SURFERS' POINT MONITORING SPRING 2024

Monitoring Report Update and Synthesis 2011-2024

Prepared for
BEACON

December 2024

ESA

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1. INTRODUCTION

This report provides a summary of physical data collected through monitoring of the Surfers' Point Managed Retreat Project (project), including the constructed Phase 1 site and the proposed Phase 2 site, over a 14 year period. The project planning, design, and post-construction monitoring was led by the City of Ventura (City) in coordination with the Ventura County Fairgrounds (property owner) and the Surfers' Point Working Group. ESA was retained by the Beach Authority for Clean Oceans and Nourishment (BEACON) to continue monitoring efforts at the project site. This report presents the monitoring data and survey results from recent surveys and compares the data to the other monitoring data collected since construction of Phase 1 in 2010.

1.1 Background

The project is a regionally important coastal restoration project that is often used as a successful example of implementation of a living shoreline or natural infrastructure on the high-energy pacific coast. The first phase of the project, which was led by the City, was constructed in 2010-2011. Dunes were graded and seeded in 2012. ESA supported the City to conduct physical monitoring of the site from 2011 through 2017, for which several monitoring reports were prepared as part of conditions of the Coastal Development Permit issued by the California Coastal Commission. BEACON funded the design of the second phase of the project, which is anticipated to be constructed in fall 2024. BEACON worked with ESA and others in 2021 to conduct a survey of the Phase 1 project area to document physical changes of the topography and the dune vegetation. BEACON subsequently retained ESA to conduct surveys at the Phase 1 and proposed Phase 2 project site on December 11, 2023, and again May 29, 2024. The Phase 2 project, led by the City, is planned to start construction in the fall of 2024. Table 1 presents a summary of monitoring efforts taken since 2011.

1.2 Purpose and Scope

ESA is providing physical monitoring assistance to assess project performance and inform management decisions. This report has been prepared in a similar manner to prior monitoring reports completed following the Phase 1 project. The following sections summarize the monitoring work completed during the winter 2023 to spring 2024 monitoring period, regional data from the last 10 years, and provides key findings and recommendations. Monitoring work included topographic surveys and photos, regional collection of water levels, wave and wind characteristics, and survey comparison. The scope of this report is to present data and observations without analysis or assessments.

TABLE 1. SUMMARY OF SURFERS' POINT PHASE 1 AND PHASE 2 MONITORING EFFORTS (2011-2024)

Data Collection Efforts	2011	2012		2013	2015				2016				2017			2021	2023	2024
	Nov[a]	July	Dec	April	April	July	Oct	Dec[b]	Feb	May	July	Aug	Jan	March	July	June	December	May
ESA Physical Processes				X					X	X		X		X	X			X
ESA/City Topo Survey; LiDAR DEM[c]	X	X	X	X		X		X		X		X		X		X	X	X (Phase 1 &2)
ESA/City Aerial Photo				X	X				X						X			
ESA/City Ground Photo				X		X	X	X			X		X	X	X			
CRC Dune Veg; Morphology[d]		Dunes + Reseeding		X		X		X		X		X		X		X	X	X
CSUCI/Sandshed UAV 2, 3-D , Orthomosaic Image																X[e]	X	X (Phase 1& 2)
Monitoring Reporting Period	2011-2012; 2012-2013				2015				2016-2017									
Monitoring Report issue Date[f]	MR #1 9-2013				MR #2 7-2016				MR #3 5-2018									MM 9-2024

NOTES:

a. Phase 1 Engineered cobble and sand with installation of public infrastructure completed in June 2011.
b. Post December Storm Event on 12-11-15.
c. Monitoring involved 5 project transects and 2 reference site transects. LiDAR Elevation Models: Three pre- and during-project LiDAR datasets, collected in the fall of 2005, 2009, and 2010, were available for comparison with the post-project topographic surveys;
d. Combining Vegetation Cover analysis and Topographic survey/Digital Elevation results with UAV imagery allows for a more complete description of dune morphology.
e. UAV Imagery available for 2016.
f. Monitoring Memo (MM) prepared in 2024.

2. DATA COLLECTION

The following sections describe the sources, methods, and processing that were used to acquire relevant data. Data collected for Spring 2024 included water levels; wave height, period, and direction; wind speed and direction; stream flow; elevation beach profiles; elevation surfaces; and photos. Regional data (e.g., water levels and wave and wind characteristics) were obtained after the end of the monitoring period. Elevation profiles and surfaces were completed on several occasions, most recently May 29, 2024. Photos provided were taken in 2021, 2023, and 2024.

