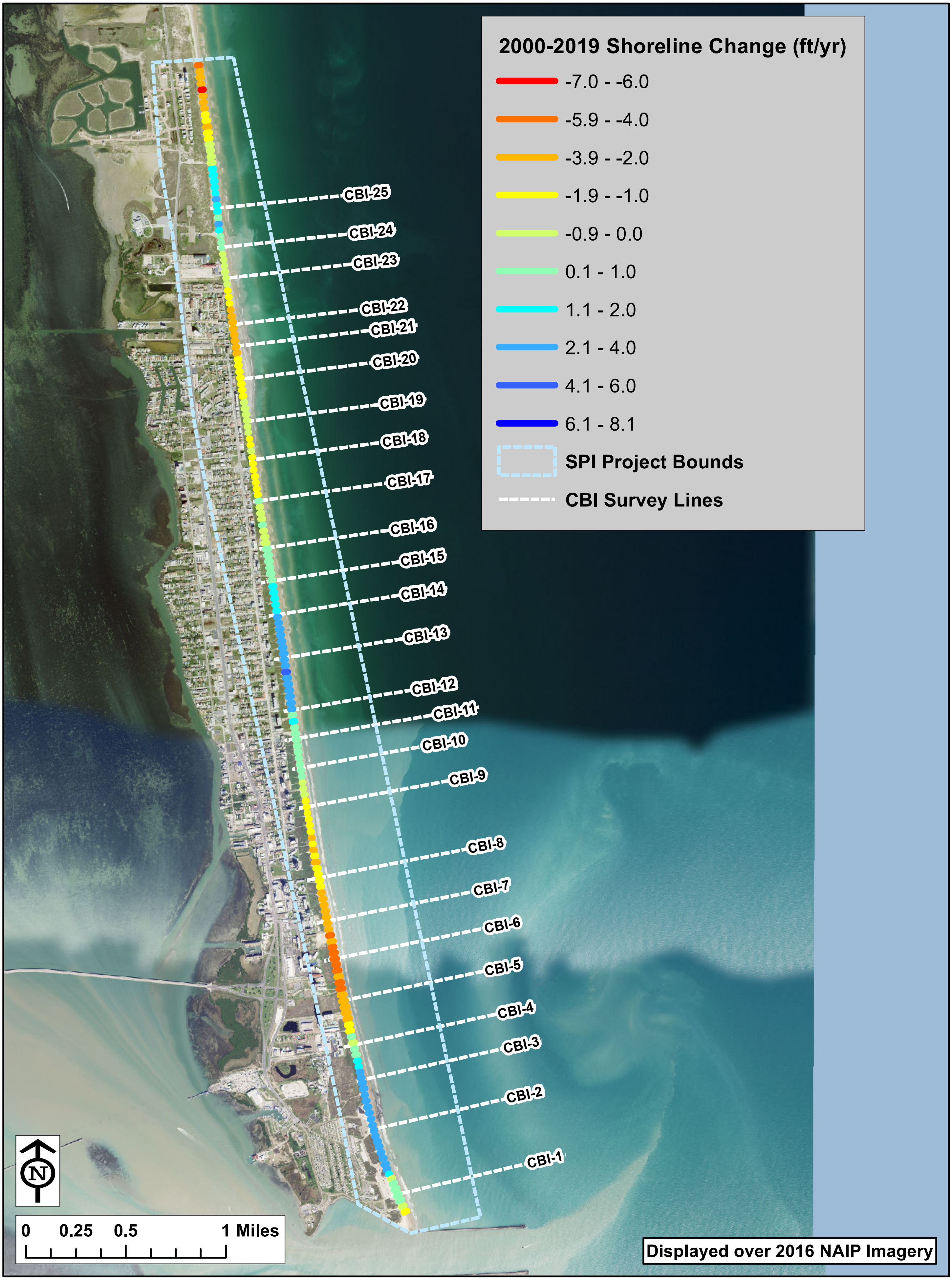
Appendix A

Shoreline Change Map: 1930–2019


1930-2019 Shoreline Change (ft/yr)
-7.0 - -6.0
-5.9 - -4.0
-3.9 - -2.0
-1.9 - -1.0
-0.9 - 0.0
0.1 - 1.0
1.1 - 2.0
2.1 - 4.0
4.1 - 6.0
6.1 - 8.1
SPI Project Bounds
CBI Survey Lines
CBI-25
CBI-24
CBI-23
CBI-22
CBI-21
CBI-20
CBI-19
CBI-18
CBI-17
CBI-16
CBI-15
CBI-14
CBI-13
CBI-12
CBI-11
CBI-10
CBI-9
CBI-8
CBI-7
CBI-6
CBI-5
CBI-4
CBI-3
CBI-2
CBI-1
N
0
0.25
0.5
1 Miles
Displayed over 2016 NAIP Imagery

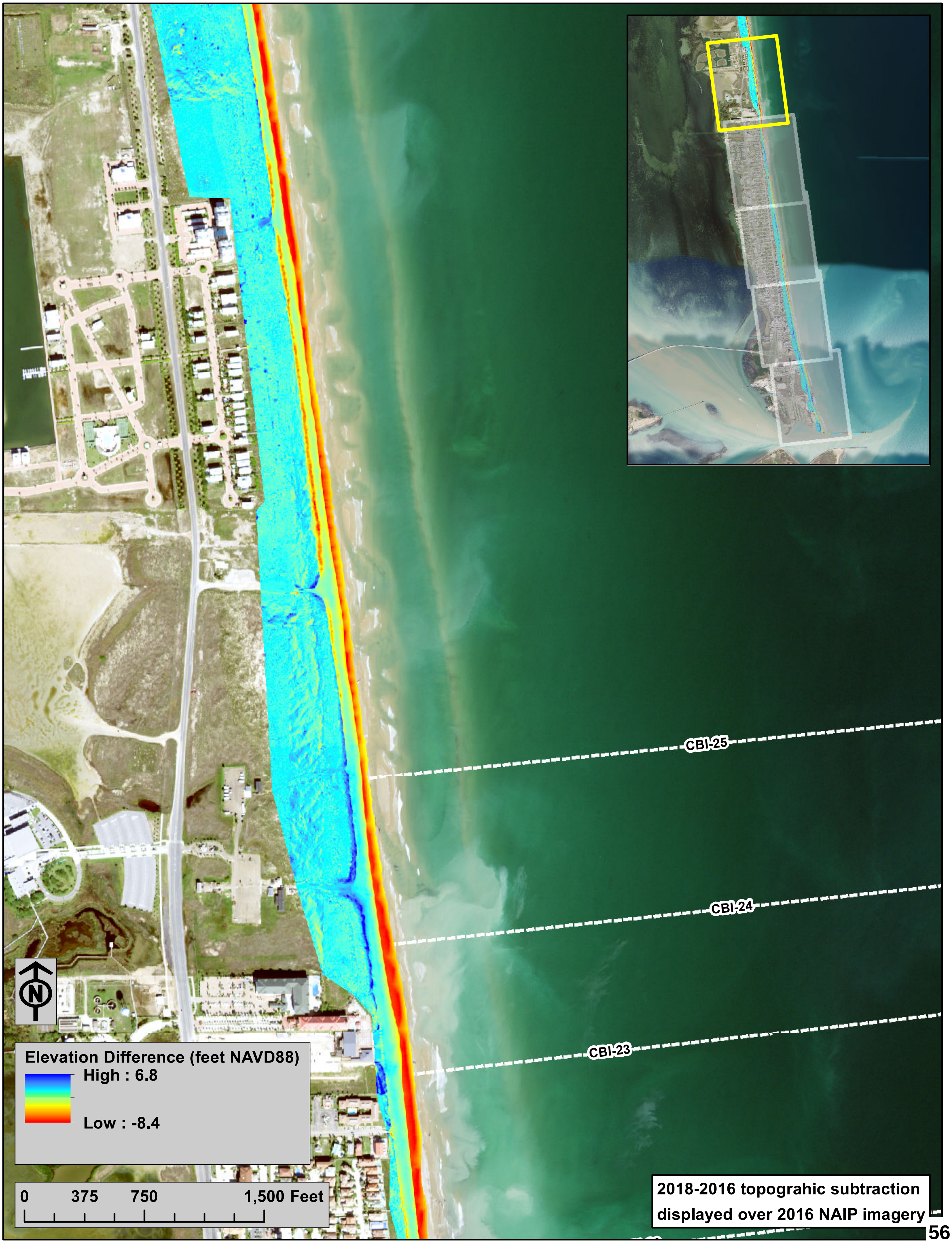
Appendix B

Shoreline Change Map: 2000–2019

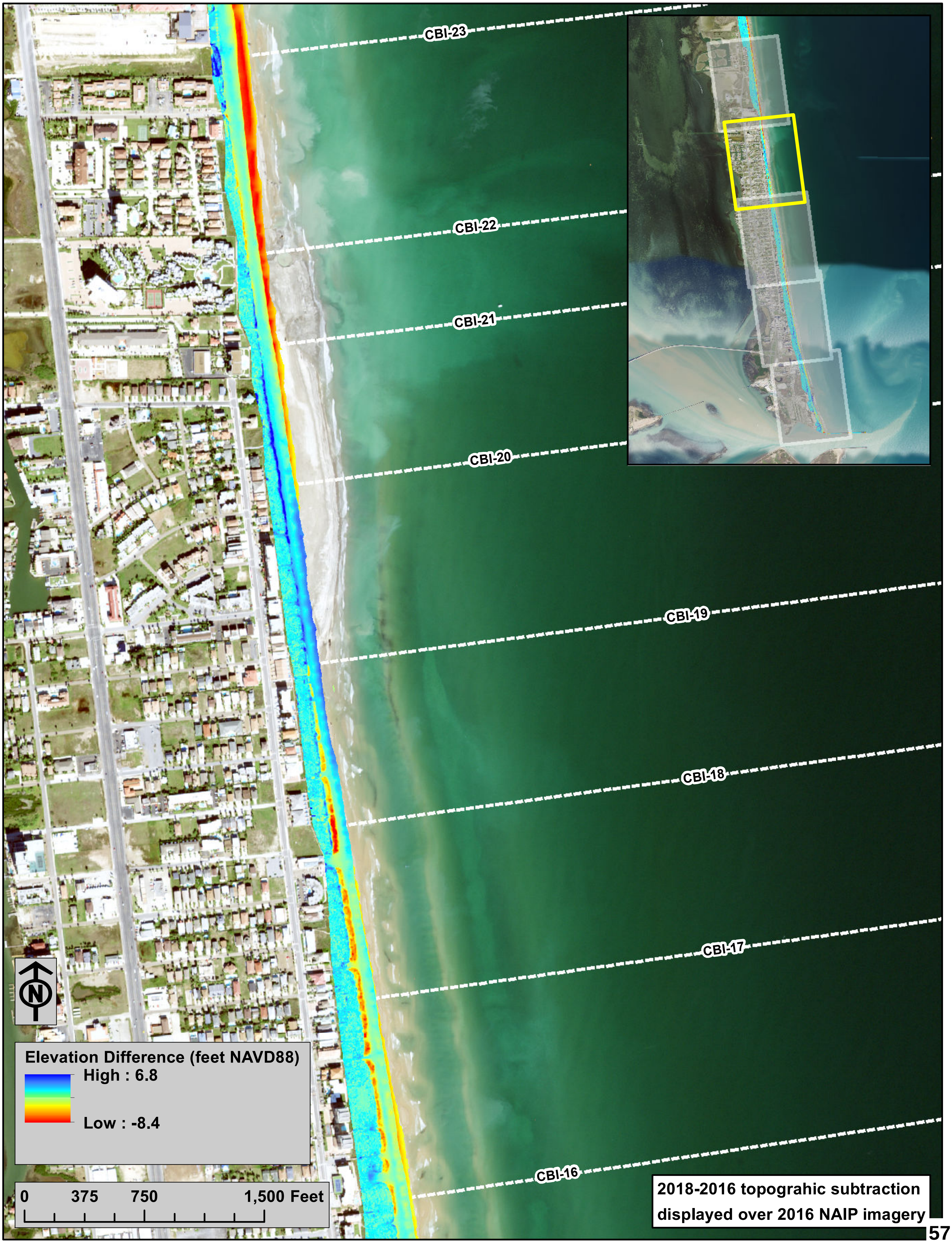

2000-2019 Shoreline Change (ft/yr)
-7.0 - -6.0
-5.9 - -4.0
-3.9 - -2.0
-1.9 - -1.0
-0.9 - 0.0
0.1 - 1.0
1.1 - 2.0
2.1 - 4.0
4.1 - 6.0
6.1 - 8.1
SPI Project Bounds
CBI Survey Lines
CBI-25
CBI-24
CBI-23
CBI-22
CBI-21
CBI-20
CBI-19
CBI-18
CBI-17
CBI-16
CBI-15
CBI-14
CBI-13
CBI-12
CBI-11
CBI-10
CBI-9
CBI-8
CBI-7
CBI-6
CBI-5
CBI-4
CBI-3
CBI-2
CBI-1
N
0
0.25
0.5
1 Miles
Displayed over 2016 NAIP Imagery