2.1 Elevation Profiles

Topographic changes of the shoreline were evaluated through repeat cross shore topographic surveys[1]. RTK-GPS survey equipment was used to measure the transects from the landside limits towards the ocean to safe, wading depths. The surveys included points on the promenade, the sea wall, and major grade-breaks across the dunes, cobble, and beach areas. Seven transects were established previously during the monitoring of the project, including five (5) shore-normal transects at the Phase 1 Project site and two (2) reference transects at Emma Wood State Park and at the eastern end of the Phase 2 project site. Surveys for the 2023-2024 monitoring year were conducted by ESA on December 11, 2023 and May 29, 2024. During the May 29, 2024 survey effort, five (5) additional transects were established in and adjacent to the Phase 2 Project site limits (Figure 1).

2.2 Elevation Surfaces

Drone-based topographic/aerial surveys have been conducted by the CA State Univ., Channel Islands (CSUCI) in partnership with BEACON. Surveys were performed in 2016, 2017, 2018, 2019, 2020, 2021, 2023, and 2024. CSUCI processed the surveys into 3D surfaces. In collaboration with CSUCI, ESA produced elevation change surfaces to analyze dune change over time (shape and volume), beach change over time (e.g., mean seal level shoreline changes, beach sand volume changes, etc.), and success of the design (dune habitat quality/growth, beach stability, etc.).

2.3 Photo Documentation

Site photos of the project have been collected through the years pre and post construction. For this monitoring effort, photos obtained June 1, 2021, November 28, 2023, December 11, 2023, and May 29, 2024 were documented. Photos were taken from 5 locations at the project site, locations 1,2, 5, and another location along the beach in between locations 5 and 6. Photo locations are documented in relation to the profiles as well as the established photo locations shown in Figure 1. In addition, high resolution aerial imagery from the years 2016 to 2024 was obtained through Nearmap.

[1] ESA performs land surveys and collects hydrographic data to augment traditional surveying services for the purposes of engineering, geomorphic interpretation, monitoring of project performance, and other specific uses consistent with California Business and Professions Code (Civil Engineering practice as defined by Section 6731.1. of the Professional Engineers Act and Geologic and Landscape Surveys as defined in the Professional Land Surveyors' Act).

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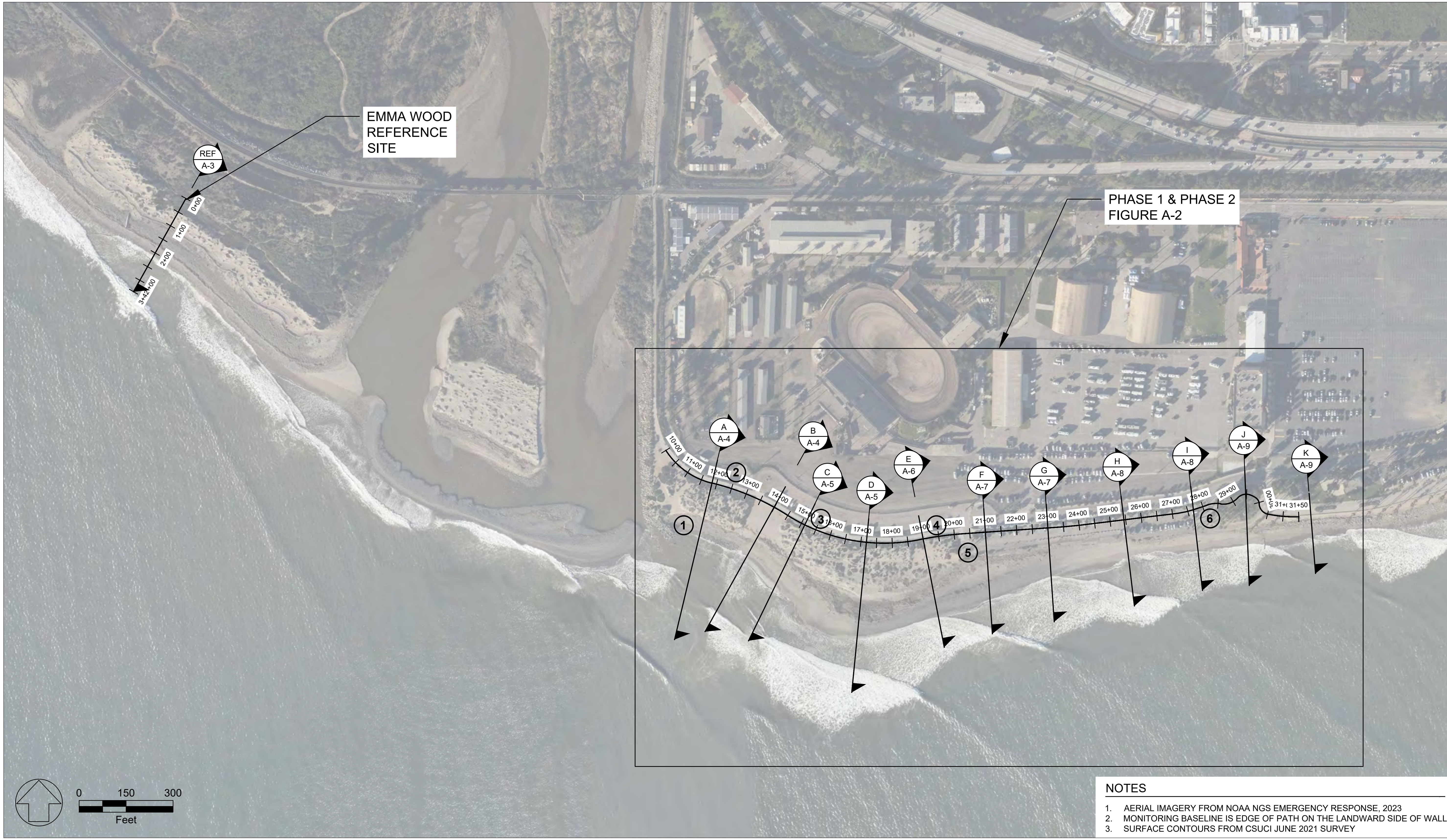

NOTES

1. AERIAL IMAGERY FROM NOAA NGS EMERGENCY RESPONSE, 2023
2. MONITORING BASELINE IS EDGE OF PATH ON THE LANDWARD SIDE OF WALL
3. SURFACE CONTOURS FROM CSUCI JUNE 2021 SURVEY

Surfers' Point Monitoring Spring 2024

Figure 1

Surfers' Point Elevation Profiles and Reference Site, Plan View

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2.4 Regional Data Gathering

Regional data on water levels, waves, wind, streamflow, and precipitation were gathered from publicly available sources. The sources for this data are shown in Figure 2.

2.4.1 Water Levels

The closest operating tide gauge to the project site is located at Santa Barbara Harbor. Observed and predicted water level data for the Monitoring Period was obtained from the National Oceanic and Atmospheric Administration (NOAA) Tide Gauge Station No. 9411340, located approximately 24 miles northwest of the project site. Water levels were obtained from October 1, 2014, to August 16, 2024, at 6-min intervals in feet relative to the NAVD88 vertical datum. To calculate non-tidal residuals, ESA subtracted the predicted tide elevations from the observed tide elevations. Non-tidal residuals refer to deviations from predicted tides presumed to be caused by climatic and meteorological conditions.

2.4.2 Waves

Wave data was obtained from the Scripps Institute of Oceanography (SIO) Coastal Data Information Program (CDIP) Monitoring and Prediction (MOP) station VE466 and three NOAA National Data Buoy Center (NDBC) wave buoys. MOP station VE466 is a virtual buoy that is located just offshore of the project approximately 0.5 miles. CDIP uses transformation coefficients to generate wave hindcast data that is precise for the virtual location. The NDBC Harvest buoy (NDBC #46218) is located off Point Arguello, 85 miles WNW from the project site. The West Santa Barbara buoy (NDBC #46054) is located off Point Conception, 67 miles west of the project site. The East Santa Barbara buoy (NDBC #46053) is located 30 miles west of the project site. Wave data obtained from the CDIP and NDBC stations included significant wave height, dominant wave period, and mean wave direction at hourly intervals from January 1, 2014 to through the latest monitoring period to August 16, 2024.

2.4.3 Wind

Wind data for the Monitoring Period was sourced from the Oxnard Airport Automated Surface Observing Station (ASOS OXR), located approximately 7.5 miles southeast of the project site. The wind data consists of hourly, 2-minute averaged wind speed and direction. The wind data was recorded 10 meters above the ground and corrected to ground level.

2.4.4 Streamflow

The Ventura River mouth is located immediately west of the project site, dividing Emma Wood State Park and the project reference site and Surfer's Point. Discharge from the river, including water and sediment, is an important external process affecting the beach morphology. Ventura River streamflow is measured at the USGS Ventura River Gauge (USGS#11118500).

2.4.5 Precipitation

Precipitation data was downloaded from the California Irrigation Management Information System (CIMIS) at Camarillo (Station #152) located approximately 18 miles ESE of the project site. Precipitation was measured in inches of precipitation hourly from October 1, 2021 to August 16, 2024.