Appendix C

3-Dimensional Elevation Change Maps

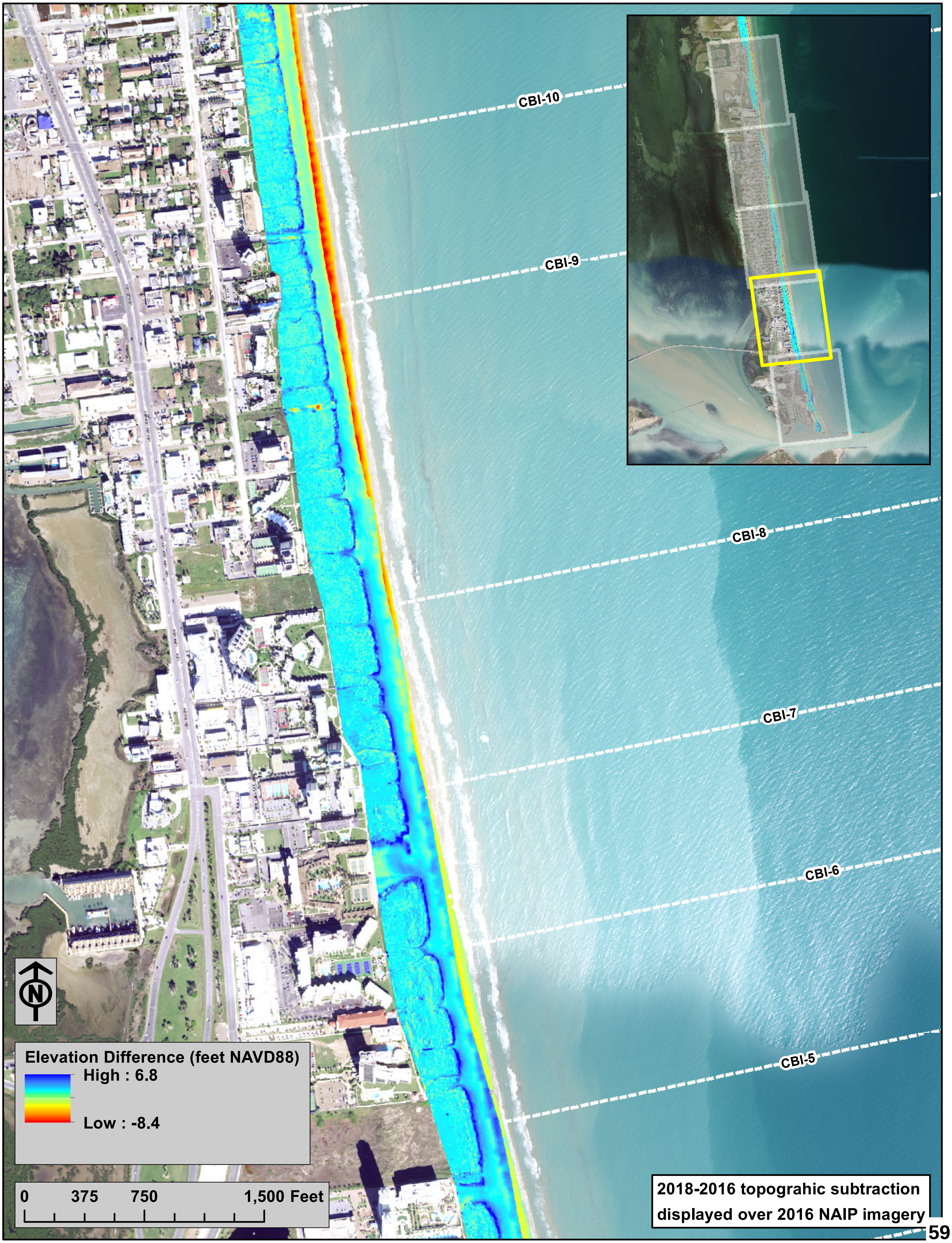


2018-2016 topograhic subtraction displayed over 2016 NAIP imagery

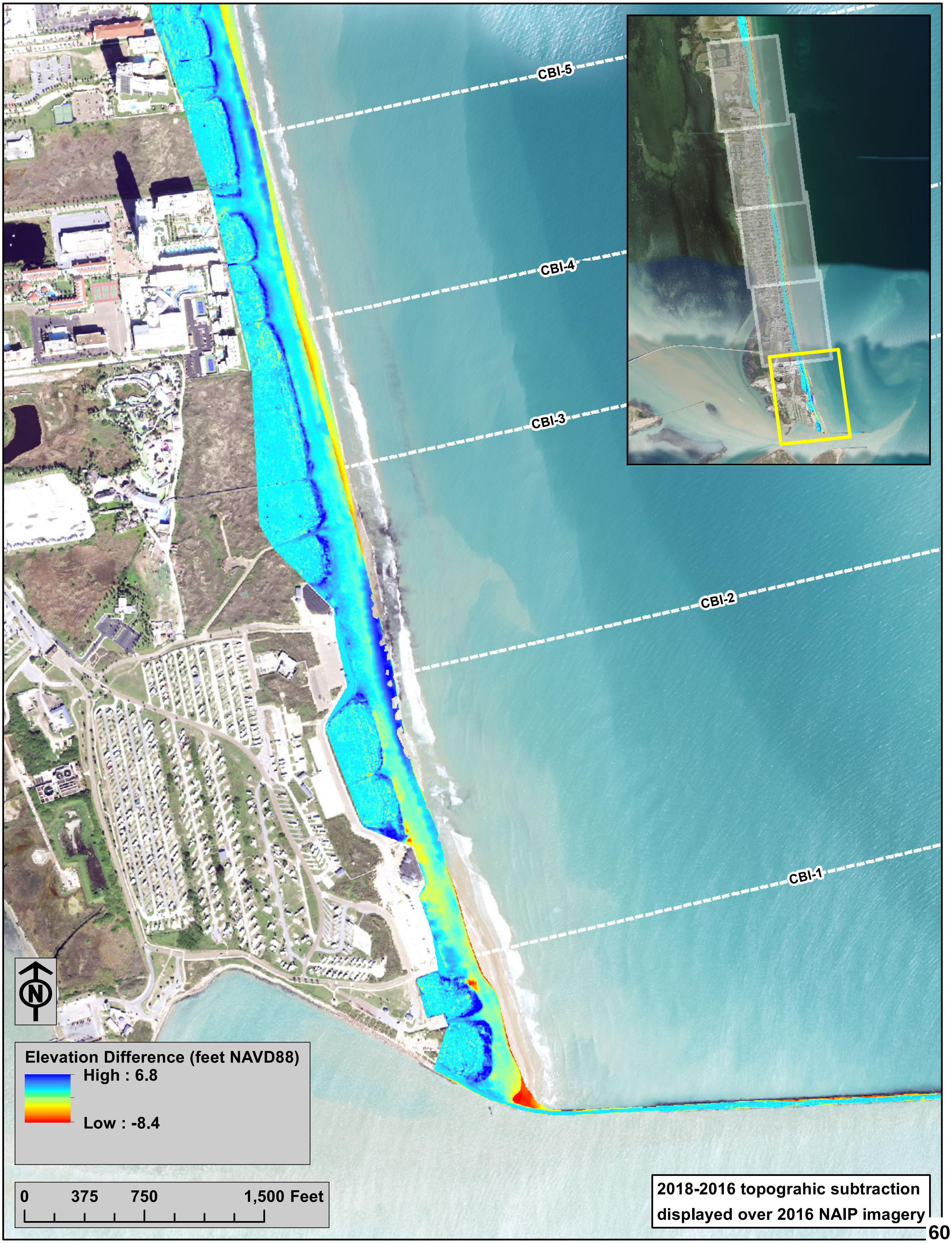


2018-2016 topograhic subtraction displayed over 2016 NAIP imagery

2018-2016 topograhic subtraction displayed over 2016 NAIP imagery



2018-2016 topograhic subtraction displayed over 2016 NAIP imagery

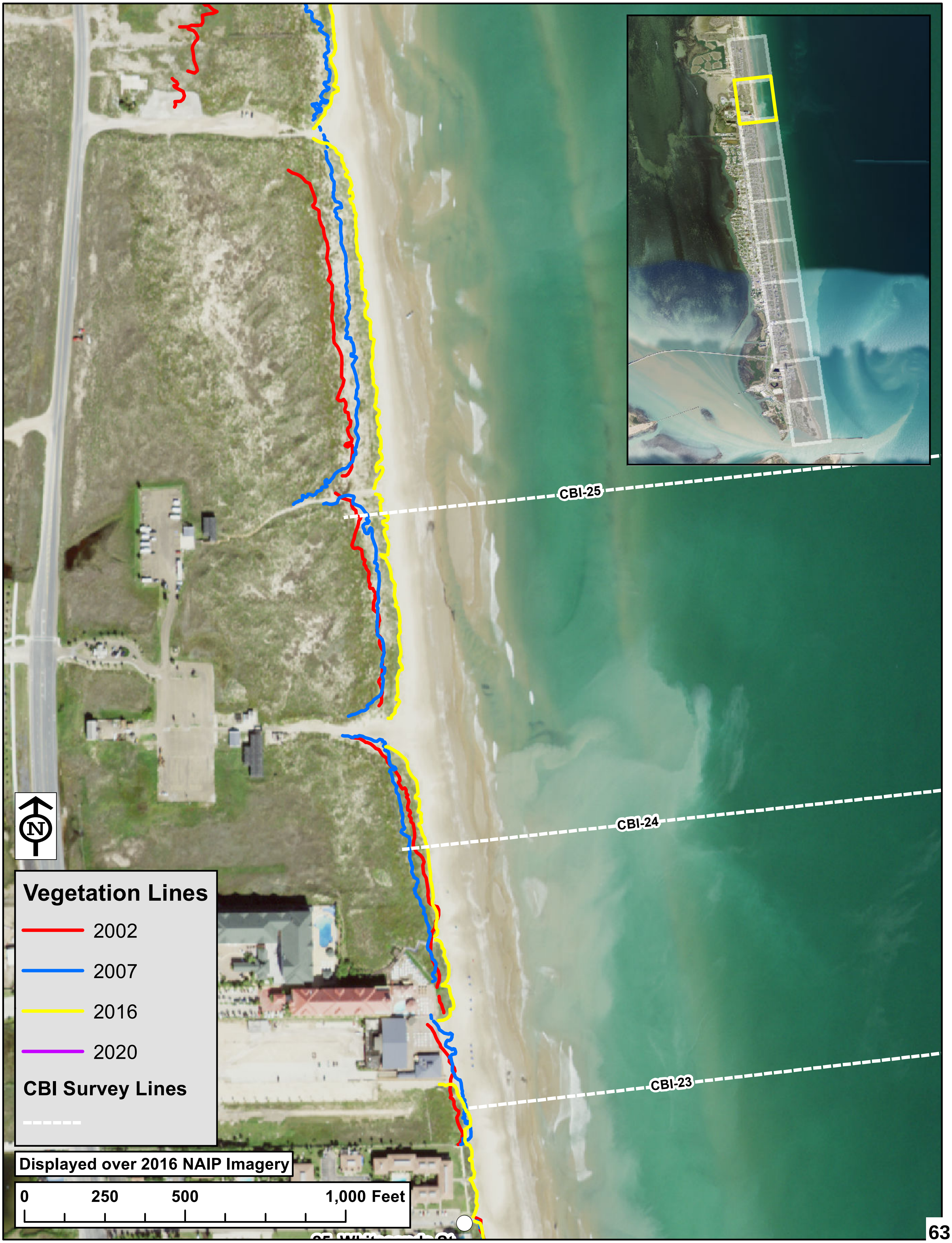


2018-2016 topograhic subtraction displayed over 2016 NAIP imagery

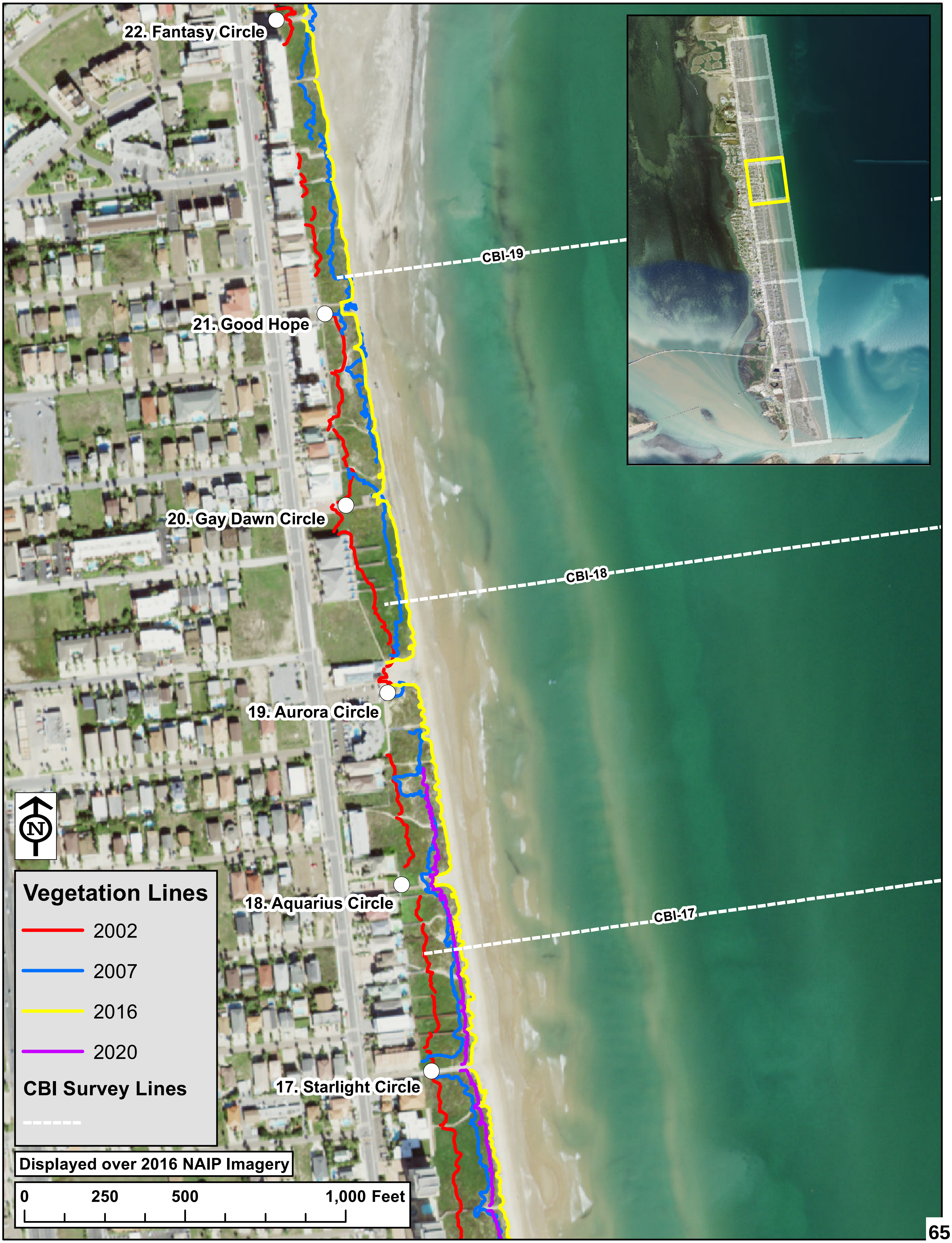
Appendix D

Vegetation Line Maps

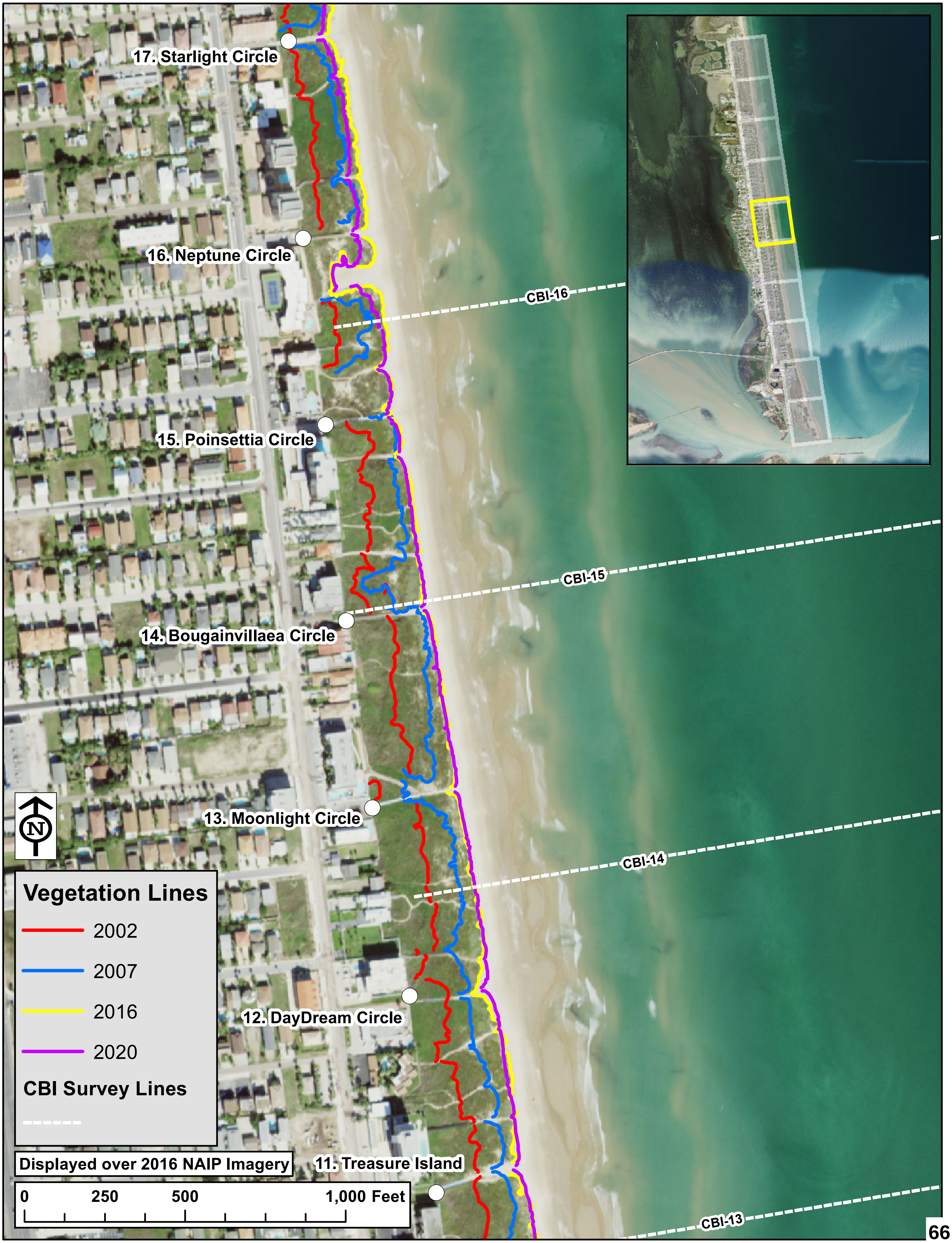

N
Vegetation Lines
2002
2007
2016
2020
CBI Survey Lines
Displayed over 2016 NAIP Imagery
0
250
500
1,000 Feet


CBI-25
CBI-24
CBI-23
Vegetation Lines
2002
2007
2016
2020
CBI Survey Lines
Displayed over 2016 NAIP Imagery
0
250
500
1,000 Feet
N

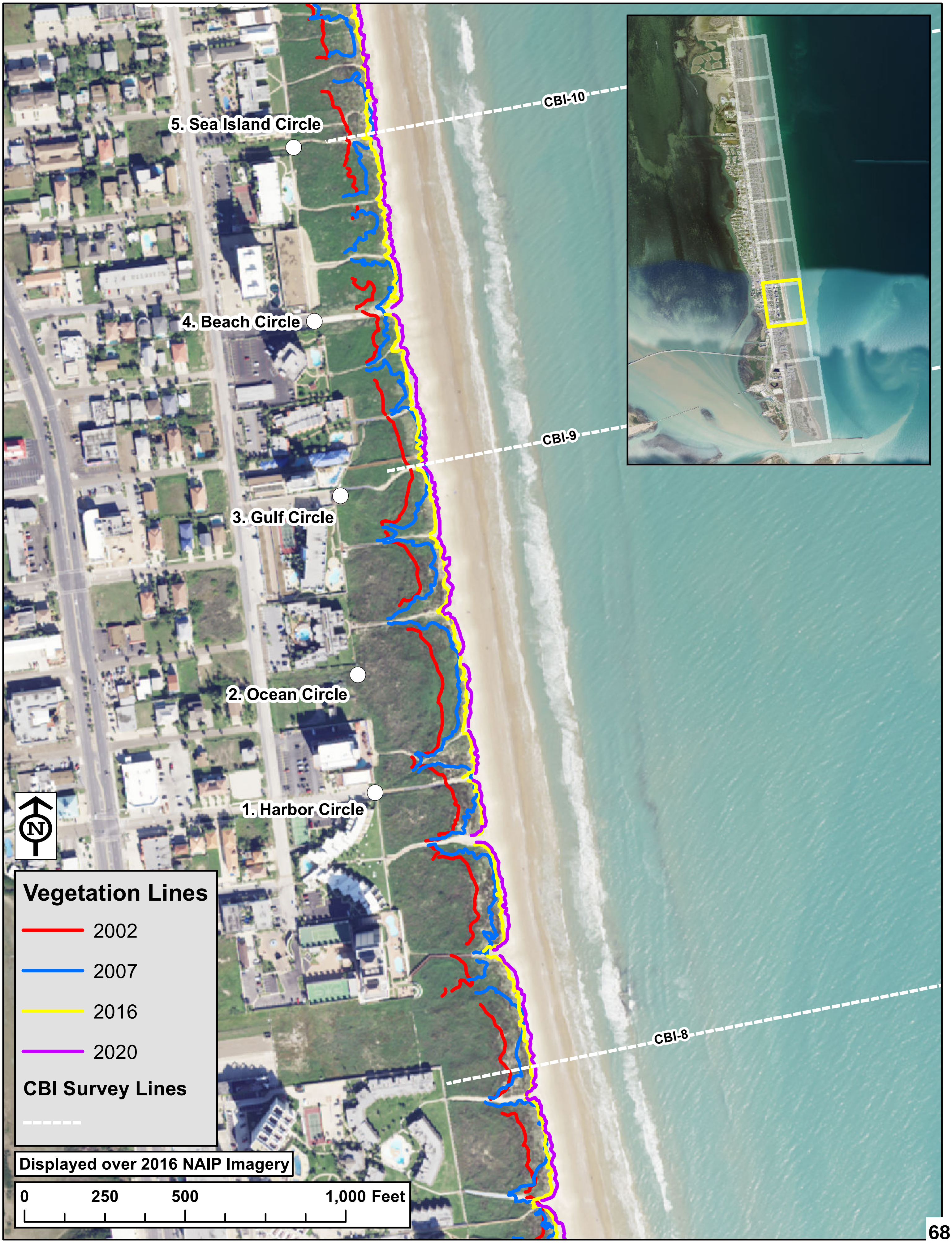

CBI-23
CBI-22
CBI-21
CBI-20
25. Whitesands St
24. Sunset Circle
23. Sapphire Circle
22. Fantasy Circle
N
Vegetation Lines
2002
2007
2016
2020
CBI Survey Lines
Displayed over 2016 NAIP Imagery
0
250
500
1,000 Feet

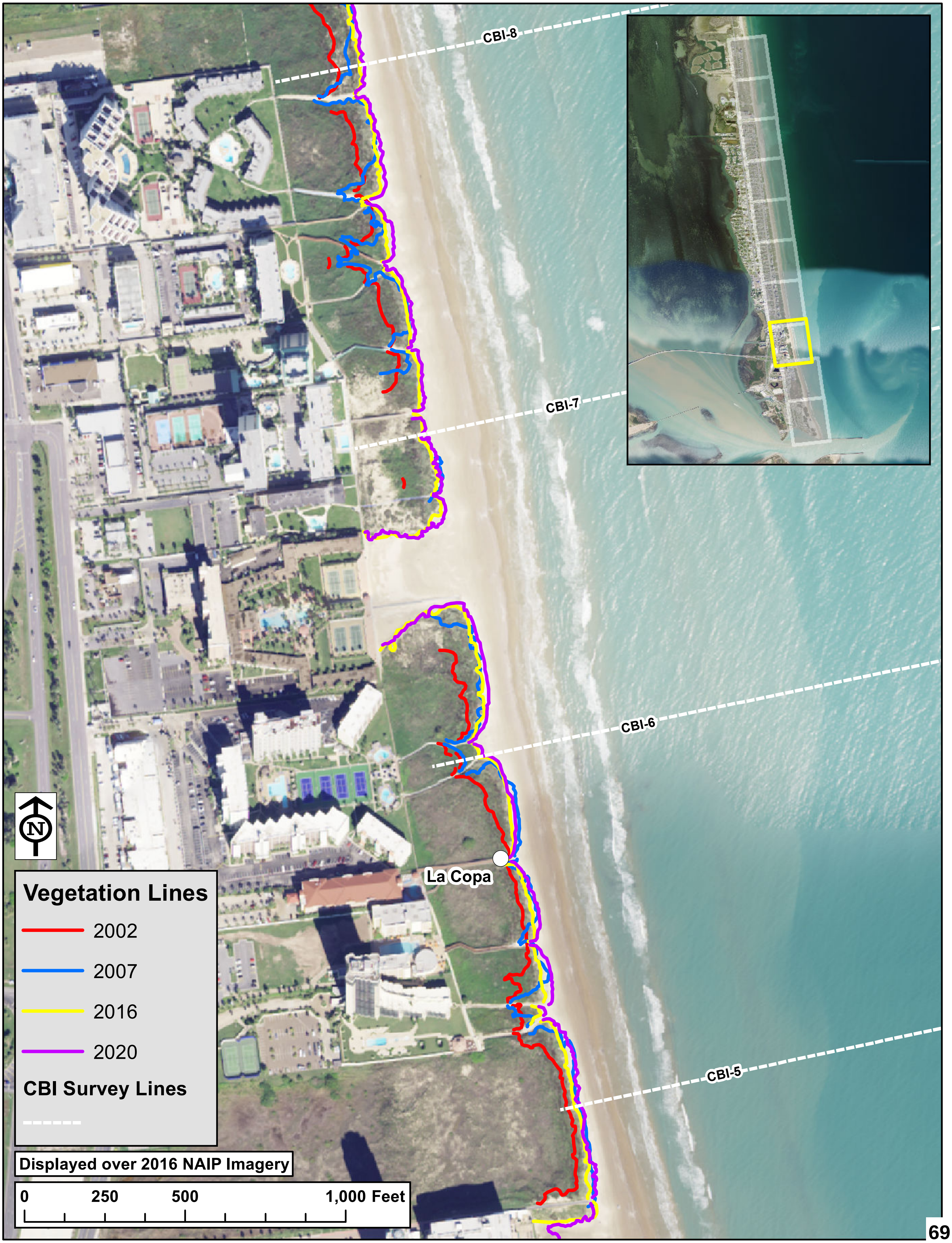


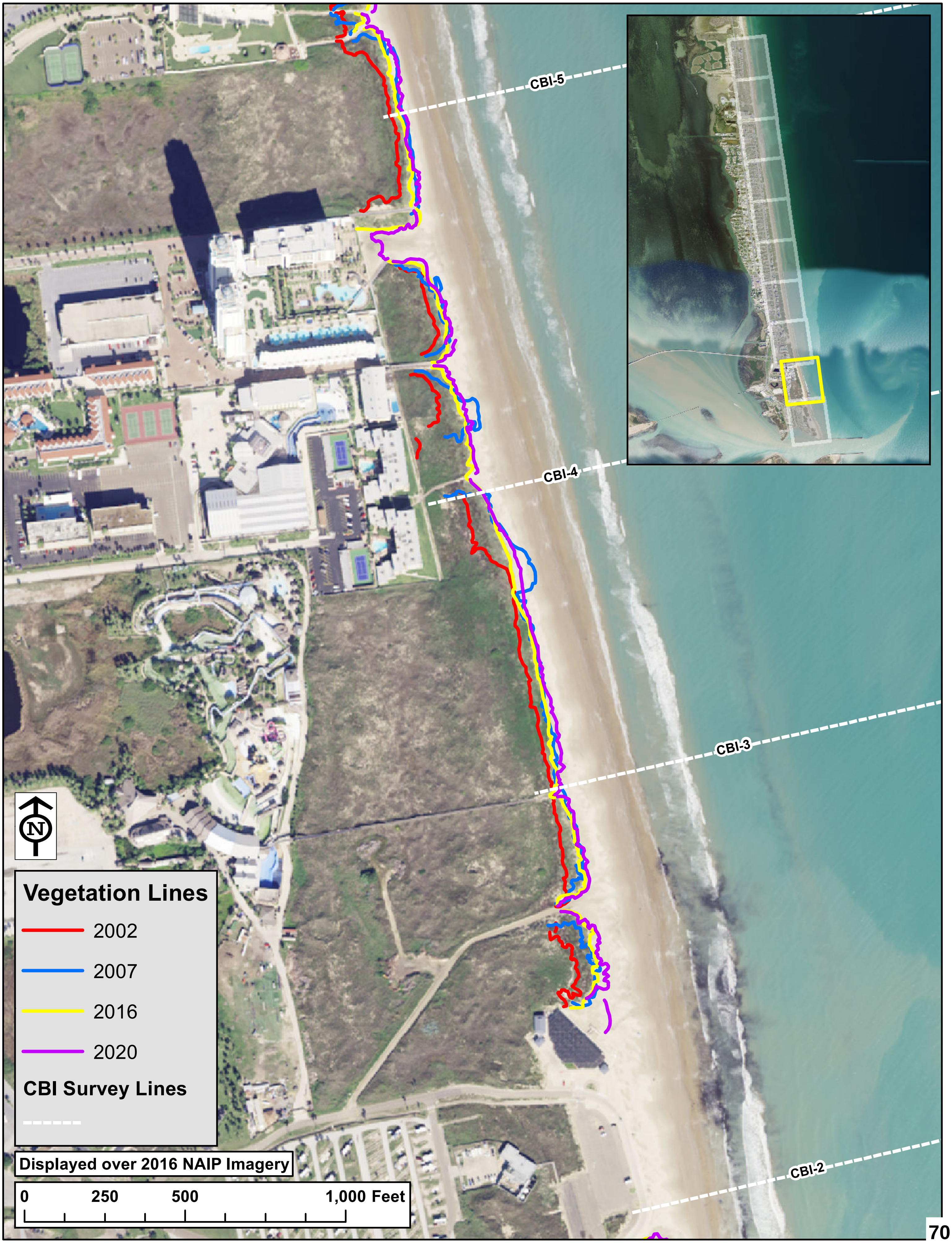
Displayed over 2016 NAIP Imagery

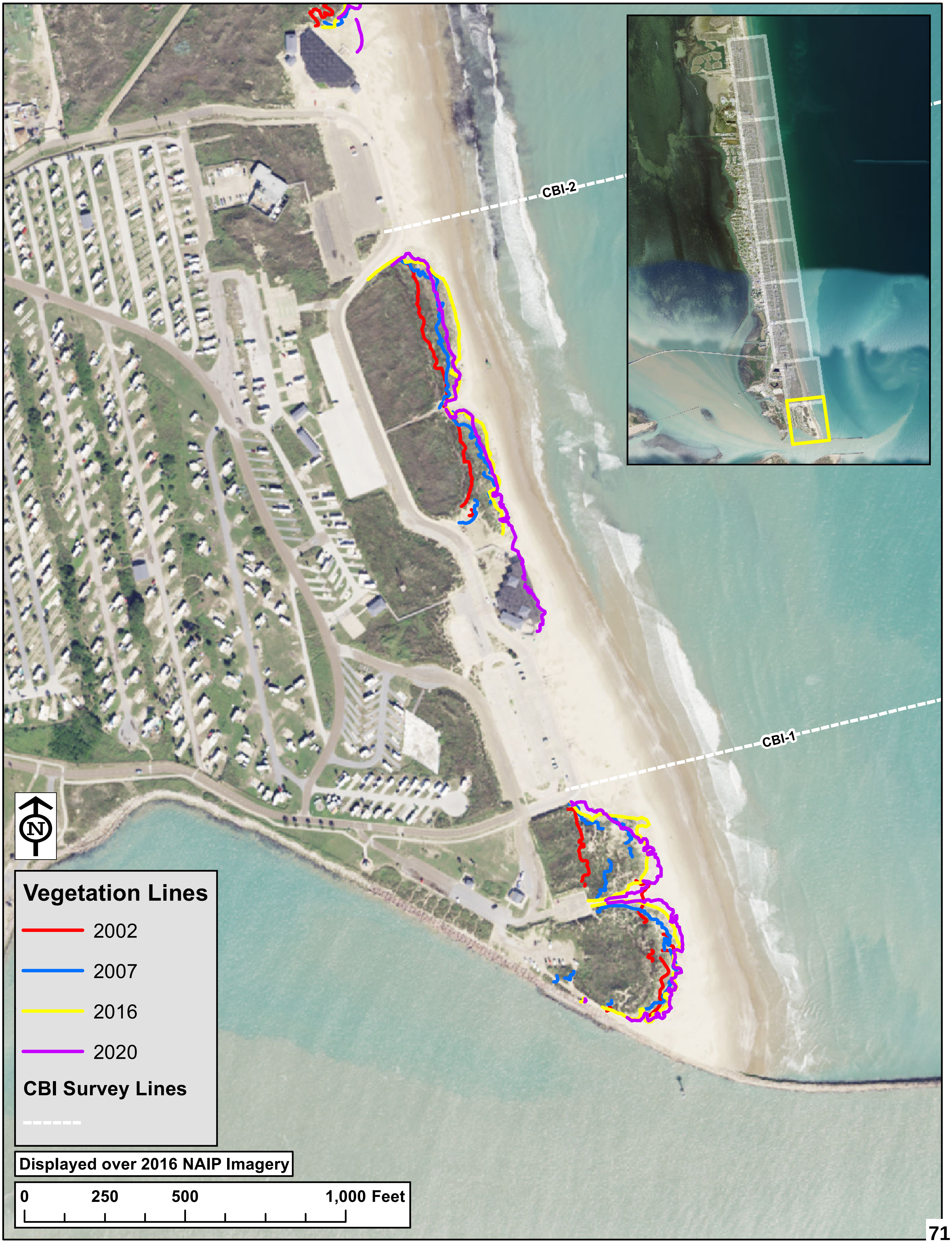

17. Starlight Circle
16. Neptune Circle
15. Poinsettia Circle
14. Bougainvillaea Circle
13. Moonlight Circle
12. DayDream Circle
11. Treasure Island
CBI-16
CBI-15
CBI-14
CBI-13
N
Vegetation Lines
2002
2007
2016
2020
CBI Survey Lines
Displayed over 2016 NAIP Imagery
0
250
500
1,000 Feet


11. Treasure Island
CBI-13
10. Riviera Circle
9. Blue Water Circle
CBI-12
8. White Cap Circle
7. Surf Circle
CBI-11
6. Seaside Circle
5. Sea Island Circle
CBI-10
N
Vegetation Lines
2002
2007
2016
2020
CBI Survey Lines
Displayed over 2016 NAIP Imagery
0
250
500
1,000 Feet


CBI-10
5. Sea Island Circle
4. Beach Circle
CBI-9
3. Gulf Circle
2. Ocean Circle
1. Harbor Circle
N
CBI-8
Vegetation Lines
2002
2007
2016
2020
CBI Survey Lines
Displayed over 2016 NAIP Imagery
0
250
500
1,000 Feet


CBI-8
CBI-7
CBI-6
CBI-5
La Copa
N
Vegetation Lines
2002
2007
2016
2020
CBI Survey Lines
Displayed over 2016 NAIP Imagery
0
250
500
1,000 Feet


CBI-5
CBI-4
CBI-3
CBI-2
N
Vegetation Lines
2002
2007
2016
2020
CBI Survey Lines
Displayed over 2016 NAIP Imagery
0
250
500
1,000 Feet


CBI-2
CBI-1
N
Vegetation Lines
2002
2007
2016
2020
CBI Survey Lines
Displayed over 2016 NAIP Imagery
0
250
500
1,000 Feet

Assessment and Investigation of the Beach and Dune Conditions at South Padre Island

Phase 2 Report: Modeling Future Conditions of the Beach and Dunes

Prepared for
City of South Padre Island
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South Padre Island, TX 78597

Prepared by
integral consulting inc.

1790 Hughes Landing Blvd.
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The Woodlands, TX 77380

November 19, 2021

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ACRONYMS AND ABBREVIATIONS

1-D	one-dimensional
ADAPT	Adaptation Decision and Planning Tool
EVA	extreme value analysis
GoM	Gulf of Mexico
Integral	Integral Consulting Inc.
MSL	mean sea level
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
QA/QC	quality assurance and quality control
SLR	sea level rise
SPI	South Padre Island
SWL	still water level
TWL	total water level
USGS	U.S. Geological Survey

1 INTRODUCTION

South Padre Island (SPI) is a narrow, low-relief barrier island along the south Texas coastline that is impacted frequently by erosive winter storm events and infrequent but extremely damaging major hurricanes. Relative rates of sea level rise (SLR) along the Texas coastline are higher than global averages due to subsidence, which exacerbates flooding and increases the inland incursion of storm waves. The dune field that backs the beach along the City of SPI coastline from the Brazos-Santiago Pass to the northern end of the City limits is discontinuous due to numerous beach access points and removal of sand by beachfront property owners. The present dune system is composed of a semi-natural dune field that varies in elevation and width alongshore, and has an extensive vegetation-planting program that helps to provide some resistance to dune erosion.

Scarping of the beach and dune is common in the winter, particularly towards the northern, more erosive part of the beach system. Overall, the beach-dune system provides critical protection to the community of SPI from storm waves and elevated water levels. The beaches and dunes are nourished and planted on a regular basis, thus maintaining a first line of protection for the City and its infrastructure from storm events.

Integral Consulting Inc. (Integral) was awarded a contract with SPI in 2020 to assess and investigate the beach and dune conditions at SPI. The project is being undertaken in four phases (Figure 1-1) following an Integral-developed framework called Coastal ADAPT (Adaptation Decision and Planning Tool) that uses a variety of modeling approaches to examine adaptation options for increasing resiliency to coastal hazards and SLR-related climate change risks. Phase 2, the focus of this report, presents the outcomes of modeling of future possible responses of the beach and dunes at SPI.

Integral offers unique experience, familiarity with relevant data, and decades of modeling experience grounded in locally proven scientific insight into the complex dynamics at play along the southeast coast of Texas. We applied advanced state-of-the-science modeling, incorporating measured data to accurately simulate waves along the SPI coastline. To assess the resiliency of the various dune configurations to an array of storm events, from mild to severe, and identify potential changes to the profiles, XBeach geomorphic modeling was performed (discussed in Section 1). This report provides the results and interpretation of the XBeach modeling, and provides recommendations for maintenance of the beach and dunes based on the historical response reported in Phase 1 of this project and the expected response in the future based on the modeling outcomes.

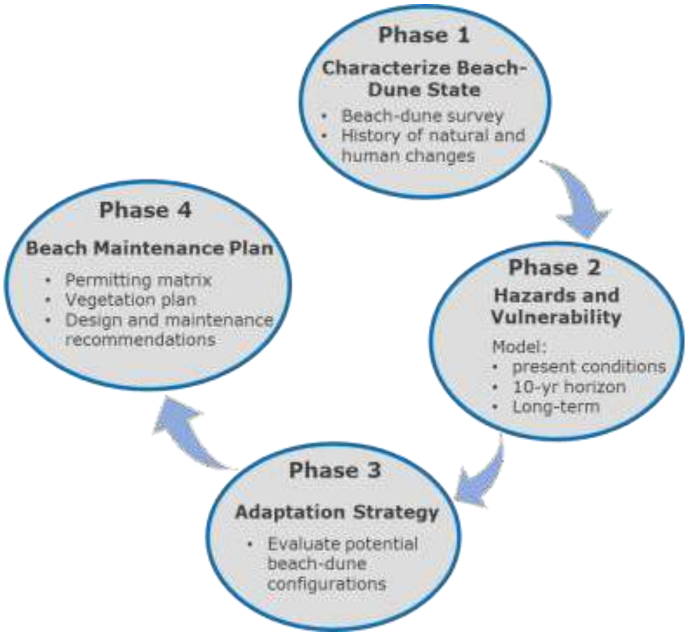


Figure 1-1. Workflow for Informing a Beach Maintenance Plan that Includes Multiple Phases to Achieve an Actionable Outcome

2 COASTAL PROCESSES AND HAZARDS

Coastal processes along SPI that create coastal hazards include tides, waves, and related storm conditions. An important measure of coastal hazards is the total water level (TWL; Figure 2-1) elevation—the combined effect of wave run-up height, storm surge, tides, and sea level elevations. River discharge is not a contributing factor to TWL at SPI. A combination of large waves occurring at high tides during storm conditions pose the largest potential to impact coastal erosion. As sea levels rise, both the wave run-up dynamics and the tide elevations will change leading to higher total water levels for longer durations. Each coastal process is summarized briefly below.

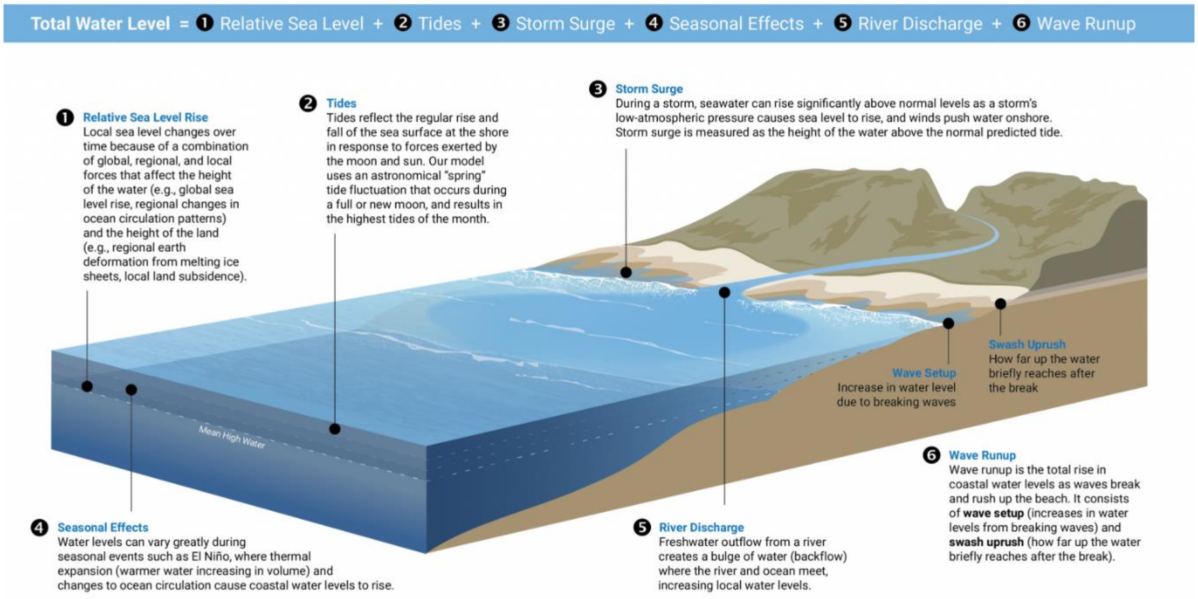


Figure 2-1. Conceptual Diagram of the Components of Total Water Level. Image courtesy of Our Coast Our Future Web Platform (Point Blue and USGS 2021).

2.1 TIDES AND WATER LEVELS

The closest National Oceanic and Atmospheric Administration (NOAA) tide gauge station is located at the entrance to the Brazos Santiago ship channel. Tides in the area are a diurnal type, meaning there is one high and one low tide each day. Tides are driven predominantly by the gravitational pull of the sun and the moon with elevations based on a tidal epoch, a 19-year period of which average tidal elevations are statistically analyzed. These tidal elevations are reported in either a tidal datum or a fixed vertical reference datum. Tidal datum elevations are typically relative to mean lower low water—the average of lowest low tides—a useful measurement for navigation purposes. A fixed vertical reference datum is established using geodetic land-based measurements. For this study, elevations will be reported in fixed land-based vertical reference datum using the North American Vertical Datum of 1988 (NAVD88).

Tide elevations vary monthly and annually based on the lunar orbit and solar positioning. During new and full moon when the gravitational pull of the sun and moon are aligned, spring tides have a higher tide range. During certain atmospheric conditions or wind conditions, tide observations can be much higher than predicted tides due to storm surge components. Still water level (SWL) is the term used to describe the elevation of the tide and the combination of non-wave components. Future SLR rise will raise the SWL elevations, thus affecting the height and extent of the potential for coastal erosion.

2.2 WAVES

Waves, created by distant and local winds, are one of the key drivers of wave run-up and resulting coastal change. Local wind-driven seas typically develop rapidly when low pressure systems track near a locale, especially in the summer and fall months during hurricane season, or when strong sea breezes are generated during the spring and summer. Although the mean wave climate is modulated by winter cold fronts, the most extreme events are related to hurricanes (Appendini et al. 2014).

When distantly generated waves approach the coast as swell, they interact with coastal and bathymetric features. A wave measured at a buoy offshore in deep water is quite different than one that breaks at the coast near SPI. The Yucatan Peninsula, for example, may block swell from the south, while a large northeast or east swell from an offshore storm or hurricane may approach SPI leading to an increased potential for coastal erosion. Modeling of the changing waves based on bathymetry and swell conditions is called wave transformation and was an important modeling component to assessing vulnerabilities for this project.

Waves break offshore in depths that are related to the wave height and the wave period. In general, the bigger the wave and the longer the wave period, the deeper the water in which the wave will break. Smaller waves can travel much closer to shore before breaking and often pose more risk of causing damage than the biggest waves. Once the wave breaks, it runs up the shoreline and the slopes and roughness affect its elevation and inland extent across the surf zone and beach. Depending on the frequency of breaking waves, wave setup can occur when a series of breaking waves can pile up water allowing subsequent waves to travel closer to shore on the piled-up water before breaking with more energy. As sea levels rise, not only will the SWL be affected, but the deeper water close to shore will allow waves to break closer to shore with less potential to dissipate the wave energy.

2.3 SEA LEVEL RISE

Increases in greenhouse gas emissions, primarily from the burning of fossil fuels, are contributing to an increase in atmospheric and ocean temperatures, causing ocean waters to warm and expand, and continental glaciers and the ice sheets of Greenland and Antarctica to lose ice mass and melt. As a result, the global rate of SLR has increased to rates of about 0.15 in./year between 1993 and 2018 (Nerem et al. 2018).

However, SLR is not the same everywhere around the world. Because of local differences in tectonic uplift, subsidence caused by oil, gas, and groundwater extraction, as well as sediment deposition and saltwater intrusion, the land itself can move vertically.

Local or relative SLR is more important to this study than global rates of SLR. The tide gauge at the SPI Coast Guard Station (Station ID: 8779748) has recorded a SLR of 0.17 in./yr ± 0.02 in./yr between 1958 to 2021, equivalent to a change of 1.4 ft in 100 years (Figure 3-1). This is equivalent to the average global rate of SLR ~0.15 in./yr; however, this trend, relative to global SLR, will change in the future (IPCC 2021).

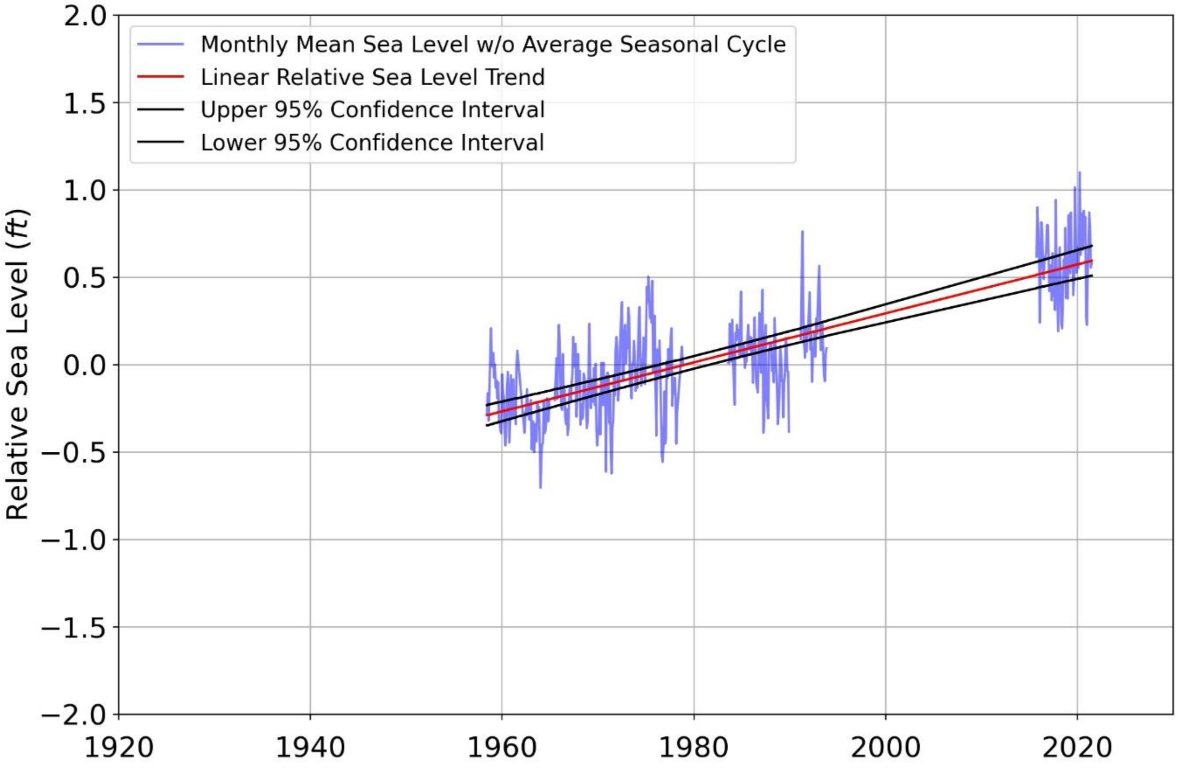


Figure 3-1. Relative Sea Level Trend at the South Padre Island, Texas, NOAA Tide Gauge 8779748. Source: https://tidesandcurrents.noaa.gov/waterlevels.html?id=8779748.

3 COASTAL EROSION ASSESSMENT

The major technical task of this study was to evaluate the potential for coastal erosion of SPI beaches and dunes for a range of projected storm events in addition to future SLR scenarios. Overall, the methods to conduct this coastal change analysis included assessment of site topographic and nearby bathymetric conditions, the regional wave climate and wave refraction to the shoreline adjacent to the site, and XBeach modeling to predict coastal erosion potential. This section summarizes the methods and focuses on the modeling and the results of the analyses. This study considered the following coastal hazards:

- **Coastal Erosion and Accretion**: Erosion and accretion along the SPI beaches and dunes from projected storm conditions associated with various recurrence frequencies. The different recurrence intervals help better understand the storm frequency over time that the beaches and dunes may be exposed to, and are listed below:
    - 2-year, also referred to as a 50% annual chance storm event
    - 10-year, also referred to as a 10% annual chance storm event
    - 100-year, also referred to as a 1% annual chance storm event.
- **Rising Sea Level**: Rise in the predicted tide levels due to SLR and its influence on coastal change.

NOAA and other government agencies and universities have substantially invested in SLR science that assigns probabilities to various SLR elevations occurring by a certain time in the future (Sweet et al. 2017). For this study, the intermediate-high risk scenario was applied, consistent with existing policy guidance (Table 3-1; Sweet et al. 2017).

Table 3-1. Future Sea Level Rise Projections at the South Padre Island, Texas, Coast Guard Station based on NOAA 2017 guidance

Sea Level Rise Scenario (ft)	Projected Years
0.0	2020 (Baseline Year)
1.54	2040 (Intermediate High)
3.54	2070 (Intermediate High)

4 ANALYSIS TRANSECTS

Six shoreline profiles were selected from the 25 profiles analyzed in the historical morphodynamic analysis (see Phase 1 Report "Characterization of the Beach and Dune State") to perform XBeach simulations and evaluate the coastal change potential. The selected profiles were CBI-03, CBI-06, CBI-13, CBI-17, CBI-22, and CBI-24 (Figure 4-1). These profiles were selected using the June 2021 survey data, carried out as part of the present project. Since CBI-22 was undergoing nourishment during the June 2021 survey, the elevation data for this profile were from the May 2020 survey. The profiles were selected based on unique morphologies and historical behavior to be a subset that is representative of the different distinct morphologies and geography in the area of interest. These include representing the three portions of the island that have been identified in long-term analyses as having variable evolution (south, central, and north). The following describe the specific characteristics of the chosen profiles:

- CBI-03: southern portion of SPI; development set far back (more representative of natural location)
- CBI-06: southern portion of SPI without potential jetty impacts; has experienced consistent vegetation progradation
- CBI-13: central portion of SPI; stable profile morphology
- CBI-17: central portion of SPI; stable profile morphology
- CBI-22: northern portion of SPI; lack of vegetation and dune historically; low dune maintained in more recent times, since ~2008
- CBI-24: northern portion of study area; undeveloped region (no building line); dune field widened and has maintained stable configuration in recent years (2018–2021).

The range of wave conditions within the Gulf of Mexico (GoM) responds to the topography and bathymetry in and along the coastline of SPI. Of primary importance is the site-specific nearshore bathymetric and topographic data along selected beach profiles.

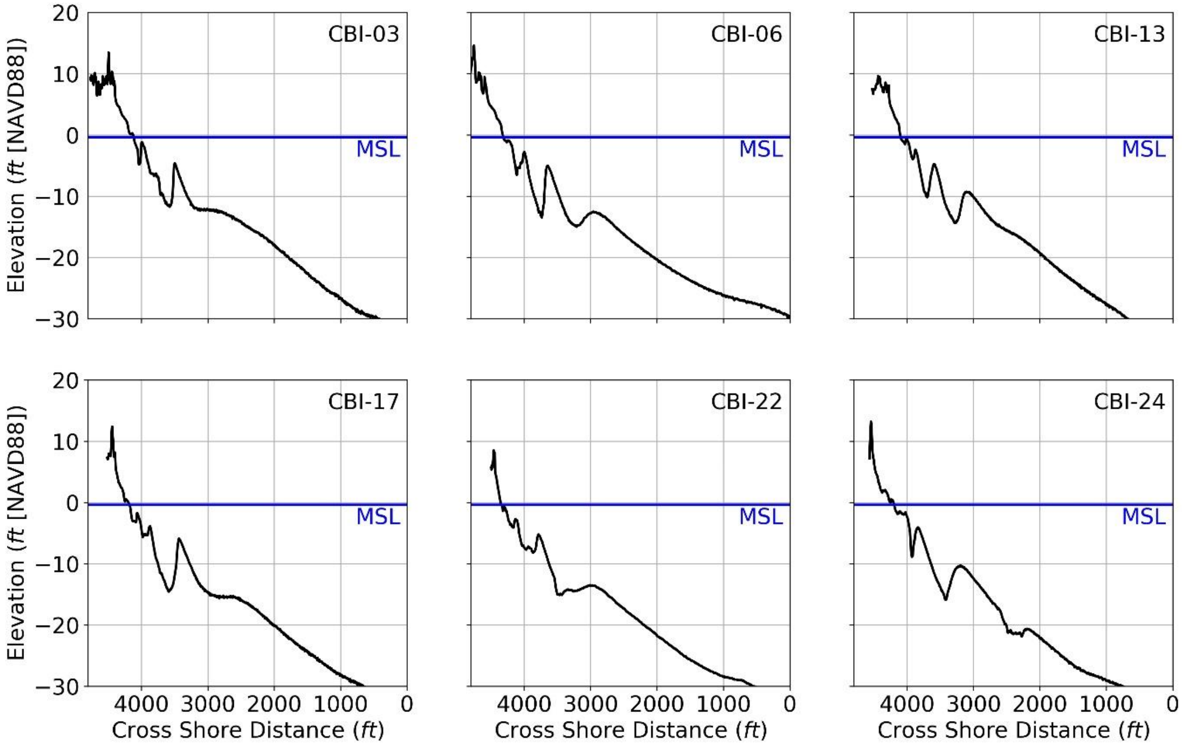


Figure 4-1. Selected SPI Shoreline Profiles with Mean Sea Level Line (June 2021, except CBI-22 in May 2020)

5 XBEACH MODELING

XBeach is a numerical model used to predict coastal erosion and accretion, and was used to model coastal change potential along the selected set of shoreline profiles under a range of storm wave and future SLR conditions (Rovelvink et al. 2009). The model assesses the interaction of waves with bathymetry and topography. XBeach is particularly suited for modeling coastal change (e.g., volume, width, elevation) processes on timescales of single storm and wave events; it simulates tidal and wave-driven sediment transport and resulting coastal change, and is a readily available, free, open-source model.

5.1 XBEACH GRID

Each of the six selected profiles were discretized into a number of grid cells representing a discrete distance in the cross-shore direction, and each grid cell was assigned an average water depth. There is only a single grid cell in the alongshore direction. The resolution of the grid cells in the cross-shore direction varied from 40 ft at the farthest offshore cells where erosion and accretion are expected to be limited, to 1.6 ft along the beach and dune profile where a majority of the erosion and accretion is expected. The grid configuration is only in the cross-shore direction, and is called the XBeach 1-D, or one-dimensional mode. In the 1-D mode, the model domain represents a single shoreline profile, and longshore transport gradients are ignored. The varying grid spacing and use of XBeach 1-D were used to provide high-resolution predictions along the beach and dune while minimizing the number of offshore grid cells to maintain computational efficiency.

5.2 XBEACH BOUNDARY CONDITIONS

At the offshore boundary at each of the XBeach grids, the application of wave conditions can take multiple forms. For this study, at each of the six selected profiles, bulk wave parameters—significant wave height, peak period, wave direction, and a directional spreading factor—accessed from the closest NOAA wave buoy, were applied at the offshore end. The bulk wave parameters were held constant over a 30-hour simulation period to represent the worst case scenario during a selected storm event.

5.2.1 Extreme Value Analysis

The range of wave processes in response to the wide sloping continental shelf along the coast of the GoM necessitates a qualitative and quantitative understanding of existing wave conditions. In an effort to summarize the existing wave conditions along SPI, the full data record from the closest NOAA wave buoy was downloaded and analyzed. This NOAA buoy, station 42020, is located ~68 miles northeast of the Brazos Santiago Channel and the south end of SPI, and has a data record from 1990–present (Figure 5-1). The NOAA buoy is in 280 ft of water near the edge of the continental shelf and is equipped with sensors to collect meteorological data, water temperature, and directional wave data. Over the full data record at this NOAA buoy, the mean wave height is 4.3 ft, the mean wave period is 6.3 seconds, and the median wave direction is 120°. The median is defined as the middle wave direction of the entire record. To evaluate the impact of extreme storm events on the coastal resiliency of SPI beaches and dunes, extreme values of wave height, representative of an array of storm events, were computed for use in the XBeach model. The extreme value analysis (EVA) provided the highest wave heights for various return periods (e.g., 2, 10, and 100 years) from a 30-year measured data record (Table 5-1).