SOURCE: NOAA, SIO, USGS, CIMIS, ESA, 2024

Figure 2
Regional Data Gathering Source Locations

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3. RESULTS AND IMPLICATIONS

The following subsections summarize the annual monitoring observations and describe relative implications from the 2023-2024 monitoring period and 2014-2024 decadal regional data.

3.1 Regional Data Gathering

This section summarizes observed water levels, waves, wind, streamflow, and precipitation.

3.1.1 El Niño-Southern Oscillation (ENSO)

The El Niño-Southern Oscillation (ENSO) describes yearly fluctuations in sea surface temperature (SST) anomalies at the equatorial Pacific Ocean. Events with positive SST anomalies above 0.5 degrees Celsius (compared against the 30-year SST average) are classified as El Niño events. Similarly, years with negative SST anomalies below -0.5 degrees Celsius are classified as La Niña events. These events can have global climate impacts including alterations in frequency, duration, and location of north Pacific storms, which translates to changes in rainfall patterns and wave-climate in Northern California (Bromirski et al. 2003). A weak La Niña was observed over the 2022-2023 monitoring period before a strong El Niño emerged in 2023-24. As of August 2024, ENSO-neutral conditions are expected for the next several months, with La Niña favored to emerge from September to November (66% chance) and persist through Northern Hemisphere winter 2024-25 (74% chance during November to January)[2]. Table 2 summarizes the ENSO conditions over the 2014 to 2024 monitoring period.

TABLE 2. EL NIÑO-SOUTHERN OSCILLATION CONDITIONS, 2014 TO 2024

Monitoring Year[a]	El Niño-Southern Oscillation Condition
2014 – 2015	Weak El Niño
2015 – 2016	Very strong El Niño
2016 – 2017	Weak La Niña
2017 – 2018	Weak La Niña
2018 – 2019	Weal El Niño
2019 – 2020	Weak El Niño
2020 – 2021	Moderate La Niña
2021 – 2022	Moderate La Niña
2022 – 2023	Weak La Niña
2023 – 2024	Strong El Niño

NOTES:
a. Monitoring years are water years (October 1 – September 30)
SOURCE: Jan Null, 2024. https://ggweather.com/enso/oni.htm

[2] NOAA El Niño-Southern Oscillation (ENSO) Diagnostic Discussion, October 18, 2023: https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.html

3.1.2 Water Levels

Water level observations for the 2023-2024 monitoring period are shown in Figure 3. The blue line illustrates the observed 6-minute averaged water levels at Santa Barbara. The orange line illustrates the non-tidal residuals (NTRs) that were calculated by subtracting the predicted water levels from the observed water levels. The maximum NTR that occurred during the 2023-2024 monitoring period was 2.1 feet, observed on December 28, 2023, which was sustained through the El Niño swell event. The same day, the wave run-up from the storm surge affected the Pierpont neighborhood and much of the coast. The figure also shows: A tsunami, originating in Tonga and partnering with a significant volcanic eruption, sent tsunami waves to the California Coast on January 15, 2022; Bomb cyclone-related events on January 5-6, 2023, December 28, 2023, and February 8, 2024.