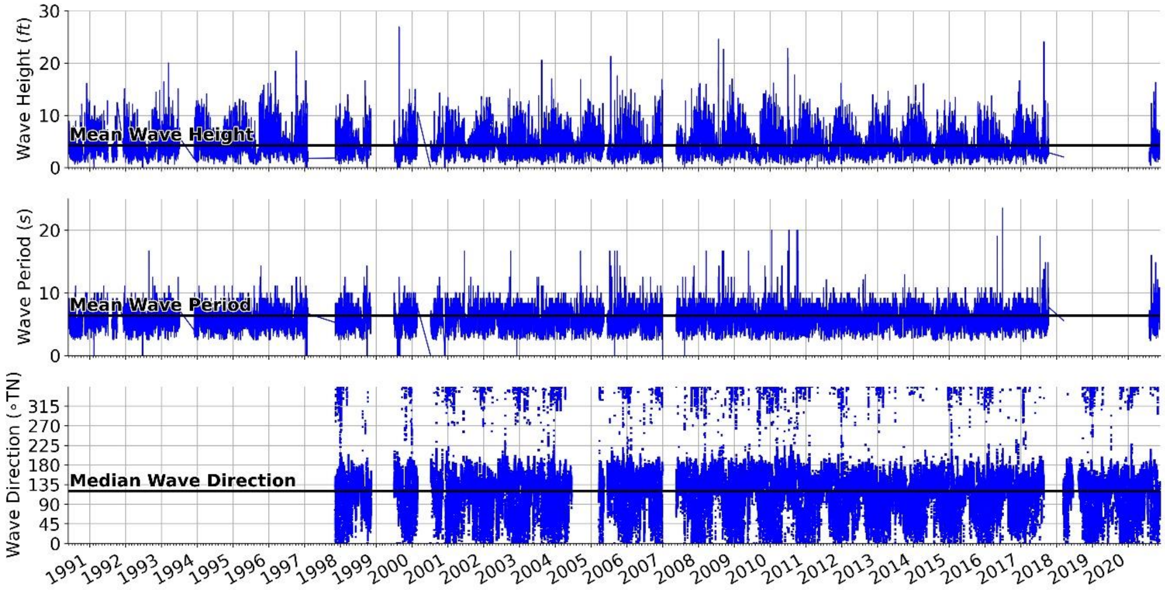


Figure 5-1. Full Record of Wave Height, Wave Period, and Wave Direction including Average Values from NOAA Buoy 42020

Table 5-1. Wave Height Return Period Values from EVA for the Offshore NOAA Buoy

Return Period	Offshore Significant Wave Height (ft)
1-year	16.2
10-year	22.9
100-year	41.7

The NOAA buoy measurements used in the EVA are typically in deep water where the influence of the bathymetry and local nearshore bathymetric features do not affect the waves. Thus, it is critically important to transform the waves from the deep water to the nearshore zone to evaluate site specific wave exposure. Linear Airy wave theory was used to transform the deep water waves into the nearshore region as shallow water waves, taking into account the effects of the shallower nearshore water depths and profile slope, and how the waves will be influenced. These transformed wave heights were used as the XBeach boundary conditions for the six selected profiles (Table 5-2). The nearshore wave heights, along with the offshore wave heights derived from the EVA, sequentially increase for the 2-, 10-, and 100-year return periods and contribute to increased wave run-up and the potential for beach and dune erosion and accretion. The return period storm events, combined with the three SLR scenarios discussed above, resulted in 54 individual XBeach model simulations representing three different significant storm events and three SLR scenarios along the six selected profiles. The wave period was held constant across the 54 XBeach simulations, set as 16 seconds, a typical wave period generated from an offshore storm event in the Gulf of Mexico. XBeach was set to run for 30 hours, representative of a typical storm event duration, and to capture a full tidal cycle. During the 30-hour period, constant wave and time varying water level boundary conditions were applied.

Table 5-2. Nearshore Significant Wave Height used for Selected Profiles

Return Period	Offshore Significant Wave Height (feet)	Nearshore Significant Wave Height (feet)
2-year	16.2	13.2
10-year	22.9	17.8
100-year	41.7	22.9

In addition to the wave conditions at the offshore boundary, a time-varying water level was applied. A time-varying water level provided a more realistic storm impact, as it would occur over a tidal cycle, and the higher tides would increase the probability of erosion and accretion along the shoreface. These data were selected from the measured data record at NOAA station # 8779749, SPI Brazos Santiago, Texas (Figure 5-2) and subset to a transition from a neap to spring tide. This simulates an increasing water level resulting from storm surge, along with the constant wave conditions.

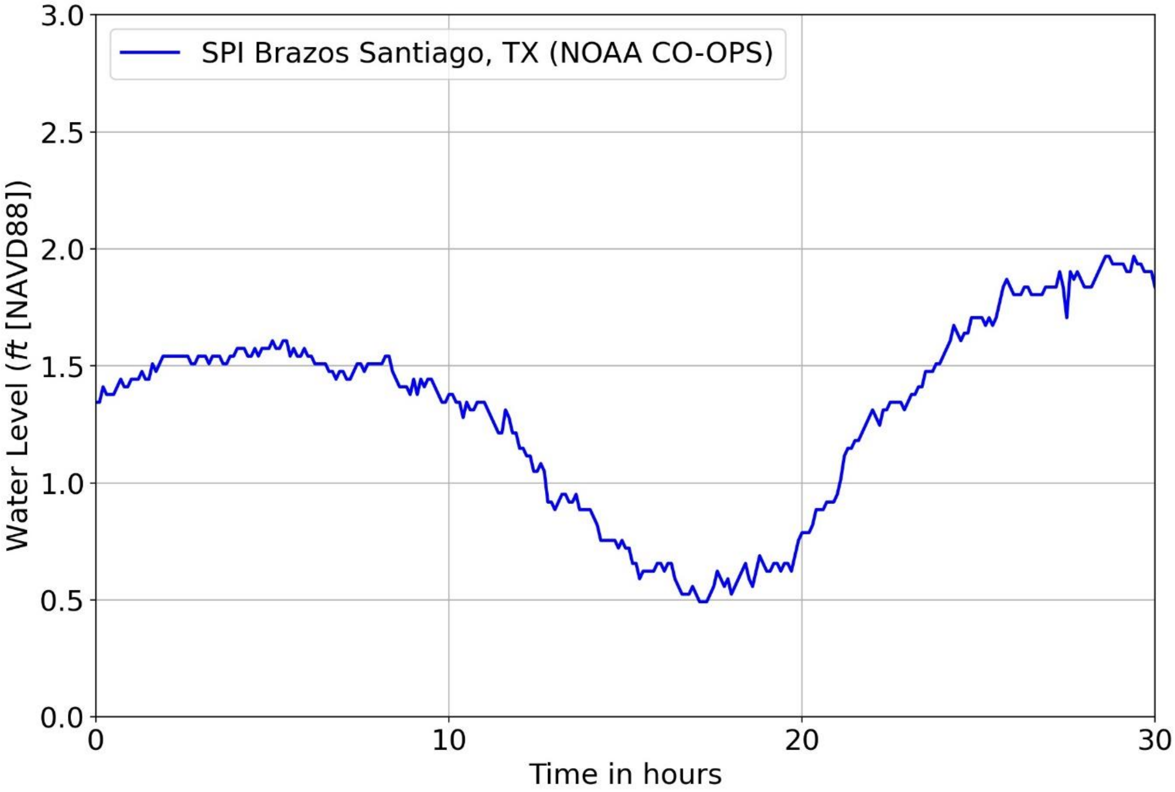


Figure 5-2. Time Varying Water Level Boundary Condition Applied to XBeach Simulations

In addition to the wave and water level boundary conditions, vegetation and sediment physical characteristics were defined along each of the selected profiles. The location of the vegetation line was identified in the beach profile survey data. The vegetation feature in XBeach provides additional roughness for predicting the wave run-up and erosion of the dunes. The sediment physical characteristics (i.e., D50, D90, porosity, and bulk density) were defined based on typical sandy beaches along the Gulf Coast region. These model parameters provide a more realistic sediment bed when simulating erosion and accretion.

5.3 XBEACH RESULTS

The model predictions provide an evaluation of coastal erosion and accretion potential along each of the selected profiles due to defined storm events. Each of the 54 simulations were evaluated and quantitative metrics were computed to assess the predicted changes to each profile under various storm conditions and SLR scenarios. The metrics include changes to the beach width, the shoreline position, and the dune toe position. The results of the analyses are presented below.

5.3.1 Beach Width

As an initial metric to evaluate the change in each profile over the range of storm events and SLR scenarios, beach width change was computed for the 54 simulations (Tables 5-3 to 5-5). The positive values in the three tables, light to dark blue, represent an increase in beach width, while the negative values, light to dark red, represent a decrease in beach width.

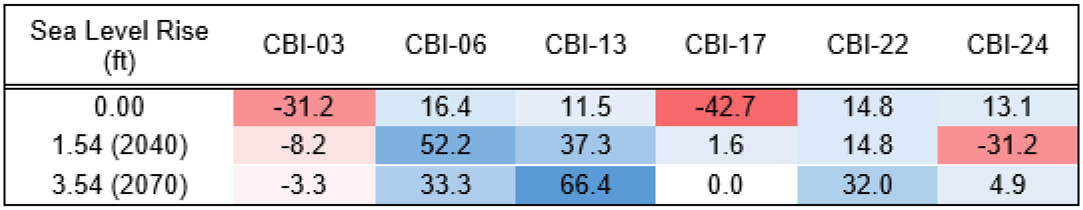
To compute the beach widths, the results from the 54 simulations were run through the Python dune analysis package Pybeach (https://pybeach.readthedocs.io/en/latest/). The maximum curvature method (maximum slope change) was chosen to calculate the dune toe and shoreline for each simulation, including the starting profiles. Beach width was then calculated as the distance from the Pybeach-derived dune toe and shoreline. The pre-storm beach width was then subtracted from the post-storm simulated beach width.

Overall, the changes in beach widths are highly variable across profiles, storm events, and SLR scenarios. As reported in the Phase 1 Report "Assessment and Investigation of the Beach and Dune Conditions at South Padre Island" and based on historical analysis, the magnitude of beach width change increases when moving north along SPI, a result consistent with the rates of change derived from beach nourishment and offshore sand placement. The pattern is variable along the coast, with erosion hotspots in the very northern portion of the study area (beyond the extent of the CBI profiles), accretion or low erosion rates (< 0.9 ft/yr) along much of the central portion of the island (CBI-09 to CBI-25), and an area of moderate erosion (-0.4 to -1.4 ft/yr) along the coast from CBI-05 to CBI-09. South of this erosional zone, the shoreline becomes accretional to the inlet jetty.

As shown in Tables 5-3 to 5-5, the beaches were predicted to increase in width in 29 of the 54 profile simulations. Twenty-four profiles showed a decrease in beach width across the simulations and one of the simulations, profile CBI-17 for the 2-year wave event and 2070 SLR scenario, was predicted to have no change (Table 5-3).

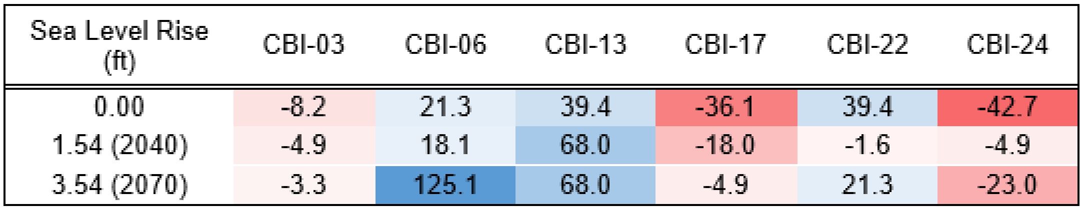
Profile CBI-06, near the south end of SPI, was predicted to have the largest increase in beach width, while CBI-24, one of the most northerly profiles, was predicted to have the largest decrease in beach width. An interesting trend shows that the largest changes in beach width are not necessarily during the largest wave events or highest SLR scenarios. This is a result of the influence of bathymetry and topography on the wave run-up and wave forces responsible for coastal erosion and accretion. During the 0.0-ft SLR scenario, smaller waves (e.g., the 10-year wave event) can travel closer to shore before breaking, thus potentially causing more erosion of the beach. During the 2040 and 2070 SLR scenarios, the breaking depths of the profiles change, impacting where the wave breaks, and if it breaks at all. The importance of this finding is that more frequent smaller wave events could increase the potential for coastal erosion. Explanations for increasing beach widths under storm and SLR conditions, when intuitively one might expect to see decreases in the beach width, are two-fold. Sediment can be transported onshore during storm events and material eroded from the dunes can be deposited on the beach. In the latter case, one would expect there to be measurable erosion of the dune. In this analysis, it appears that where there are large increases in beach width, material is moved from the very shallow submerged portions of the profiles onto the beach.

Table 5-3. Predicted Change in Beach Width, in feet, for the 2-Year Wave Event



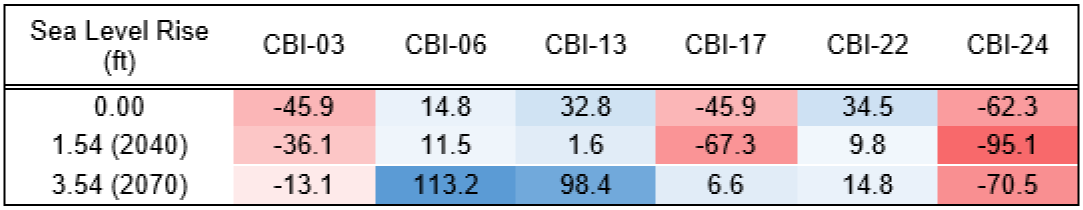
Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	-31.2	16.4	11.5	-42.7	14.8	13.1
1.54 (2040)	-8.2	52.2	37.3	1.6	14.8	-31.2
3.54 (2070)	-3.3	33.3	66.4	0.0	32.0	4.9

Table 5-4. Predicted Change in Beach Width, in feet, for the 10-Year Wave Event



Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	-8.2	21.3	39.4	-36.1	39.4	-42.7
1.54 (2040)	-4.9	18.1	68.0	-18.0	-1.6	-4.9
3.54 (2070)	-3.3	125.1	68.0	-4.9	21.3	-23.0

Table 5-5. Predicted Change in Beach Width, in feet, for the 100-Year Wave Event



Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	-45.9	14.8	32.8	-45.9	34.5	-62.3
1.54 (2040)	-36.1	11.5	1.6	-67.3	9.8	-95.1
3.54 (2070)	-13.1	113.2	98.4	6.6	14.8	-70.5

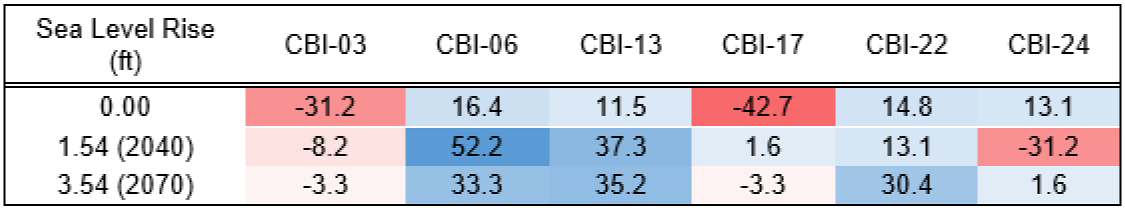
5.3.2 Shoreline and Dune Toe Position Change

The computation of the beach width change requires the identification of the shoreline and dune toe position along each profile. In addition to examining the beach width change, we also examined changes in the positions of the shoreline and dune toe, which are presented below. This was conducted for each of the 54 simulations using Pybeach (Tables 5-6 to 5-11). The positive values in the tables, light to dark blue, represent a predicted shoreline advance, or seaward movement, while the negative values, light to dark red, represent a shoreline retreat, or landward movement.

For shoreline position changes (Tables 5-6 to 5-8), 23 of the 54 simulations predicted an advance of the shoreline. On 28 profiles shoreline retreat was predicted, and three simulations predicted no change in the shoreline position. Profile CBI-17 for the 100-year wave event and 2070 SLR scenario, and CBI-13 for the 100-year wave event for the current and 2040 SLR scenarios, had no predicted shoreline position change but did have predicted beach width change (Table 5-8).

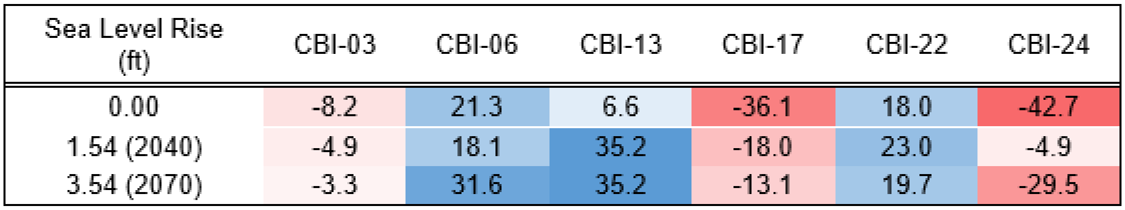
Similar to the changes in beach width, profile CBI-06 was predicted to have the largest shoreline advance, during the 2-year wave event and the 2040 SLR scenario (Table 5-6). Across each of the storm wave events and SLR scenarios, profile CBI-06 was predicted to have an advance in its shoreline position. Profile CBI-24 was predicted to have the largest shoreline retreat, which occurs during the 100-year wave event, 2040 SLR scenario (Table 5-8). Most of the remaining simulations were shown to have predicted shoreline retreat.

Table 5-6. Predicted Change in Shoreline Position, in feet, for the 2-Year Wave Event



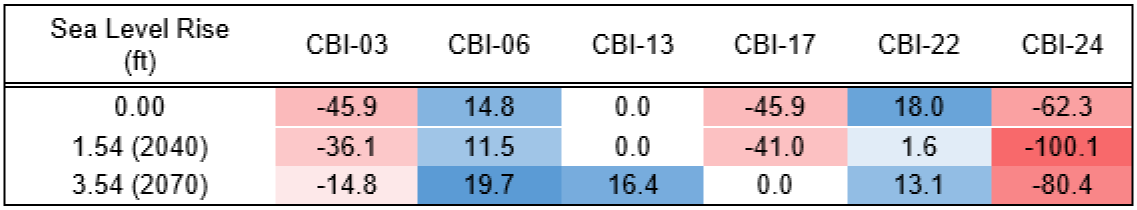
Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	-31.2	16.4	11.5	-42.7	14.8	13.1
1.54 (2040)	-8.2	52.2	37.3	1.6	13.1	-31.2
3.54 (2070)	-3.3	33.3	35.2	-3.3	30.4	1.6

Table 5-7. Predicted Change in Shoreline Position, in feet, for the 10-Year Wave Event



Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	-8.2	21.3	6.6	-36.1	18.0	-42.7
1.54 (2040)	-4.9	18.1	35.2	-18.0	23.0	-4.9
3.54 (2070)	-3.3	31.6	35.2	-13.1	19.7	-29.5

Table 5-8. Predicted Change in Shoreline Position, in feet, for the 100-Year Wave Event



Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	-45.9	14.8	0.0	-45.9	18.0	-62.3
1.54 (2040)	-36.1	11.5	0.0	-41.0	1.6	-100.1
3.54 (2070)	-14.8	19.7	16.4	0.0	13.1	-80.4

The change in position of the dune toe was also computed for each of the 54 simulations. The positive values in the three tables, light to dark blue, represent a predicted dune toe advance, or seaward movement, while the negative values, light to dark red, represent a landward dune toe retreat.

As shown in Tables 5-9 to 5-11, 29 of the 54 simulations predicted no change in dune toe position. An additional 13 simulations predicted less than 10 ft of dune toe retreat. The dune at the southernmost profile, CBI-03, was not predicted to be impacted during the 2- or 10-year wave events under the three SLR scenarios. Moving northwards along the SPI coastline, the dune generally was predicted to be impacted during the 2-year wave event and the 2070 SLR scenario. During the 10-year and 100-year wave events, as would be expected, the dunes were impacted during the three SLR scenarios for profiles CBI-06, -13, -17, -22, and -24 (Tables 5-10 and 5-11).

As a note, the -32.8-ft change for the four simulations at profile CBI-13 are a result of the Pybeach analysis selecting the dune toe location landward of where the starting profile dune toe was located. After a post-processing analysis, it was found that the dune toe was minimally impacted during these four simulations. In addition, the 24.6-ft advance of the dune toe predicted for profile CBI-22 (Table 5-10) was a result of Pybeach selecting a dune toe location shoreward of the actual dune toe. After a post-processing analysis, it was found that the dune toe position did retreat similar to the 10-year wave event and present SLR scenario (Table 5-10). This update would result in the predicted beach width change for profile CBI-22, during the 10-year wave event and 2040 SLR scenario, to increase.

Table 5-9. Predicted Change in the Dune Toe Position, in feet, for the 2-Year Wave Event

Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	0.0	0.0	0.0	0.0	0.0	0.0
1.54 (2040)	0.0	0.0	0.0	0.0	-1.6	0.0
3.54 (2070)	0.0	0.0	-31.2	-3.3	-1.6	-3.3

Table 5-10. Predicted Change in the Dune Toe Position, in feet, for the 10-Year Wave Event

Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	0.0	0.0	-32.8	0.0	-21.3	0.0
1.54 (2040)	0.0	0.0	-32.8	0.0	24.6	0.0
3.54 (2070)	0.0	-93.5	-32.8	-8.2	-1.6	-6.6

Table 5-11. Predicted Change in the Dune Toe Position, in feet, for the 100-Year Wave Event

Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	0.0	0.0	-32.8	0.0	-16.4	0.0
1.54 (2040)	0.0	0.0	-1.6	26.2	-8.2	-4.9
3.54 (2070)	-1.64	-93.5	-82.0	-6.6	-1.6	-9.8

Profile CBI-13 showed substantial erosion of the dune toe during the 10- and 100-year wave events and for the three SLR scenarios (Tables 5-10 and 5-11). The large increase in beach width for CBI-13 was a result of an advance of the shoreline position, but the sediment for that accretion likely eroded from the dune toe.

The largest predicted advance in the position of the dune toe was along profile CBI-22 for the 10-year wave event and 2040 SLR scenario (Table 5-10). The same profile was predicted to have a similar advance in its shoreline position, which resulted in a minimal change in the beach width.

5.3.3 Dune Crest Height

The final quantitative metric evaluated for this study, change in dune crest height, was computed independent of beach width. The dune crest height represents the highest elevation along the dune of each of the selected profiles. The dune crest height change was computed for each of the 54 simulations by using Pybeach to extract the pre-storm and post-storm dune crest elevations, and then the pre-storm dune crest elevation was subtracted from the post-storm dune crest elevation (Tables 5-12 to 5-14). The negative values in the three tables below, highlighted in light to dark red, represent a decrease in dune crest height. There were no predicted increases in dune crest height.

Table 5-12. Predicted Change in the Dune Crest Height, in feet, for the 2-Year Wave Event

Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	0.0	0.0	0.0	0.0	0.0	0.0
1.54 (2040)	0.0	0.0	0.0	0.0	0.0	0.0
3.54 (2070)	0.0	0.0	0.0	0.0	-3.3	0.0

Table 5-13. Predicted Change in the Dune Crest Height, in feet, for the 10-Year Wave Event

Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	0.0	0.0	0.0	0.0	-0.2	0.0
1.54 (2040)	0.0	0.0	0.0	0.0	-0.1	0.0
3.54 (2070)	0.0	0.0	0.0	0.0	-3.3	0.0

Table 5-14. Predicted Change in the Dune Crest Height, in feet, for the 100-Year Wave Event

Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	0.0	0.0	0.0	0.0	0.0	0.0
1.54 (2040)	0.0	0.0	0.0	0.0	-3.2	0.0
3.54 (2070)	0.0	0.0	0.0	0.0	-3.3	0.0

As shown in Tables 5-12 to 5-14, 48 of the 54 simulations had no predicted change in dune crest height. Two of the simulations predicted decreases in dune crest elevation of 0.2 ft or less. CBI-22 was the only profile where the dune crest height was predicted to erode. CBI-22 had the lowest starting dune crest height of the six selected profiles. The changes in dune crest height at

CBI-22 signify that some overtopping of the dune was predicted, though mostly during the 2070 SLR scenario for the three wave events, and during the 2040 SLR scenario only during the 100-year wave event. Overtopping can lead to flooding in the dune swales, potentially impacting dune fauna and flora. Dune crest elevation changes were predicted for profile CBI-22 with the largest changes predicted for the three wave events during the 2070 SLR scenario, when the dune crest elevation decreases by 3.3 ft.

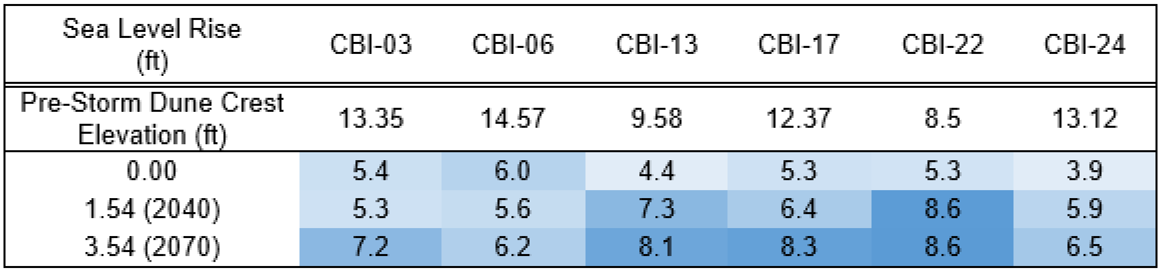
5.3.4 Maximum Wave Run-up

For the maximum wave run-up analysis, wave run-up elevation along each profile is based on the TWL, a combination of tides, surge, and wave conditions (Figure 2-1). The TWL analysis considers multiple worst case scenarios, which include a range of SLR scenarios and storm wave events at differing recurrence intervals (2-year, 10-year, and 100-year). The combination of SLR and wave heights along each profile were evaluated using XBeach to predict potential wave run-up elevation and inland flood exposure to SPI in the future.

The predicted maximum wave run-up along each of the profiles, for each of the storm scenarios, and each of SLR scenarios are presented in Tables 5-15 to 5-17. Overall, the XBeach results illustrate that, in general and as expected, as the offshore wave heights increase and as the SWL elevation increases with SLR, the potential wave run-up height increases.