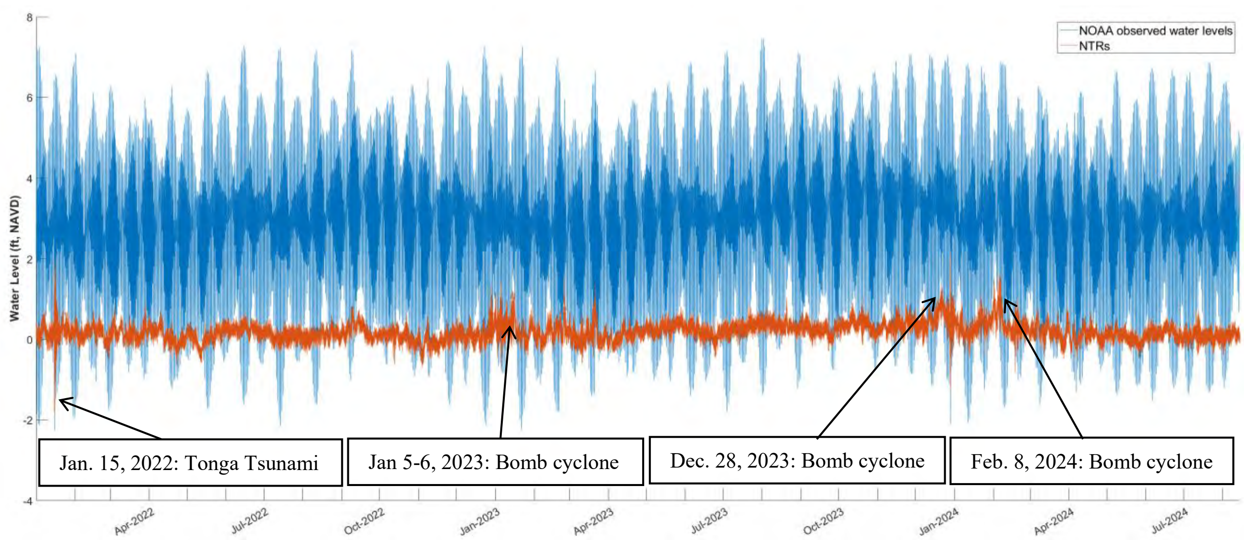

Figure 3.
Water Levels and Non-Tidal Residuals for Santa Barbara Tide Gauge During the 2022-2024 Monitoring Period

Figure 4 shows exceedance curves of the NTRs for each water year since 2014 (colored lines) compared to the NTR exceedance for all years combined (black line).

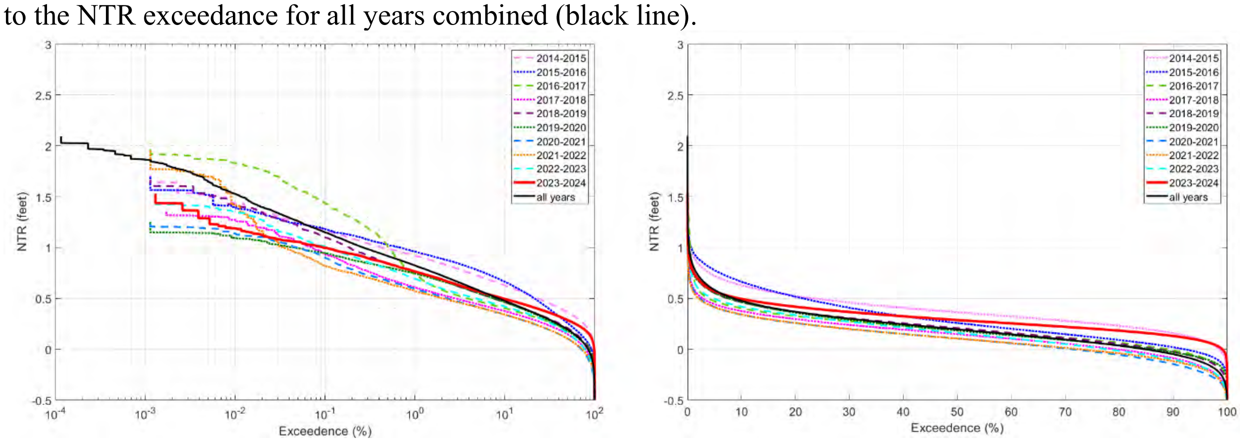

Figure 4.
Exceedance Curves for Santa Barbara Tide Gauge NTRs During Water Years 2014-2015 to 2023-2024

The panel on the left presents the data on a semi-log axis, which provides details on the extreme events with higher return periods, and the panel on the right helps to illustrate the distribution of the NTR on a seasonal scale for typical conditions. During the 2023-2024 monitoring period, the NTRs for exceedance ranging from 0.05% to 20% closely resemble those observed in the 2018-2019 and 2019-2020 periods, which coincided with El Niño events. These NTRs surpass those of all measured water years other than the 2014-2015 and 2015-2016 water years (both E Niño years) and are also higher than the cumulative NTRs from 2014 onwards.

For exceedance levels above 20%, the NTRs observed during the 2023-2024 monitoring period are most similar to the 2014-2015 and 2015-2016 NTRs. The 2023-24 NTRs over 50% exceedance are higher than all water years except 2014-15 and are significantly higher than the cumulative NTRs from 2014 onwards.

3.1.3 Waves

The Surfers' Point offshore and nearshore significant wave heights, peak wave periods, and peak wave directions for 2014 to 2024 are illustrated in Figures 5 to 8 for the Harvest (purple), West Santa Barbara (green), East Santa Barbara (light blue) and CDIP nearshore buoy VE 466 (pink). Additionally, the wave power for these buoys was calculated based on the wave characteristics as,

$$P = \gamma g H_{rms}^2 T_p / 32\pi$$

where γ is the unit weight of sea water (64.1 lbf/ft^3), H_{rms} is the root-mean-square of wave height estimated as $H_{rms} = H_s/1.414$, and g is gravitational acceleration (32.17 ft/sec^2). For simplicity, these wave power calculations use the deep-water wave speed and have not been corrected (i.e., reduced) to account for shallow water reduction at their respective depths.

The largest wave events over the 2014 to 2024 monitoring period occurred at the NDBC Harvest buoy around October 25, 2021 (29.9 ft), February 1, 2016 (27.6 ft), and January 5, 2023 (26.9 ft). At the CDIP nearshore buoy, the largest wave events occurred around January 5, 2023 (17.3 ft), December 28, 2023 (16.0 ft), and January 10, 2021 (14.5 ft).

Figures 9 and 10 show the wave height and power roses for the CDIP MOP station and the NDBC Harvest, West Santa Barbara, and East Santa Barbara wave buoys over the 2014-2024 monitoring period. The predominant wave direction over the monitoring period is northwest at the Harvest buoy, northwest at the West Santa Babara buoy, west at the East Santa Barbara buoy, and SSW at the CDIP nearshore buoy. These figures illustrate how waves refract from offshore to the nearshore region through the Santa Barbara channel. Note that the greatest amount of wave focusing at the project site is associated with powerful, long period, west swells. Figure 5 shows how other powerful swells, often with more of a northwestern source direction offshore, do not translate to significant wave heights at the project site. Therefore, the most impactful swell events to Surfers' Point and the Ventura shore are large west swells. We note that tropical cyclones incident to Southern California are also possible and are expected to generate very large and powerful waves from the southeast that could affect the project area.

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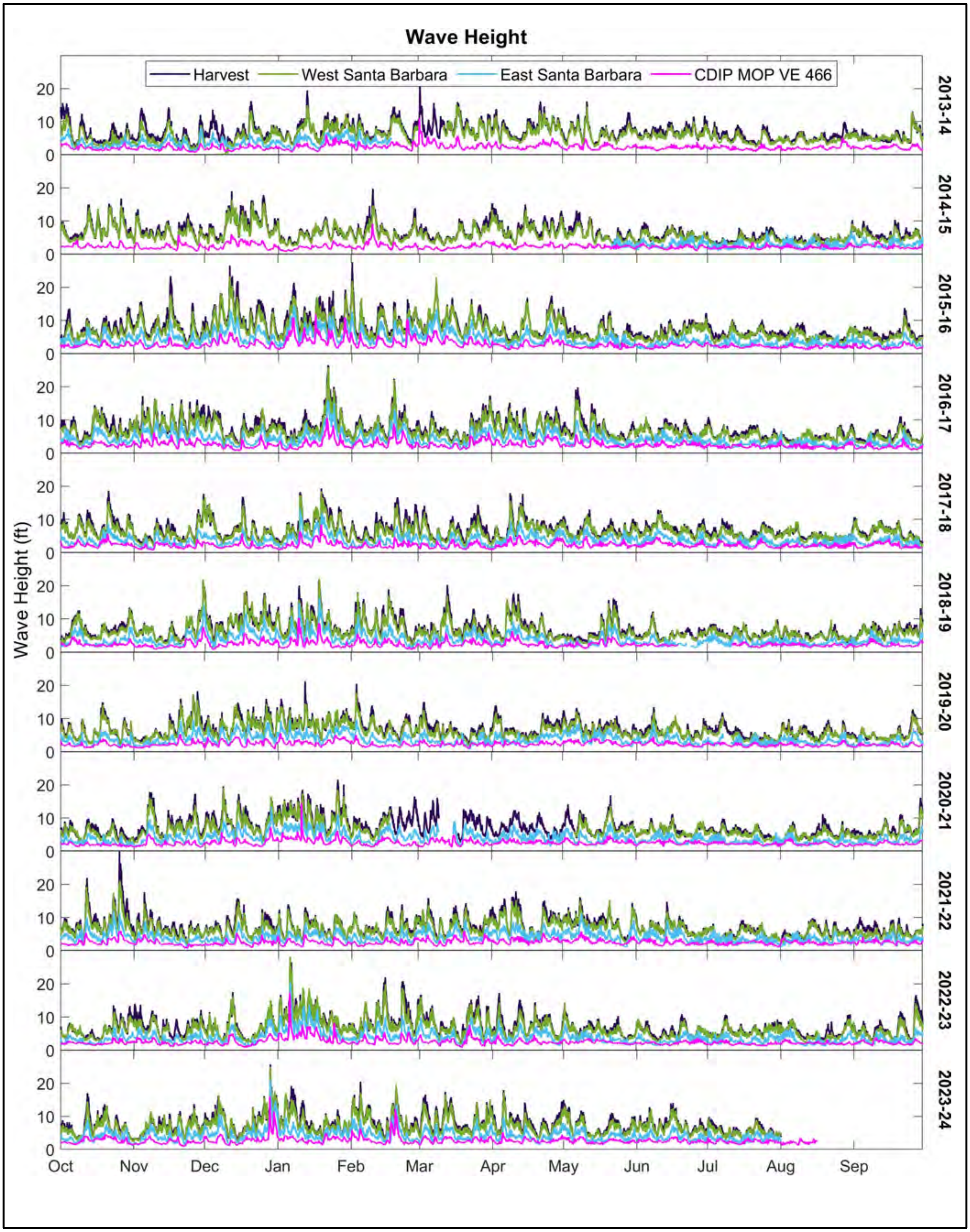
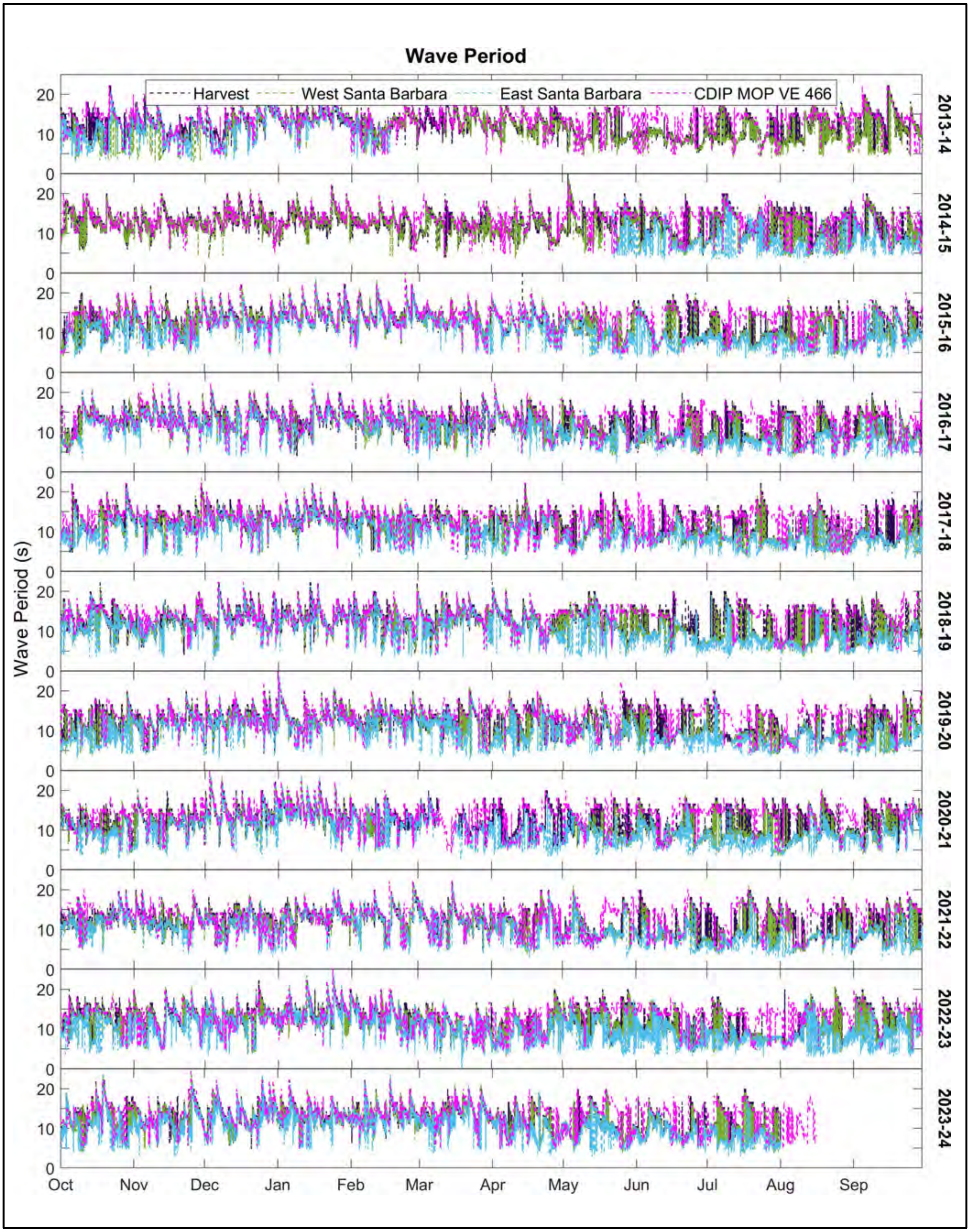