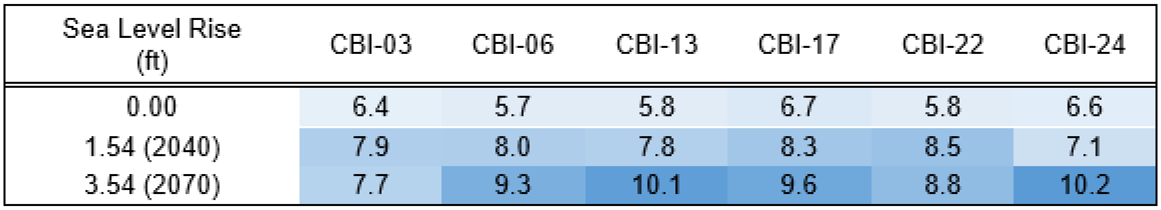
Wave run-up elevation values during the 100-year storm events with moderate (2040) and high (2070) SLR are approaching elevations in which dune overtopping may occur. As a note, the predicted maximum run-up along profile CBI-03 during the 10-year wave event was higher for the 2040 SLR scenario as compared to the 2070 SLR scenario (Table 5-16). The reason is a result of the influence of bathymetry and topography on the breaking waves. With the deeper water depths during the 2070 SLR scenario, the influence of the seafloor on the wave is reduced; as a result, the wave may not break along the shoreface and not create as high of run-up compared to the shallower water depths.

Table 5-15. Predicted Maximum Wave Run-up, in feet NAVD88, for the 2-Year Wave Event



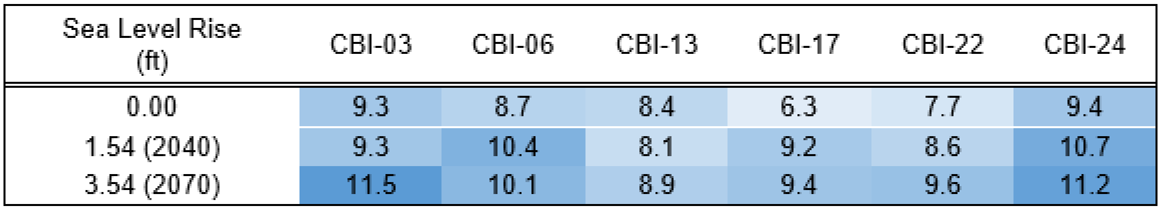
Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
Pre-Storm Dune Crest Elevation (ft)	13.35	14.57	9.58	12.37	8.5	13.12
0.00	5.4	6.0	4.4	5.3	5.3	3.9
1.54 (2040)	5.3	5.6	7.3	6.4	8.6	5.9
3.54 (2070)	7.2	6.2	8.1	8.3	8.6	6.5

Table 5-16. Predicted Maximum Wave Run-up, in feet NAVD88, for the 10-Year Wave Event



Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	6.4	5.7	5.8	6.7	5.8	6.6
1.54 (2040)	7.9	8.0	7.8	8.3	8.5	7.1
3.54 (2070)	7.7	9.3	10.1	9.6	8.8	10.2

Table 5-17. Predicted Maximum Wave Run-up, in feet NAVD88, for the 100-Year Wave Event



Sea Level Rise (ft)	CBI-03	CBI-06	CBI-13	CBI-17	CBI-22	CBI-24
0.00	9.3	8.7	8.4	6.3	7.7	9.4
1.54 (2040)	9.3	10.4	8.1	9.2	8.6	10.7
3.54 (2070)	11.5	10.1	8.9	9.4	9.6	11.2

5.3.5 Individual Profiles

The next stage of analysis focused on the individual profiles and their predicted accretion and erosion as a result of the storm events and SLR scenarios.

Figure 5-3 illustrates the initial condition of one of the profiles, CBI-03, before the impact of a single storm event. A line for the mean sea level (MSL) elevation was added for reference. The SWL, at this start of each simulation, was derived from the NOAA water level data shown in Figure 5-1.

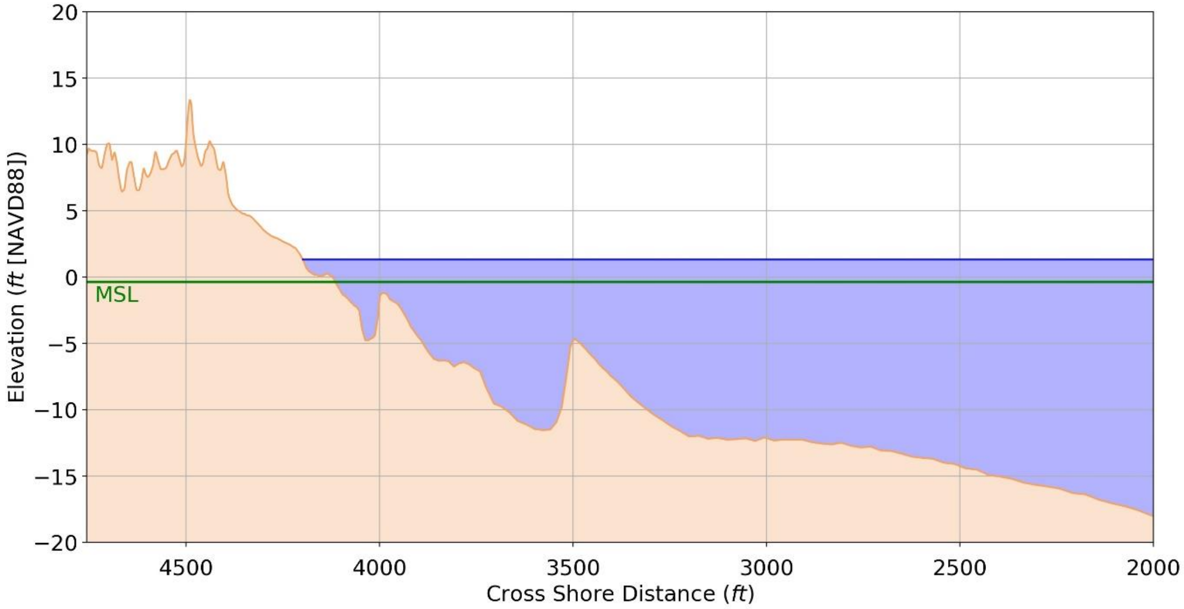


Figure 5-3. Initial Still Water Level and Bed Elevation for Profile CBI-03. MSL Datum Shown for Reference.

5.3.5.1 CBI-03

The predicted changes to the CBI-03 profile for the 2-, 10-, and 100-year wave events, across the three SLR scenarios, are shown in Figures 5-4 to 5-6. The beach width for CBI-03 decreased across the nine simulations. The change in beach width during the 100-year wave event under present SLR was largest for this storm scenario (Figure 5-6, top). Each of the storm events and SLR scenarios were predicted to decrease the beach width for this profile. The beach profile was steepened as a result of the breaking waves along the shoreline, thus reducing the distance from the dune toe to the shoreline. The smaller reductions in beach width during the SLR scenarios are a result of the waves breaking farther up the beach, and eroding sand, although sand is predicted to be deposited along the beach at or just below MSL. The 100-year wave event for the present and 2040 SLR scenarios had the largest change in beach width, and the smallest was during the 2-year and 10-year wave events and the 2070 SLR scenario.

The primary factor in the predicted decreases in beach width across the 9 simulations was the retreat of the shoreline position. The dune toe was only impacted during the 100-year wave event for the 2070 SLR scenario, when the waves and the water levels were the highest. As a note, the foredune was predicted to erode during the 100-year wave event and the 2070 SLR scenario, though this was not shown in the dune crest height tables presented above since it’s not the highest dune along the profile (Figure 5-6, bottom).

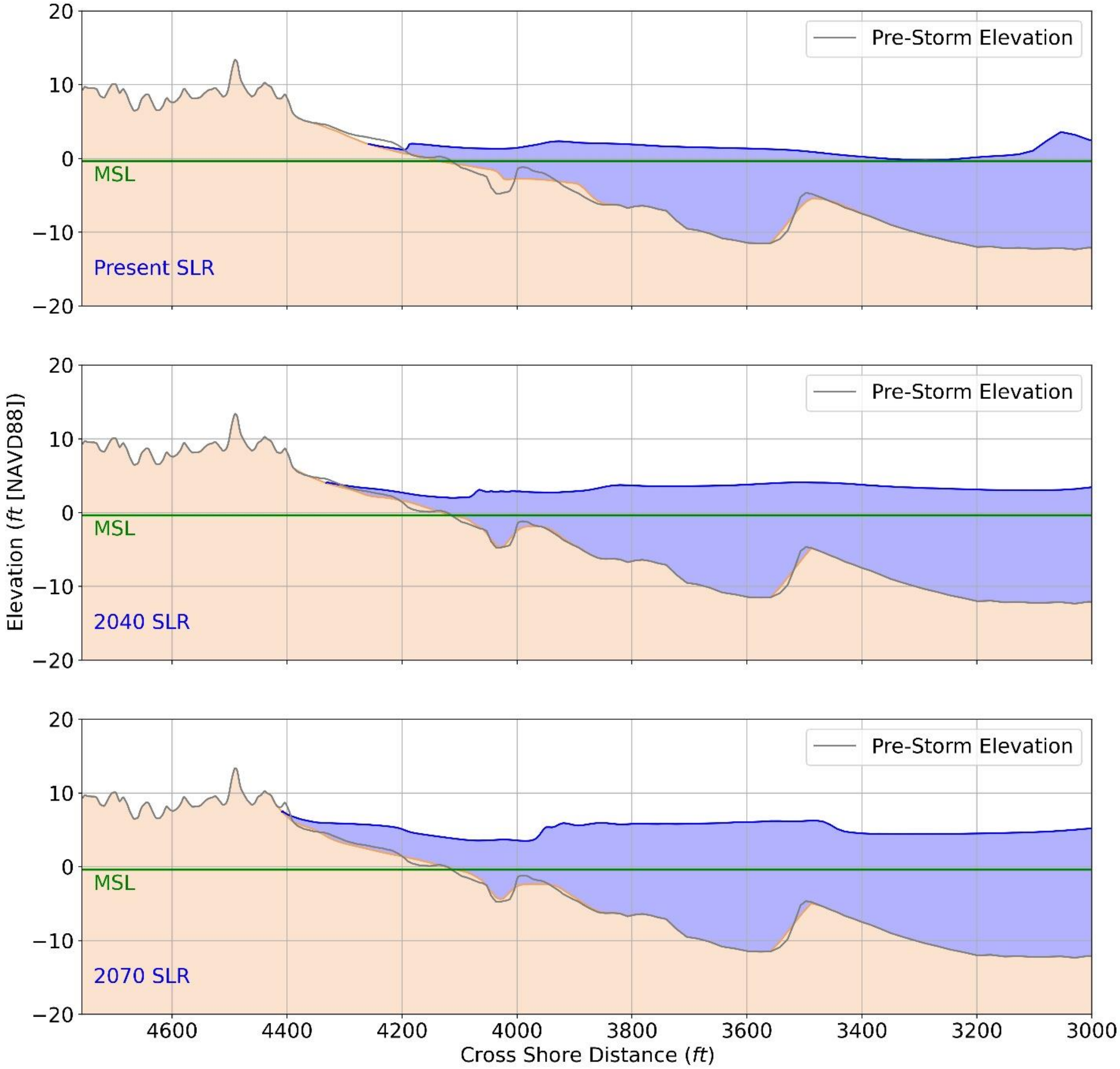


Figure 5-4. Predicted Shoreline Elevation for CBI-03 after 30 Hours of Exposure to a 2-Year Storm Event and 3 SLR Scenarios

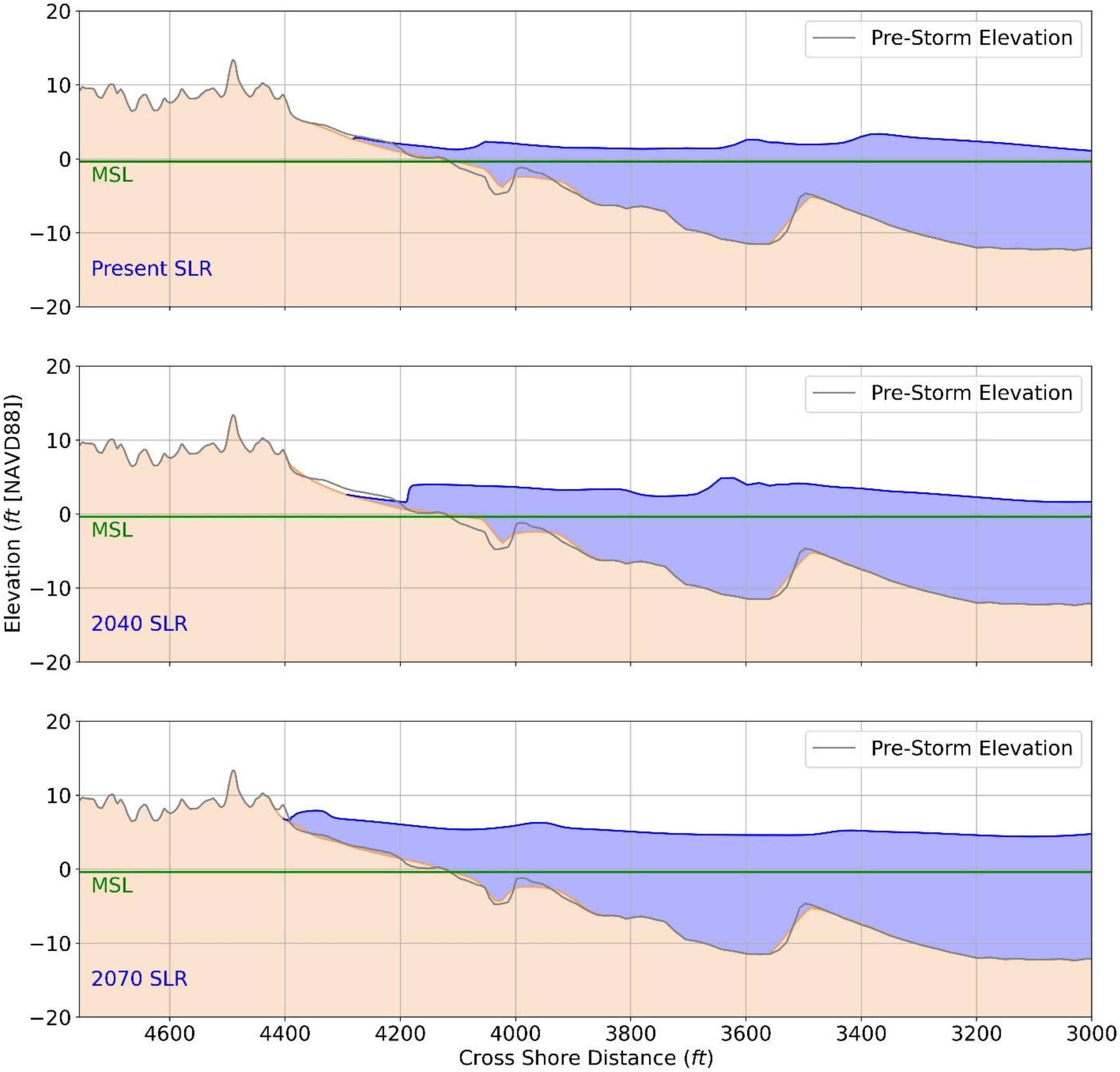


Figure 5-5. Predicted Shoreline Elevation for CBI-03 after 30 Hours of Exposure to a 10-Year Storm Event and 3 SLR Scenarios

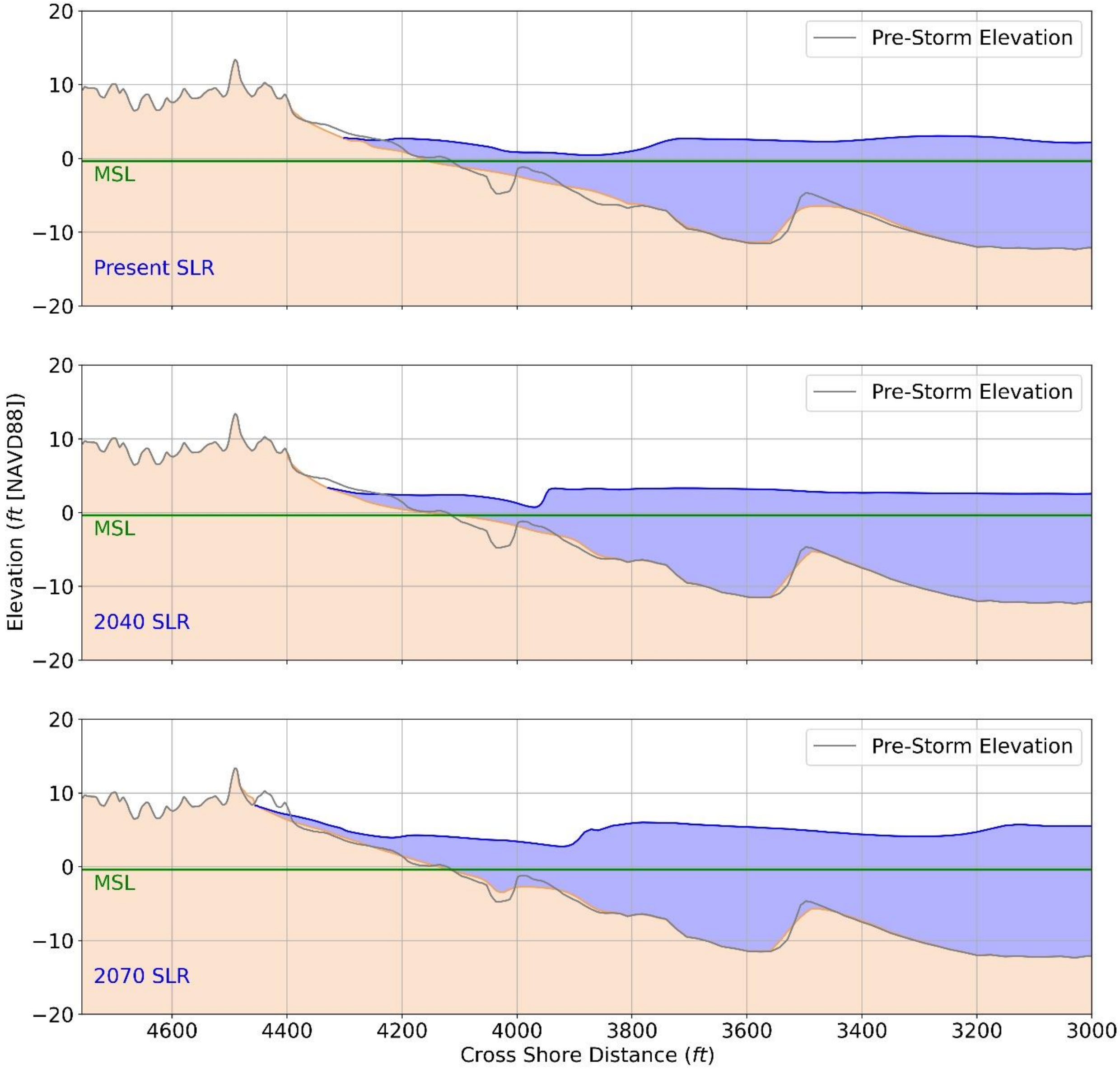


Figure 5-6. Predicted Shoreline Elevation for CBI-03 after 30 Hours of Exposure to a 100-Year Storm Event and 3 SLR Scenarios

5.3.5.2 CBI-06

The predicted changes to the CBI-06 profile for the 2-, 10-, and 100-year wave events, across the three SLR scenarios, are shown in Figures 5-7 to 5-9. The beach width was predicted to increase for the nine simulations along CBI-06, although as discussed earlier, the largest increase in beach width during the 10-year wave event was due to a large amount of erosion on the foredune (Figure 5-8, bottom). A similar beach width increase was predicted for the 100-year wave event and 2070 SLR scenario, a result of the retreating dune toe (Figure 5-9, bottom).

The primary factor in the predicted increases in beach width across the nine simulations was the advancement in the shoreline position. The dune toe was only impacted during the 10- and 100-year wave events for the 2070 SLR scenario, when the waves and the water levels were the highest. Interestingly, the foredune was predicted to erode during the 10-year wave event and the 2070 SLR scenario, though this was not shown in the dune crest height tables presented above since it's not the highest dune along the profile (Figure 5-8, bottom). The reason for the 10-year wave event causing foredune erosion and not during the 100-year wave event, with the same SLR scenario, is a result of the influence of bathymetry and topography on the breaking waves. Smaller waves, representative of those during the 10-year wave event, can travel closer to shore before breaking especially with higher sea levels. These waves would likely break closer to the foredune, causing the predicted erosion. Overtopping of the foredune was predicted for the 100-year wave event and the 2070 SLR scenario, though the foredune was not eroded. This is likely the reason for the dune toe change table showing a similar impact as the 10-year wave event (Table 5-11).

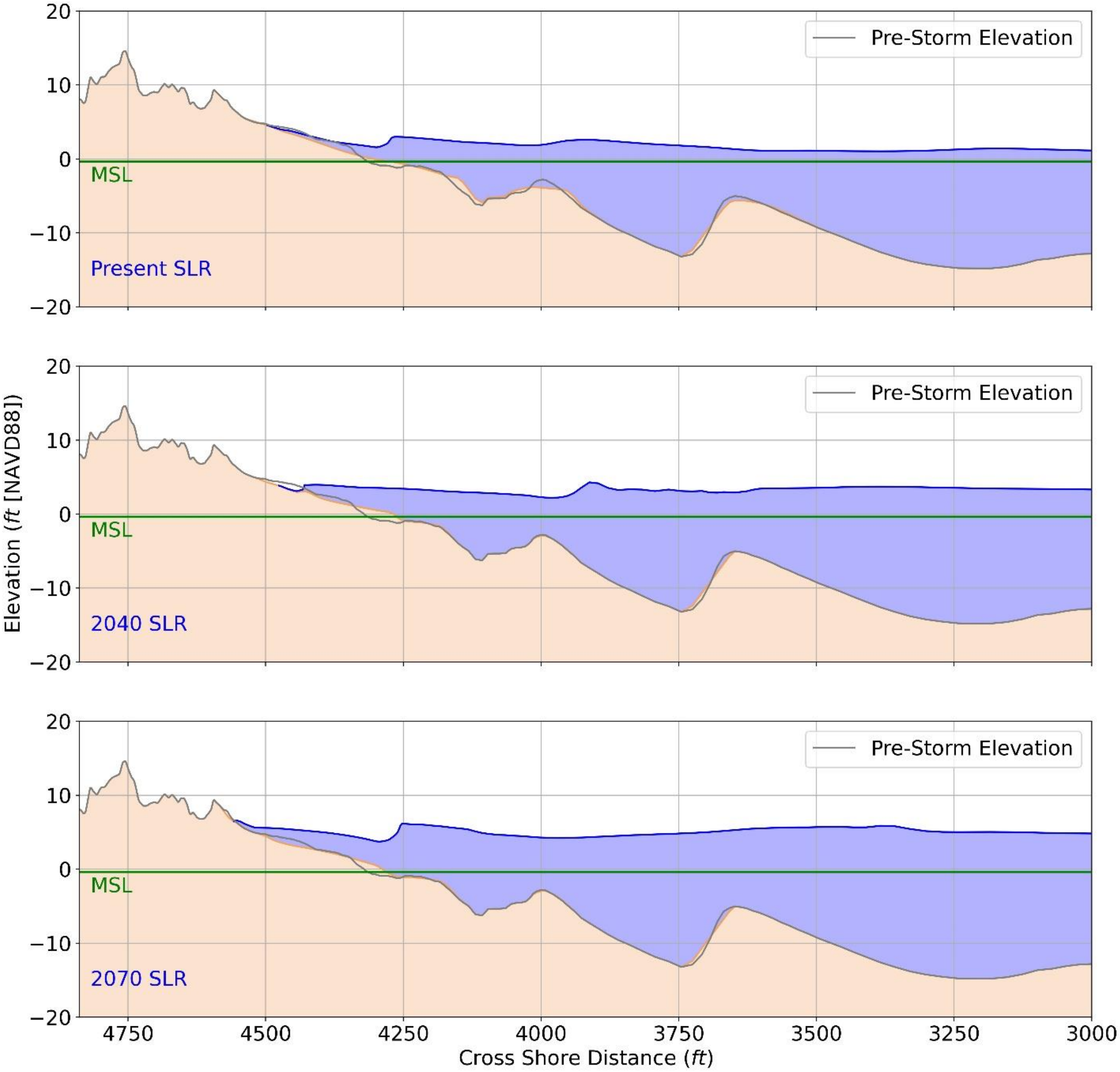


Figure 5-7. Predicted Shoreline Elevation for CBI-06 after 30 Hours of Exposure to a 2-Year Storm Event and 3 SLR Scenarios

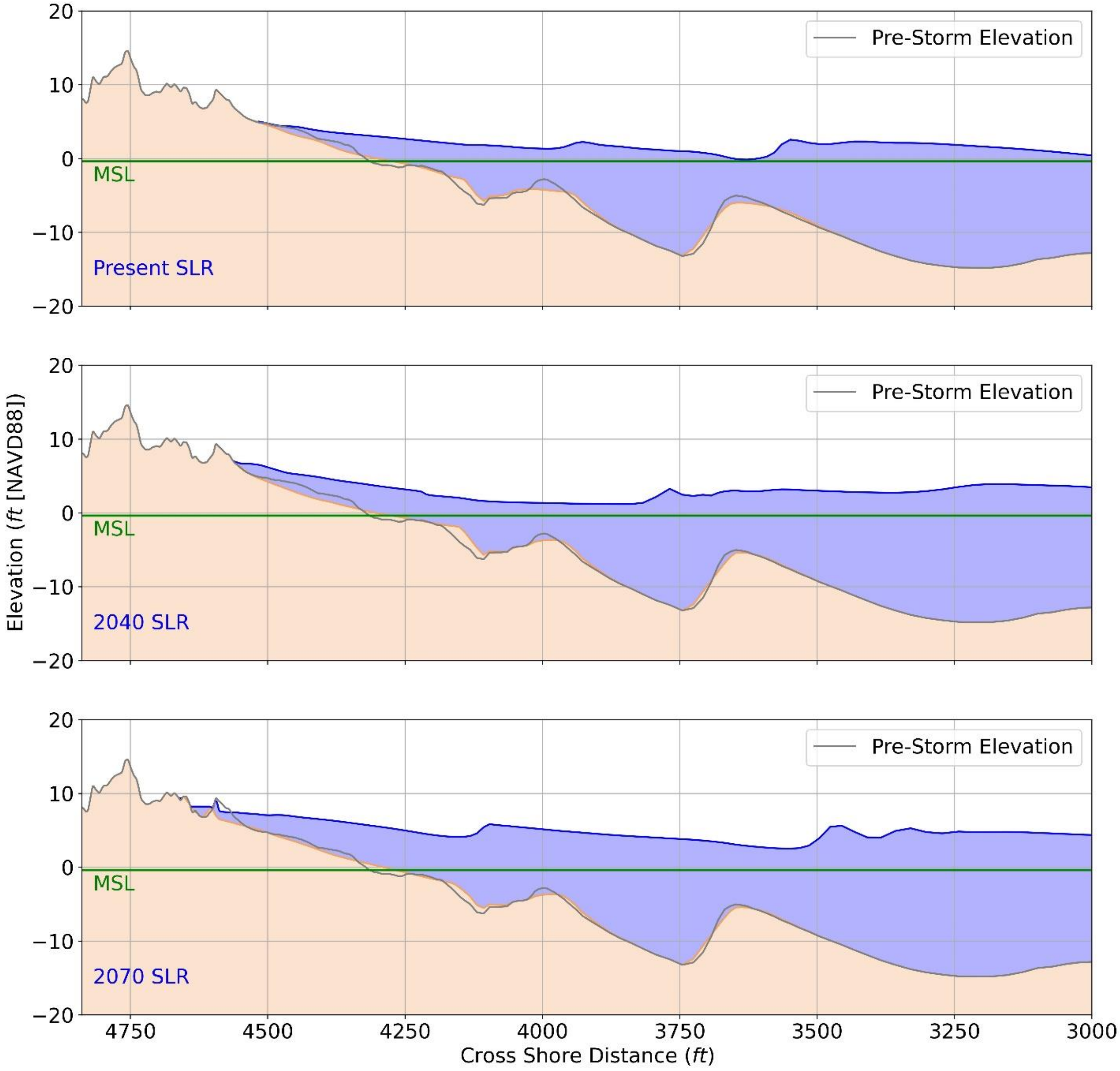


Figure 5-8. Predicted Shoreline Elevation for CBI-06 after 30 Hours of Exposure to a 10-Year Storm Event and 3 SLR Scenarios

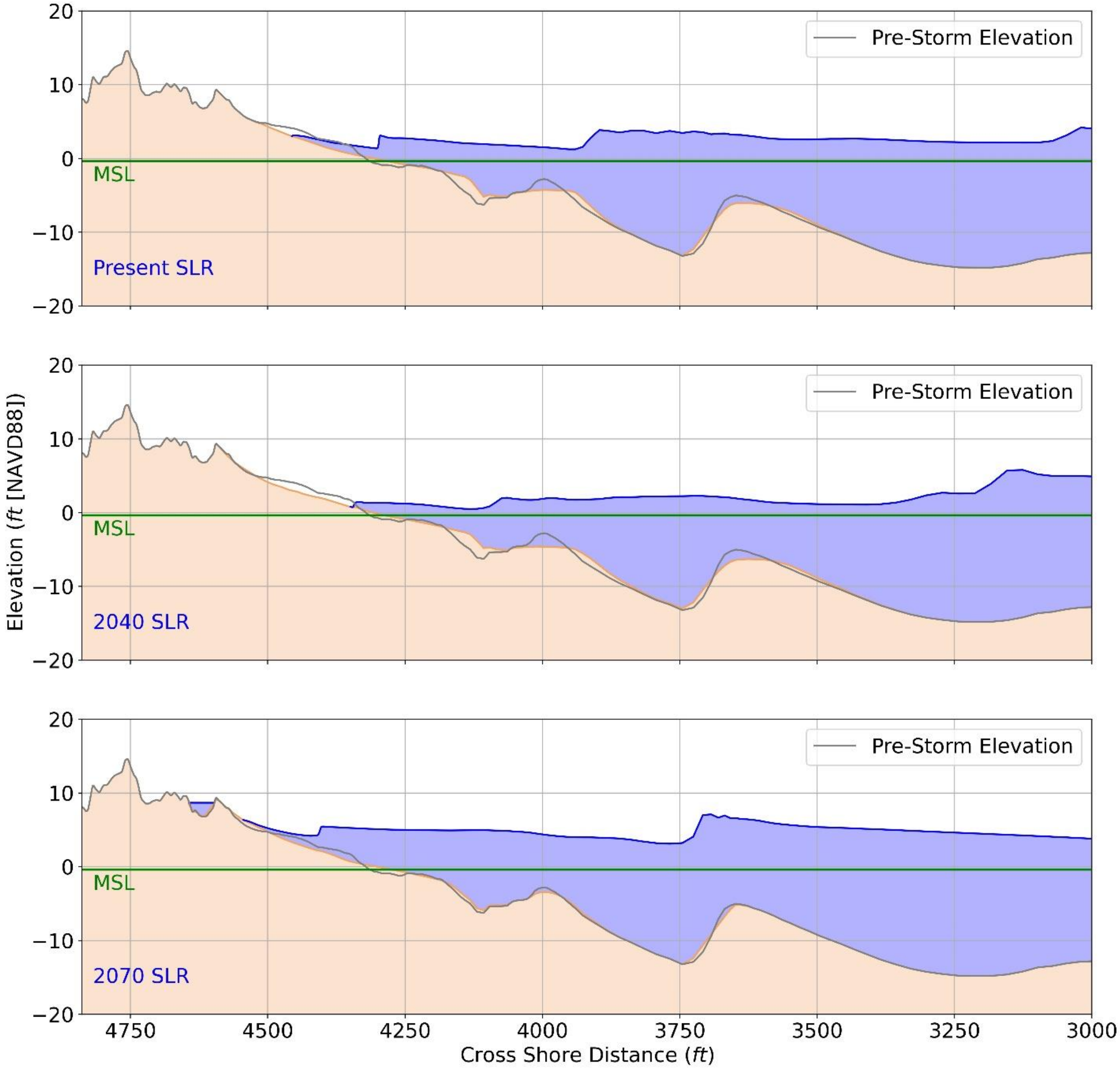


Figure 5-9. Predicted Shoreline Elevation for CBI-06 after 30 Hours of Exposure to a 100-Year Storm Event and 3 SLR Scenarios

5.3.5.3 CBI-13

The predicted changes to the CBI-13 profile for the 2-, 10-, and 100-year wave events, across the SLR scenarios, are shown in Figures 5-10 to 5-12. Similar to CBI-06, the beach width for the nine simulations along CBI-13 is predicted to increase. The largest increase in beach width occurred during the 100-year wave event and the 2070 SLR scenario, although this was again as a result of a retreat of the dune toe (Figure 5-12, bottom). Most of the other simulations had a similar retreat of the dune toe, resulting in the predicted increase in beach width.

The shoreline position and dune toe position were shown to generally advance and retreat, respectively, for CBI-13. This was likely a result of erosion of the foredune and material subsequently being deposited on the beach, resulting in the increases in beach width. The foredune was predicted to have some erosion during the 2- and 10-year wave events and the 2070 SLR scenario, though this was not shown in the dune crest height tables presented above since it's not the highest dune along the profile (Figures 5-10 and 5-11, bottom). Overtopping of the foredune was predicted during the 100-year wave event and the 2040 and 2070 SLR scenarios (Figure 5-12, middle and bottom).

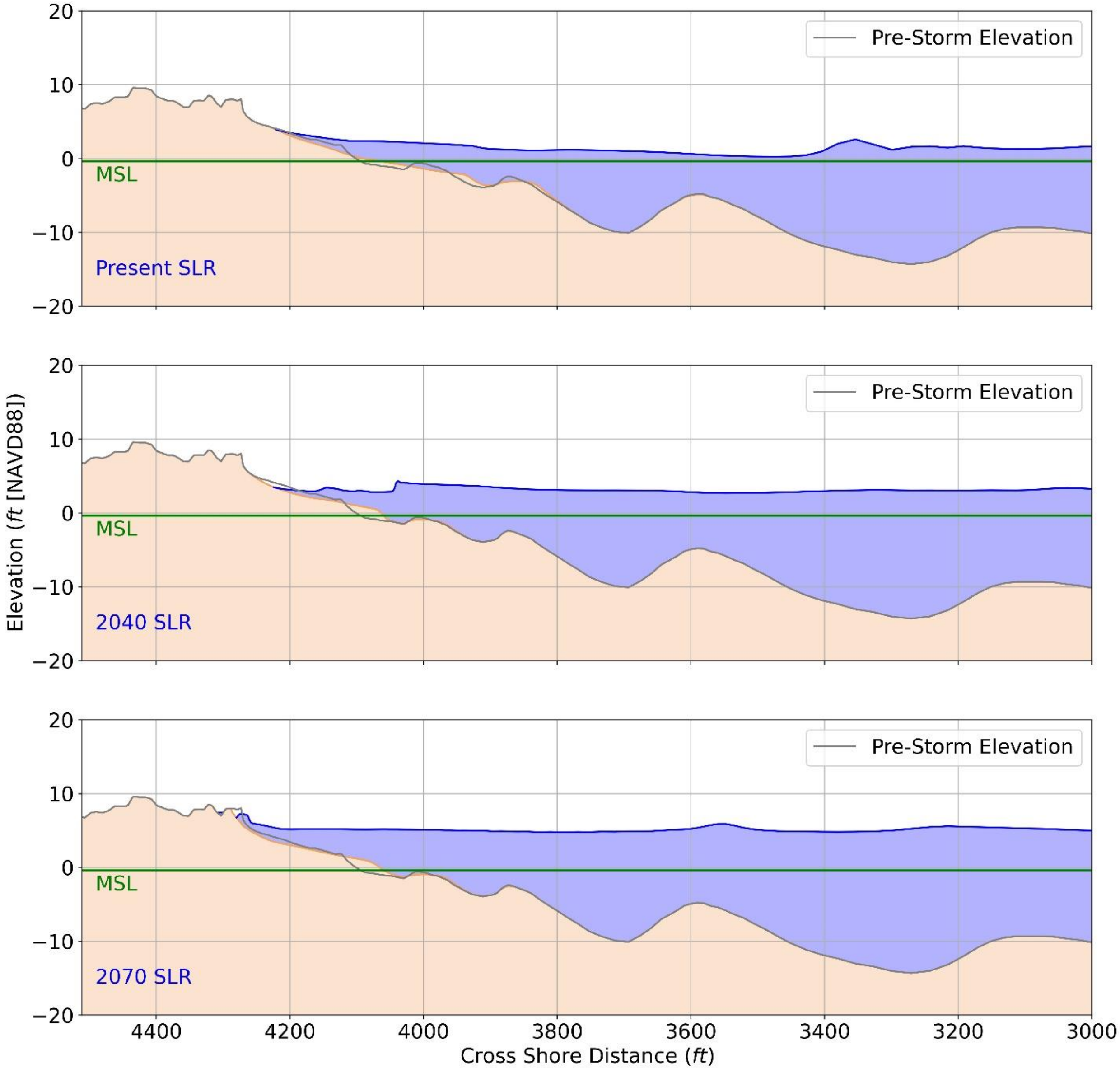


Figure 5-10. Predicted Shoreline Elevation for CBI-13 after 30 Hours of Exposure to a 2-Year Storm Event and 3 SLR Scenarios

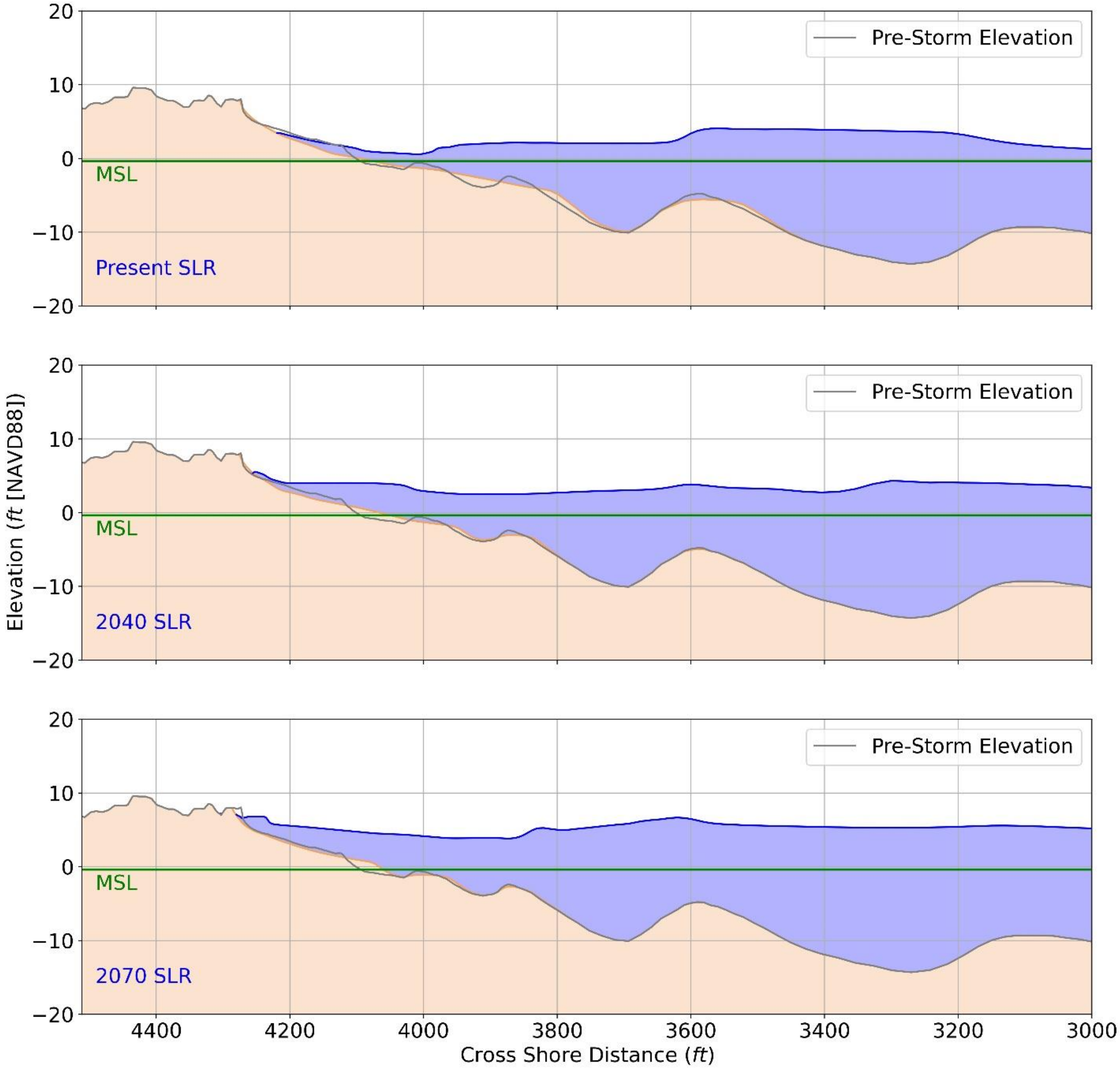


Figure 5-11. Predicted Shoreline Elevation for CBI-13 after 30 Hours of Exposure to a 10-Year Storm Event and 3 SLR Scenarios

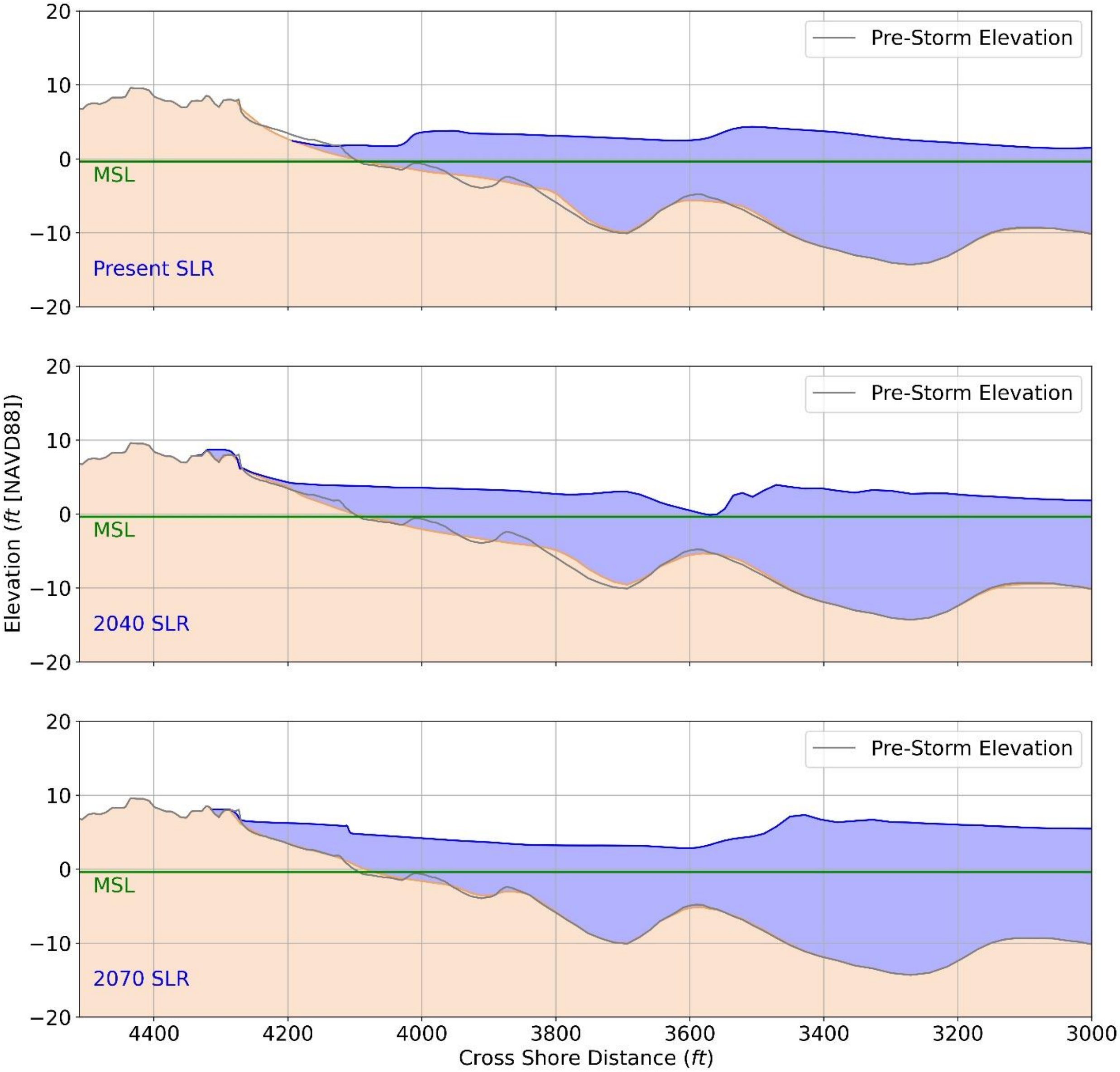


Figure 5-12. Predicted Shoreline Elevation for CBI-13 after 30 Hours of Exposure to a 100-Year Storm Event and 3 SLR Scenarios

5.3.5.4 CBI-17

The predicted changes to the CBI-17 profile for the 2-, 10-, and 100-year wave events, across the SLR scenarios, are shown in Figures 5-13 to 5-15, respectively. A decreasing beach width was predicted for all but three of the CBI-17 simulations. One of those three simulation had no predicted change in beach width, and the remaining two had changes up to 6.6 ft. The largest changes in beach width occurred during the 100-year wave event under the present and 2040 SLR scenarios. This is a result of a steepening of the lower beach, and material deposited seaward of the shoreline, below MSL (Figure 5-14 and Figure 5-15, top). The shoreline position was the primary factor in the decrease in beach width along this profile. Four of the nine simulations along this profile had predicted changes to the dune toe position. Three of those four occurred during the 2070 SLR scenario, and the largest occurred during the 100-year wave event and the 2040 SLR scenario. No beach width change was predicted for the 2-year wave event and 2070 SLR scenario (Figure 5-13, bottom), though the profile along the lower beach was altered.