SOURCE: NOAA, CDIP, ESA, 2024

Figure 5
Wave Heights for CDIP MOP VE 466 and NOAA NDBC Harvest,
East Santa Barbara, and West Santa Barbara Buoys
January 2014 to August 2024



SOURCE: NOAA, CDIP, ESA, 2024

Figure 6
Wave Periods for CDIP MOP VE 466 and NOAA NDBC Harvest, East Santa Barbara, and West Santa Barbara Buoys
January 2014 to August 2024

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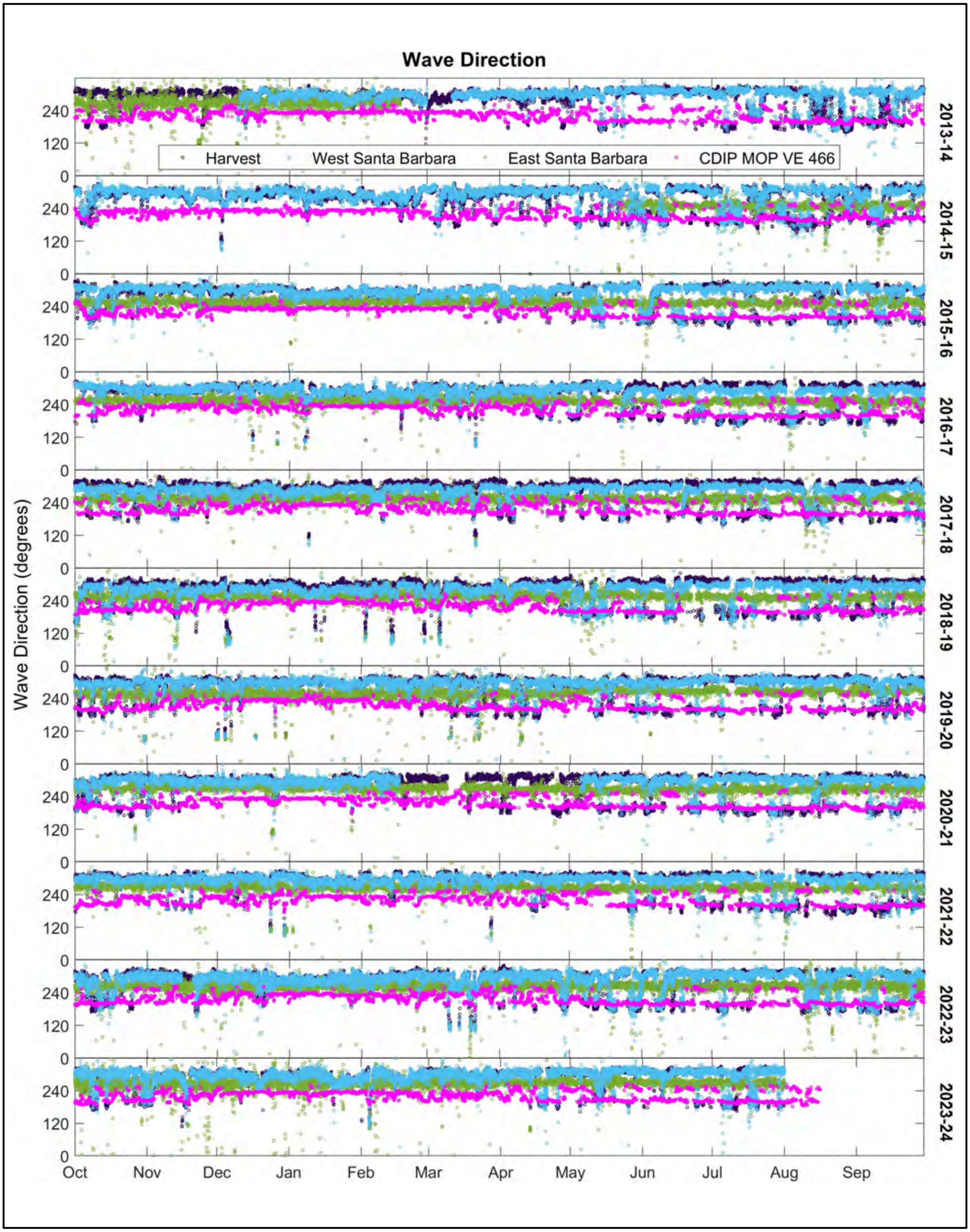