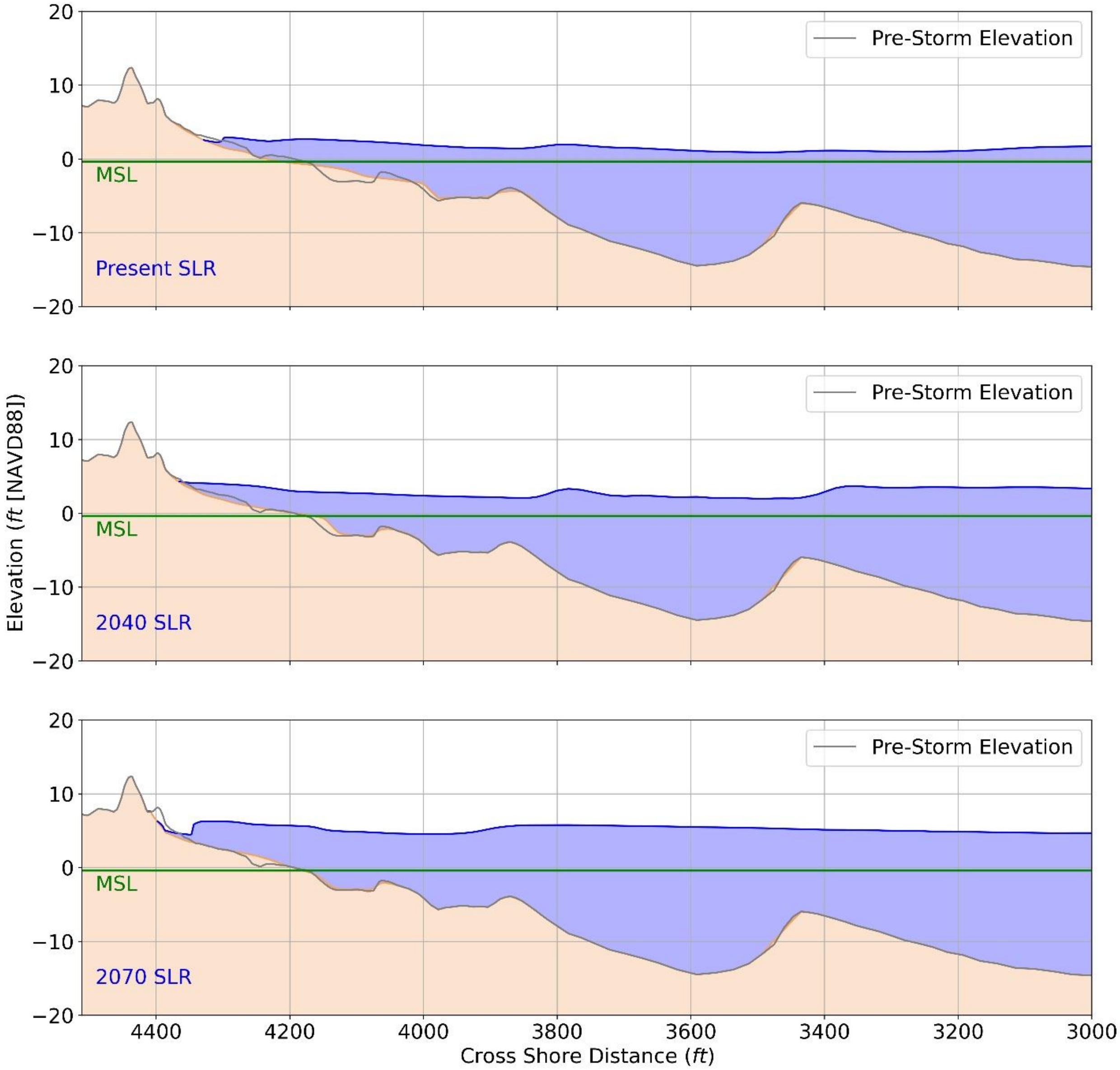


Figure 5-13. Predicted Shoreline Elevation for CBI-17 after 30 Hours of Exposure to a 2-Year Storm Event and 3 SLR Scenarios

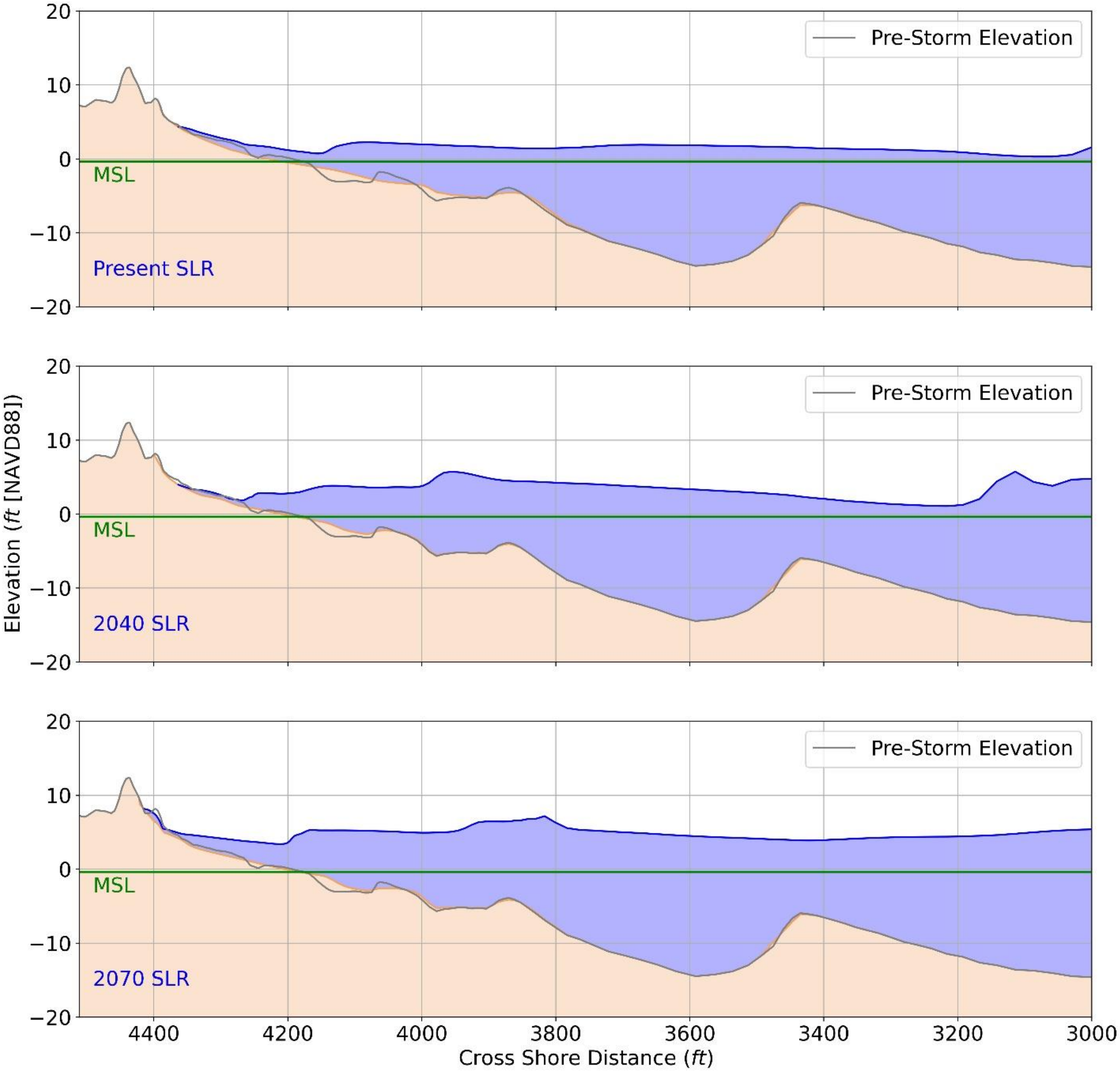


Figure 5-14. Predicted Shoreline Elevation for CBI-17 after 30 Hours of Exposure to a 10-Year Storm Event and 3 SLR Scenarios

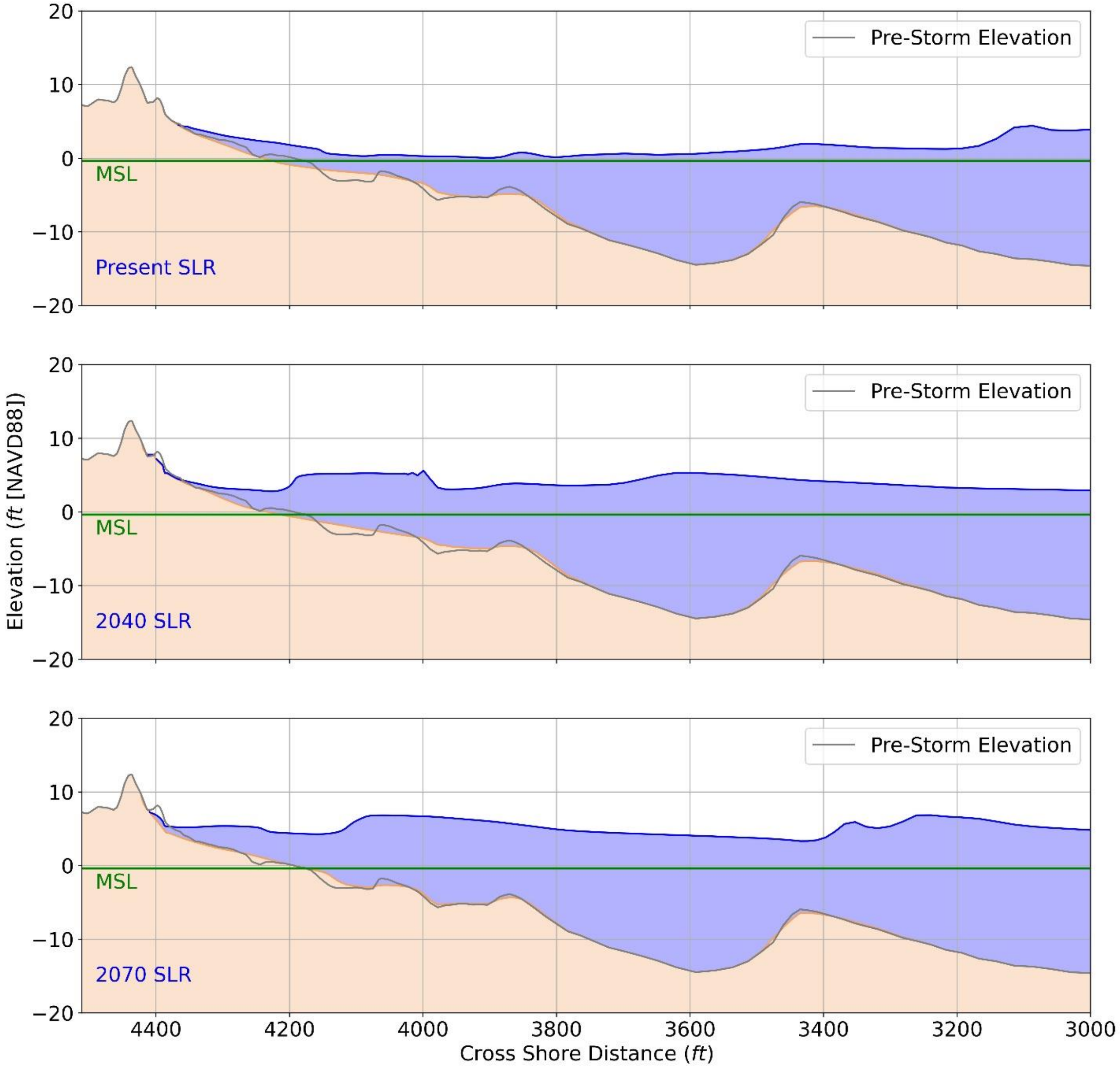


Figure 5-15. Predicted Shoreline Elevation for CBI-17 after 30 Hours of Exposure to a 100-Year Storm Event and 3 SLR Scenarios

5.3.5.5 CBI-22

The predicted changes to the CBI-22 profile for the 2-, 10-, and 100-year wave events, across the SLR scenarios, are shown in Figures 5-16 to 5-18. An increasing beach width was predicted for each of the CBI-22 simulations, except one. The increasing beach width was generally a result of an advancing shoreline position and retreat of the dune toe.

Interestingly, the 10-year storm event under present SLR conditions predicted a larger amount of erosion along the foredune as compared to the 100-year storm event (Figure 5-17). This is a result of the influence of bathymetry and topography on the wave energy. Smaller waves can travel closer to shore before breaking, especially with varying water levels. At the offshore point of the profile, the 100-year wave height is higher than the 10-year wave height (Table 5-2). As a result, the larger offshore wave of the 100-year event comes in contact with the seafloor at a deeper depth and will break, expelling its energy before rushing up to the foredune, thus reducing the potential for erosion. The 10-year offshore wave will break closer to the shoreline, thus increasing the potential for erosion. The importance of this finding is that more frequent wave events, rather than larger waves, could cause increased potential for coastal erosion. However, the occurrence of this is dependent on the local bathymetry as most of the other selected profiles were predicted to have larger amounts of erosion during the 100-year storm event, as would be expected.

The entire dune system was predicted to erode in four of the nine simulations at CBI-22, also confirmed in the dune crest height tables (Tables 5-12 to 5-14). The erosion was only predicted for the 2070 SLR scenario for the 2- and 10-year wave events (Figures 5-16 and 5-17, bottom). For the 100-year wave event, the dune erosion was predicted for the 2040 and 2070 SLR scenarios (Figure 5-18, middle and bottom). While the magnitude of the change in dune crest elevations were similar for these four simulations, upon closer inspection of the figures below, the new eroded profile is different, except for the height of the dune crest.

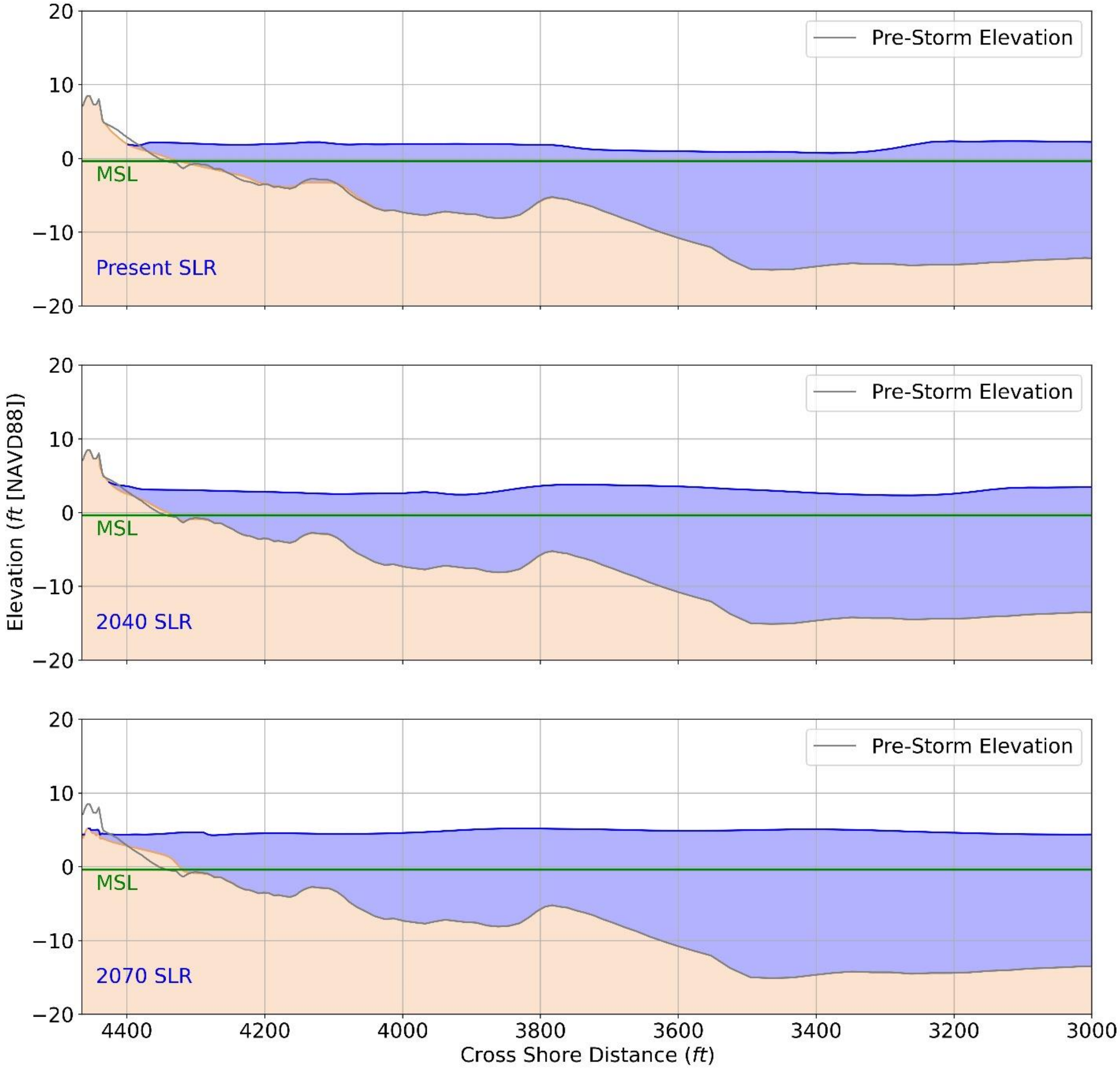


Figure 5-16. Predicted Shoreline Elevation for CBI-22 after 30 Hours of Exposure to a 2-Year Storm Event and 3 SLR Scenarios

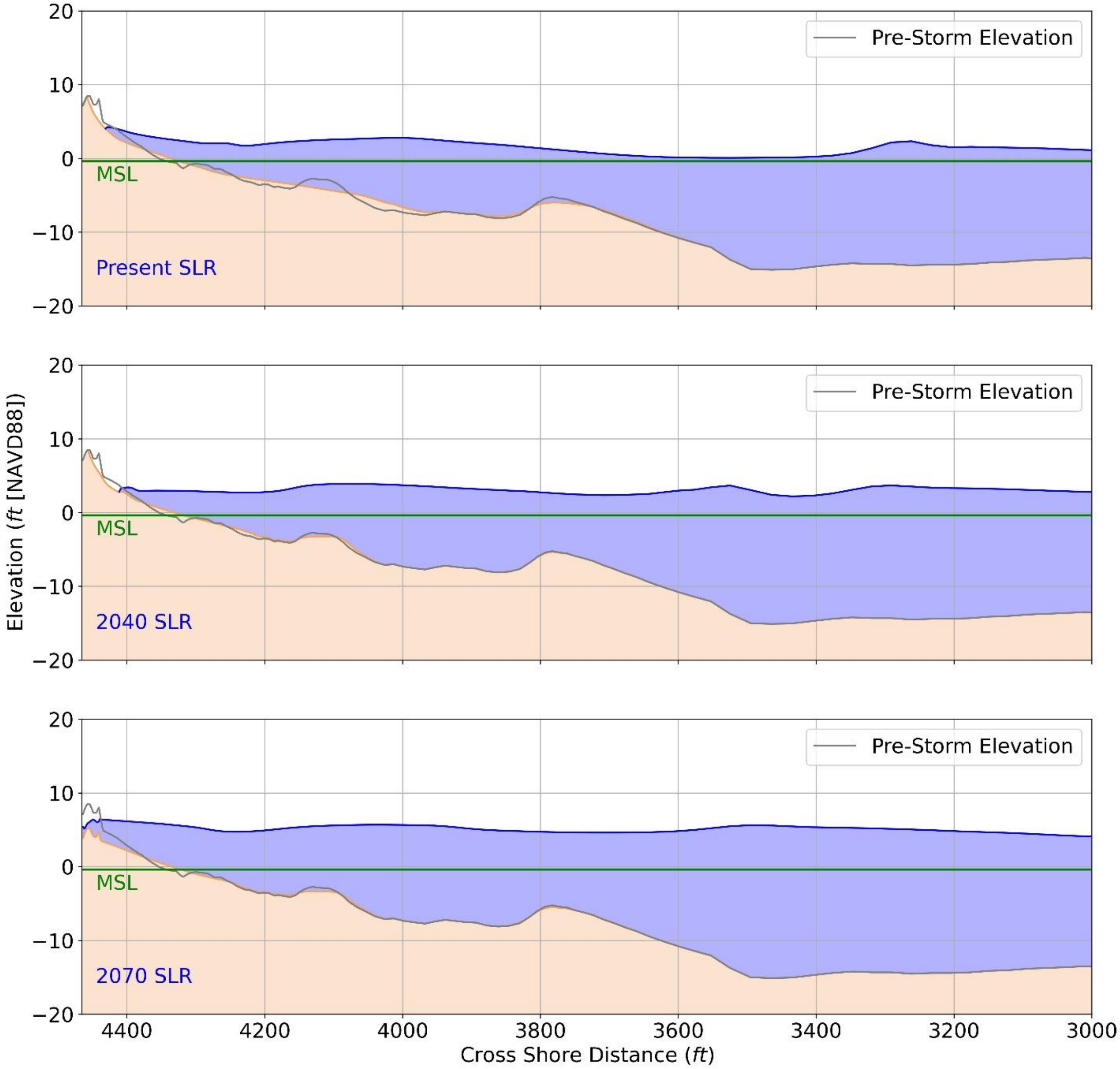


Figure 5-17. Predicted Shoreline Elevation for CBI-22 after 30 Hours of Exposure to a 10-Year Storm Event and 3 SLR Scenarios

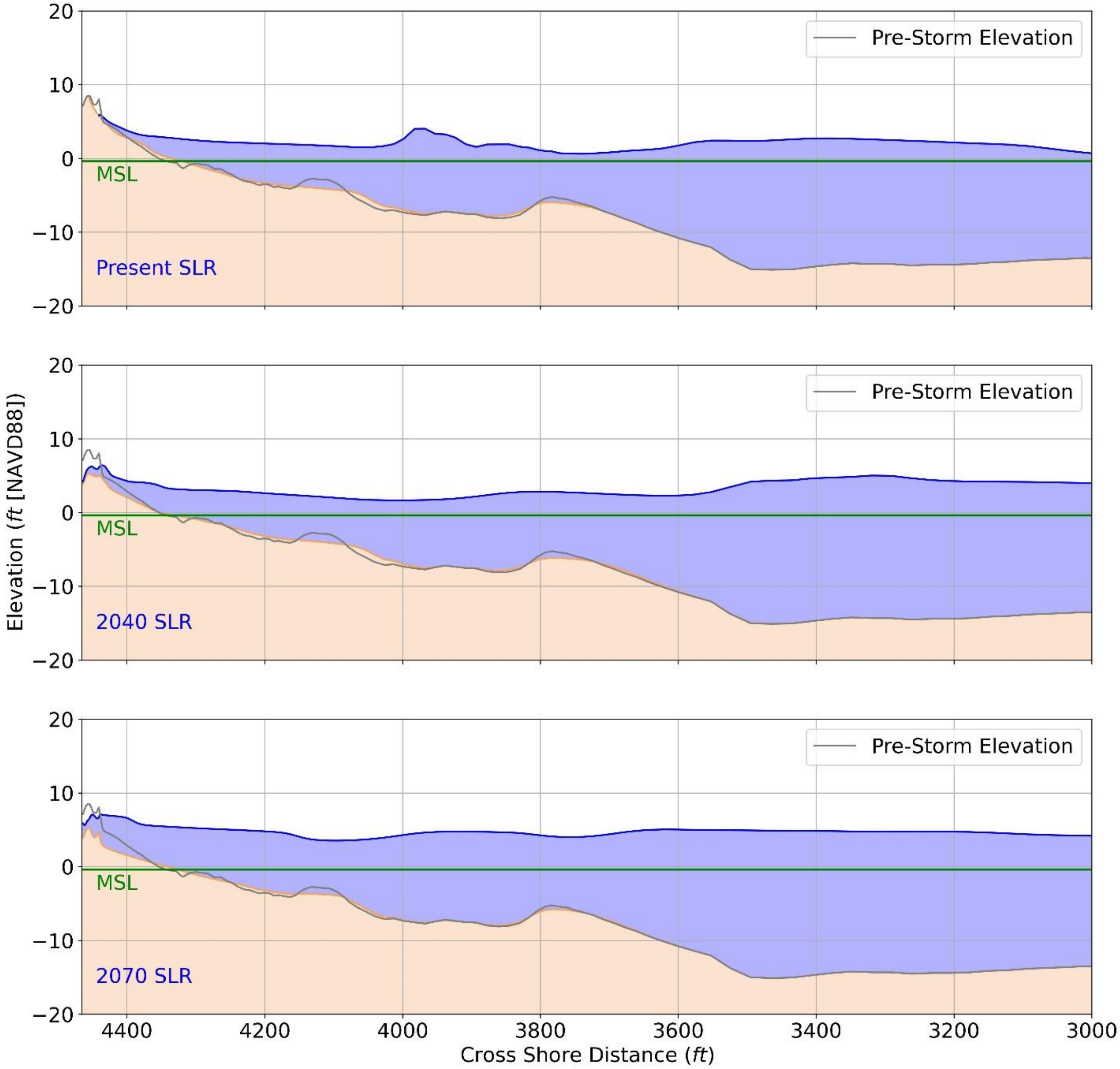


Figure 5-18. Predicted Shoreline Elevation for CBI-22 after 30 Hours of Exposure to a 100-Year Storm Event and 3 SLR Scenarios

5.3.5.6 CBI-24

The predicted changes to the CBI-24 profile for the 2-, 10-, and 100-year wave events, across the SLR scenarios, are shown in Figures 5-19 to 5-21, respectively. This profile was predicted to have the largest decreases in beach width, and is the northernmost profile that was evaluated with XBeach. During the 2-year wave event, the beach width was predicted to increase for the present and 2070 SLR scenarios, a result of a shoreline position advancement and, in the case of the 2070 SLR scenario, retreating dune toe. For the 10- and 100-year wave events, the beach width was predicted to decrease, primarily as a result of retreat of the shoreline position. This is a result of a steepening of the shoreface due to erosion and deposition of material seaward of the shoreline, below MSL.

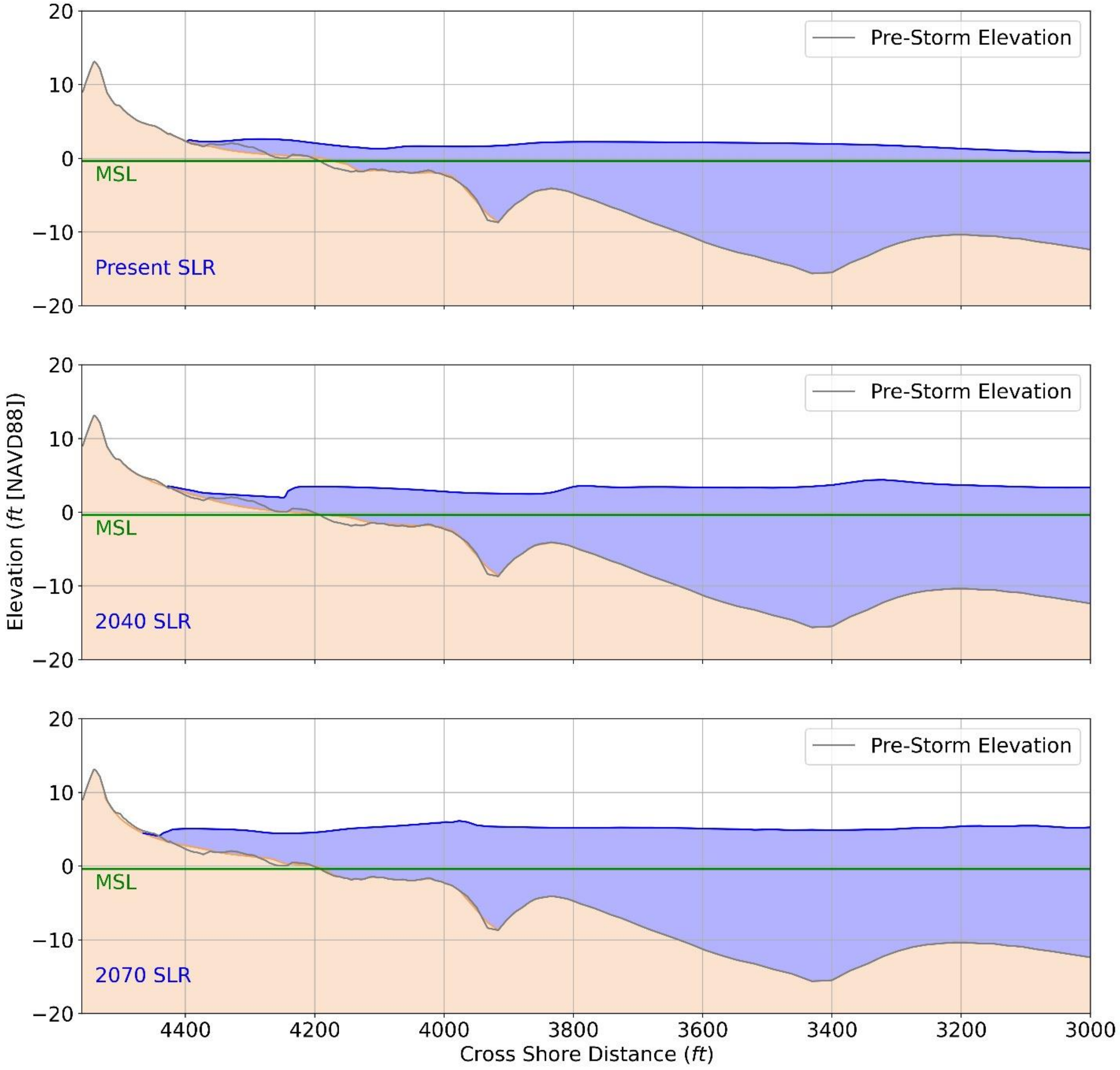


Figure 5-19. Predicted Shoreline Elevation for CBI-24 after 30 Hours of Exposure to a 2-Year Storm Event and 3 SLR Scenarios

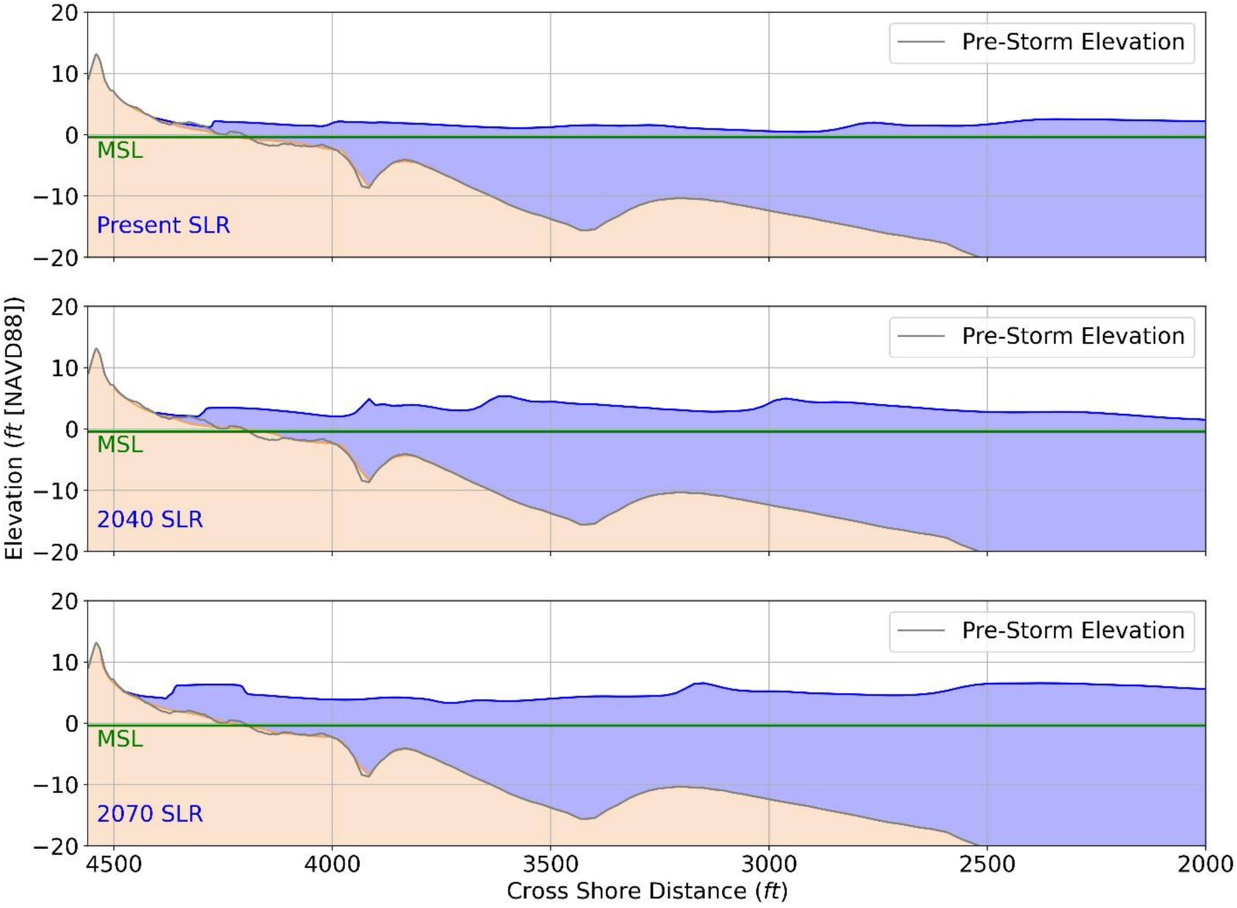


Figure 5-20. Predicted Shoreline Elevation for CBI-24 after 30 Hours of Exposure to a 10-Year Storm Event and 3 SLR Scenarios

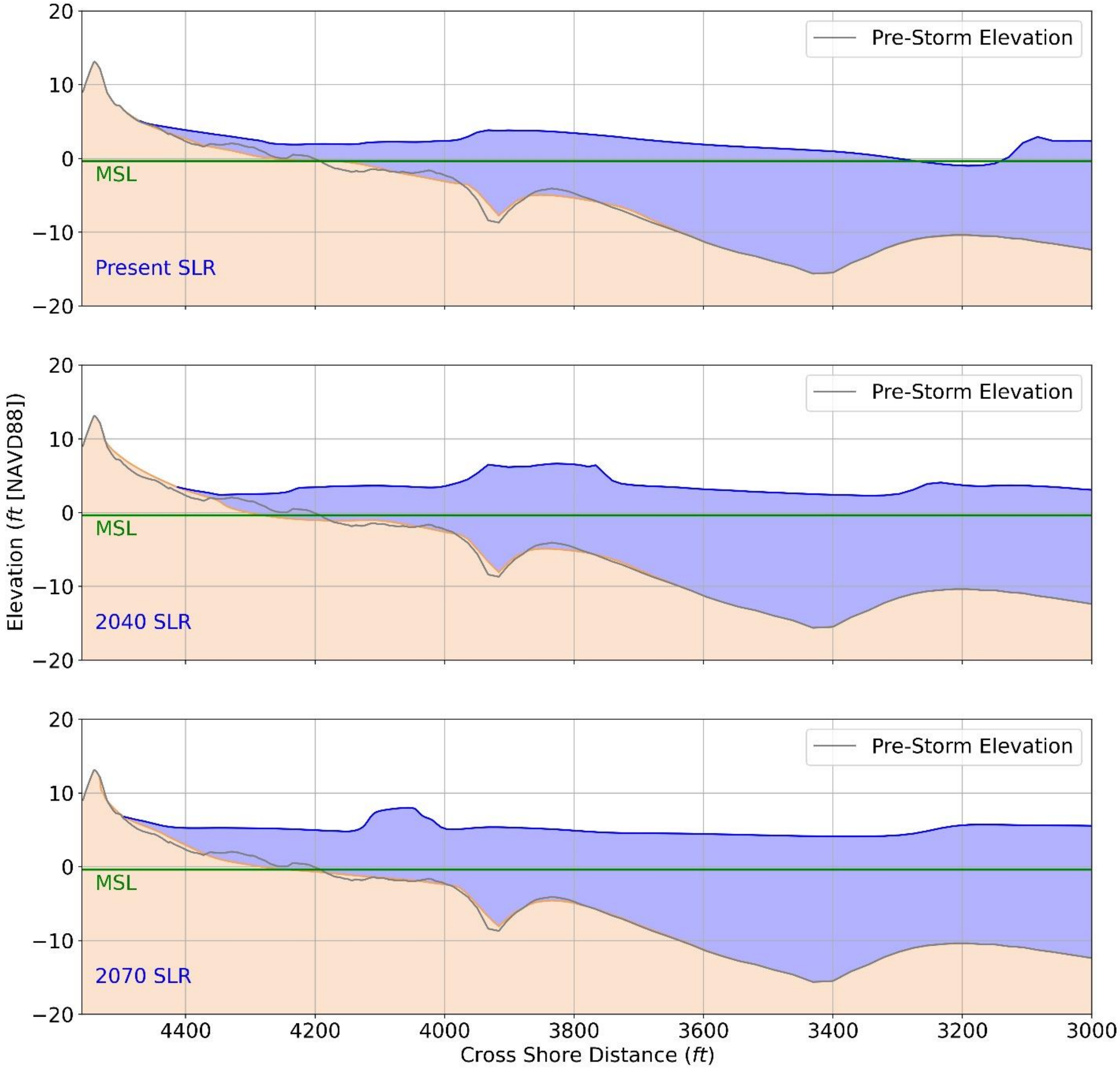


Figure 5-21. Predicted Shoreline Elevation for CBI-24 after 30 Hours of Exposure to a 100-Year Storm Event and 3 SLR Scenarios

5.4 MODEL UNCERTAINTY

Model grid resolution and bathymetry interpolation lead to potential sources of model uncertainty. Modeled bathymetry within a grid cell, while reflective of the mean bathymetry measured using an echo sounder, might be shallower or deeper in certain regions of the cell, leading to enhanced sub-grid-scale erosion/deposition in nature that is not captured by the model.

In addition, uncertainties can arise when assigning values to the sediment bed properties. Sediment bed properties were defined uniformly and contain primarily sand. Variability of these properties within a profile can lead to variability in predicted erosion and accretion, and hence uncertainty in model predictions. The effect of this variability can be evaluated by undertaking sensitivity tests that vary the sediment bed composition during the selected storm events.

However, the net effect of these uncertainties on the short-term sediment transport along each of the profiles is assumed minimal relative to the predictions of erosion and accretion, and conform to the scope of this project. Additionally, uniform sediment bed definition along the length of each profile is assumed based on limited data and may not be explicitly representative of erosion parameters in a specific area. Since the modeling represents acute storm events, the accuracy of predicted changes in bottom elevation is only qualitatively evaluated against the survey data in terms of the model's ability to predict overall patterns of coastal erosion and accretion potential.

Finally, there are uncertainties associated with the auto-derivation of metrics from the model-output profiles. PyBeach uses a code written in Python, and although typical methods were used to extract the dune crest, dune toe, and shoreline, the results can be impacted by the complex topography of the dunes along the selected SPI profiles. However, this method was used to extract the same metrics from the actual survey data, and we qualitatively QA/QC'd outputs and results.

6 SUMMARY OF FINDINGS

In summary, there was a wide range of predicted changes for the selected profiles along SPI in response to the 2-, 10-, and 100-year wave events, and the present, 2040, and 2070 SLR scenarios. The overall findings of this study are bulleted below. As shown in the tables and figures previously presented, most of the predicted beach width change is due to changes in the shoreline position as opposed to changes in the dune toe position. In general, the predicted wave impacts for most of the 54 simulations are along the lower beachface, causing erosion or accretion at or near the shoreline, and the dune toe is not being eroded in most cases.

- CBI-06, CBI-13, and CBI-22 were predicted to have an increase in beach width, except in one of the simulations (the 10-year wave event with 2040 SLR for CBI-22).
  - Beach width increases are primarily a function of progradation of the shoreline from either erosion of the foredunes or deposition of sediment from either cross-shore or along-shore transport. Though, as stated in Section 5.1, in using XBeach in 1-D mode, the model domain represents a single shoreline profile, and longshore transport gradients are ignored.
- Predicted impacts to the foredune were more common in the more northerly profiles.
- The largest shoreline position retreat was predicted in CBI-24, the northernmost profile.
- As material was eroded from the foredune and lower beach, it was deposited offshore, just below MSL.
- Overtopping of the foredune occurred along multiple profiles, including CBI-03, CBI-06, CBI-13, and CBI-22, mostly during the 2070 SLR scenarios. However, only profile CBI-22 was predicted to have overtopping of the entire dune system.
- The largest changes (both erosion and accretion) do not necessarily occur during the largest storm events.

The predicted change in beach width, shoreline position, dune toe position, and the overall shape of the profile is representative of change during storm events. However, there are intervening years where portions of the system will move back to a dynamic equilibrium state after an acute event.

7 RECOMMENDATIONS AND NEXT STEPS

The coastal hazard analysis of six selected profiles along South Padre Island, Texas, identifies key areas of future concern for the shoreline. In short, this study has identified predicted impacts of potential coastal change during storm events under future SLR along SPI. The next step is to integrate the findings of this study to inform coastal planning decisions.

The predicted maximum wave run-up values provide the indication to support maintaining a robust primary dune; run-up values during the 100-year storm events with moderate (2040) and high (2070) SLR are approaching elevations in which dune overtopping may occur. The practice of lowering dunes that exceed 10 ft in elevation will exacerbate overtopping, leading to more erosion of the dunes and potential inland flooding. It is widely accepted in the coastal literature that wide beaches, and wide and high dunes, optimally mitigate inland flooding and help to maintain a robust recreational resource. The modeling shows that when there is a wide beach and dune system, the impacts from storms plus SLR may erode the beach, but help prevent the dunes from severe impacts. Based on the modeled responses, as well as the past behavior of the system as described in the Phase 1 Report, it is recommended that a minimum dune elevation of 12.7 ft (higher than the largest predicted wave run-up elevation with a 10% safety factor) be maintained for the most resilient configuration at SPI. Ideal beach widths should be maintained with a minimum width of 200 ft, although greater width would provide more protection to the dunes. This resilient configuration will be evaluated against competing community interests (e.g., viewsheds) in the next phase.

The modeling results and historical analysis also support that having an intact continuous dune system is important to the resiliency of the system. In locations where dunes have been removed for recreation or other purposes, the system is inherently more vulnerable as large storm waves can reach the base of the buildings or infrastructure. Large storms may result in flooding of these community assets. The impact is not limited to the area where the dunes have been removed; up-rushing waves reaching a seawall or building may deflect off the hardened structure and push water laterally, causing erosion of the dunes along adjacent coastal reaches.

A similar, but smaller scale, vulnerability to storm waves and SLR is the numerous walkways through the dunes. During storms, especially with the elevated water levels associated with SLR, water flowing directly into the shore-perpendicular passages can result in lateral erosion of the adjacent dunes. Reducing the number of walkways, or having walkways converted to dune walkovers, would increase the resiliency of the system.

8 REFERENCES

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Item No. 4.4

CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE
AGENDA REQUEST FORM

MEETING DATE: January 25, 2022

NAME & TITLE: Kristina Boburka, Shoreline Director

DEPARTMENT: Shoreline Department

ITEM
Committee member introductions and committee overview. (Boburka)

ITEM BACKGROUND
Welcome and introduction to new members. Discuss the roles of the Shoreline Task Force.

BUDGET/FINANCIAL SUMMARY
None.

COMPREHENSIVE PLAN GOAL
N/A

LEGAL REVIEW
Sent to Legal:
Approved by Legal:

RECOMMENDATIONS/COMMENTS:

ORDINANCE NO. 11-01

AN ORDINANCE OF THE CITY OF SOUTH PADRE ISLAND, TEXAS, AMENDING CHAPTERS 16 AND 22 OF THE CODE OF ORDINANCES ESTABLISHING THE SHORELINE TASK FORCE (SLTF) FOR THE CITY AND TRANSFERRING ALL THE FUNCTIONS OF THE BAY AREA TASK FORCE IMPLEMENTATION COMMITTEE (HEREBY ABOLISHED) TO THE SHORELINE TASK FORCE AND PROVIDING THAT THE SHORELINE TASK FORCE REPLACES THE BEACH & DUNE TASK FORCE, AND WILL CARRY OUT ITS FUNCTIONS UNDER CHAPTER 22 OF THE CODE OF ORDINANCES (DUNE PROTECTION, BEACH RE-NOURISHMENT AND ACCESS PLAN) PROVISIONS FOR MEMBERSHIP; EXISTING MEMBERS OF BAY AREA TASK FORCE AND BEACH AND DUNE TASK FORCE WILL SERVE ON THE SHORELINE TASK FORCE AND THE COMMITTEE WILL REDUCE FROM 11 TO 7 UPON EXISTING TERM EXPIRATIONS; PROVIDING FOR A PENALTY FOR VIOLATION NOT TO EXCEED FIVE HUNDRED DOLLARS ($500.00); PROVIDING FOR SEVERABILITY; AND AUTHORIZING PUBLICATION IN CAPTION FORM.

WHEREAS, the City of South Padre Island has heretofore passed Resolutions to establish the Bay Area Task Force Implementation Committee and assigned to it the function of making recommendations to the City Council; and

WHEREAS, the Beach and Dune Task Force was created by ordinance and codified as Chapter 22 of the Code of Ordinances and this ordinance is to amend Chapter 16 and 22 of the Code of Ordinances to establish the Shoreline Task Force and substitute the Shoreline Task Force in name and for all the functions of the Beach and Dune Task Force; and

WHEREAS, the City Council has determined that such an ordinance should be enacted.

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF SOUTH PADRE ISLAND, TEXAS:

Section 1. Chapter 16 of the Code of Ordinances of the City of South Padre Island is hereby amended to provide the title of "ARTICLE I" to the beginning of Chapter 16 and add a new ARTICLE II beginning with Section 16-50 to read as follows:

"ARTICLE II
Bay Area

Sec. 16-50 Shoreline Task Force.

A Shoreline Task Force is hereby established with an initial membership of eleven (11) members to be reduced to seven (7) members on September 30, 2011. All members are appointed by the City Council and may be removed at any time by Resolution without reason.

Sec. 16-51 Member Appointment and Terms.

(A) The initial Task Force shall consist of the current members of the Beach and Dune Task Force and the Bay Area Task Force Implementation Committee with the same term expiration of the appointment to those respective boards. When the current six (6) members that have a term that expires on September 30, 2011 only two of the seats may be filled and the membership shall be reduced to seven (7) members.

(B) After September 30, 2011 the Shoreline Task Force will be composed of seven (7) members and the members shall draw numbers (between 1 and 7) to affix numbers to each seat. The two members appointed or re-appointed as provided in "A" above will have a two year term and the remaining five members that have terms that expire on September 30, 2012 will draw to determine which one of their seat positions will only be appointed for a one time one year term, so that thereafter terms will be staggered with two year terms with three seats one year and four the next year. Any vacancies for a position/seat shall be filled for the unexpired term of that position. A member shall hold office until his/her successor has been appointed by the City Council.

Sec. 16-52 Chairman of Board.

The members of the Shoreline Task Force shall elect a Chairman and the Vice-Chairman to a one-year term. The Vice-Chairman shall act as Chairman in the absence of the Chairman.

Sec. 16-53 Quorum.

The majority of the appointed members of the Shoreline Task Force shall constitute a quorum but no action of the Shoreline Task Force shall be of any force or effect unless it is adopted by a favorable vote of four (4) or more members.

Sec. 16-54 Duties and Functions.

(A) To carry out all of the duties and functions of the Beach and Dune Task Force as provided by Chapter 22 of the Code of Ordinances.

(B) Make recommendations to the City Council pertaining to the following:
(1) Bay accesses;
(2) Boat ramps;
(3) Parking for boat trailers and vehicles;
(4) Public Safety of the Bay;
(5) Marina feasibility;
(6) Bay side issues:
(7) Any additional tasks assigned by the City Council. "

Section 2. Chapter 22 of the Code of Ordinances of the City of South Padre Island is hereby amended to re-name and substitute the Shoreline Task Force for the name and for all the functions of the Beach and Dune Task and change the membership on the board as reflected in Section 1 of this Ordinance.

Section 3. The Bay Area Task Force Implementation Committee as established by Resolution No. 853 and 2009-40 is abolished.

Section 4. If for any reason any section, paragraph, subdivision, clause, phrase, word, or provision of this Ordinance shall be held invalid or unconstitutional by final judgment of a court of competent jurisdiction, it shall not affect any other section, paragraph, subdivision, clause, phrase, word, or provision of this Ordinance for it is the definite intent of this City Council that every section, paragraph, subdivision, clause, phrase, word, or provision hereof be given full force and effect for its purpose.

Section 5. This Ordinance repeals all portions of any prior ordinances or parts of ordinances of the Code of Ordinances in conflict herewith.

Section 6. Any violation of this Ordinance may be punished by a fine not to exceed Five Hundred Dollars ($500.00) for each offense or for each day such offense shall continue and the penalty provisions of Section **21-1** of the Code of Ordinances is hereby adopted and incorporated for all purposes.

Section 7. If for any reason any section, paragraph, subdivision, clause, phrase, word or provision of this Ordinance shall be held invalid or unconstitutional by final judgment of a court of competent jurisdiction, it shall not affect any other section, paragraph, subdivision, clause, phrase, word or provision of this Ordinance for it is the definite intent of this City Council that every section, paragraph, subdivision, clause, phrase, word or provision hereof be given full force and effect for its purpose.

Section 8. This Ordinance shall become effective when published in summary form or by publishing its caption.

PASSED, APPROVED AND ADOPTED on First Reading, this 19th day of January 2011.

PASSED, APPROVED AND ADOPTED on Second Reading, this 2nd day of February 2011.

ATTEST:

S Hill

Susan Hill, CITY SECRETARY

CITY OF SOUTH PADRE ISLAND, TEXAS

ROBERT N. PINKERTON, JR., MAYOR

Item No. 4.5

CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE
AGENDA REQUEST FORM

MEETING DATE: January 25, 2022

NAME & TITLE: Kristina Boburka, Shoreline Director

DEPARTMENT: Shoreline Department

ITEM

Discussion and possible action on the Shoreline Task Force 2022 meeting calendar. (Boburka)

ITEM BACKGROUND

Discuss meetings throughout the year, board position obligations in attendance.

BUDGET/FINANCIAL SUMMARY

N/A

COMPREHENSIVE PLAN GOAL

N/A

LEGAL REVIEW

Sent to Legal:
Approved by Legal:

RECOMMENDATIONS/COMMENTS:

2022

Shoreline Task Force 2022 Meetings

🟩 Scheduled City Council Meetings
🟦 Scheduled Shoreline Task Force Meetings
🟨 Holidays
☐ Spring Break Texas Week

January

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Shoreline Department Liaisons:

Kristina Boburka, Shoreline Director

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Cell: (412) 708-2352
kboburka@myspi.org

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Erika Hughston, Coastal Coordinator
Office: (956) 761-8111
Cell: (956) 365-9020
ehughston@myspi.org

September

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Please let us know at least a day prior to the meeting if you are unable to attend. Unexcused absences will be marked and recorded. Only three (3) unexcused absences will be allowed before possible termination on board.

Item No. 4.6

CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE
AGENDA REQUEST FORM

MEETING DATE: January 25, 2022

NAME & TITLE: Kristina Boburka, Shoreline Director

DEPARTMENT: Shoreline Department

ITEM

Update on department projects (Boburka, Hughston):
- Coastal Management Program (Cycles 24, 25, 26, 27)
- RESTORE Act
- Texas Parks and Wildlife Department's Planning Grant
- National Fish and Wildlife Foundation's National Coastal Resiliency Fund
- Wind and Water Sports Venue
- Tompkins Channel
- City's Dune Protection, Beach Renourishment, and Beach Access Plan

ITEM BACKGROUND

Update on large department projects and grants.

BUDGET/FINANCIAL SUMMARY

N/A

COMPREHENSIVE PLAN GOAL

LEGAL REVIEW

Sent to Legal:
Approved by Legal:

RECOMMENDATIONS/COMMENTS: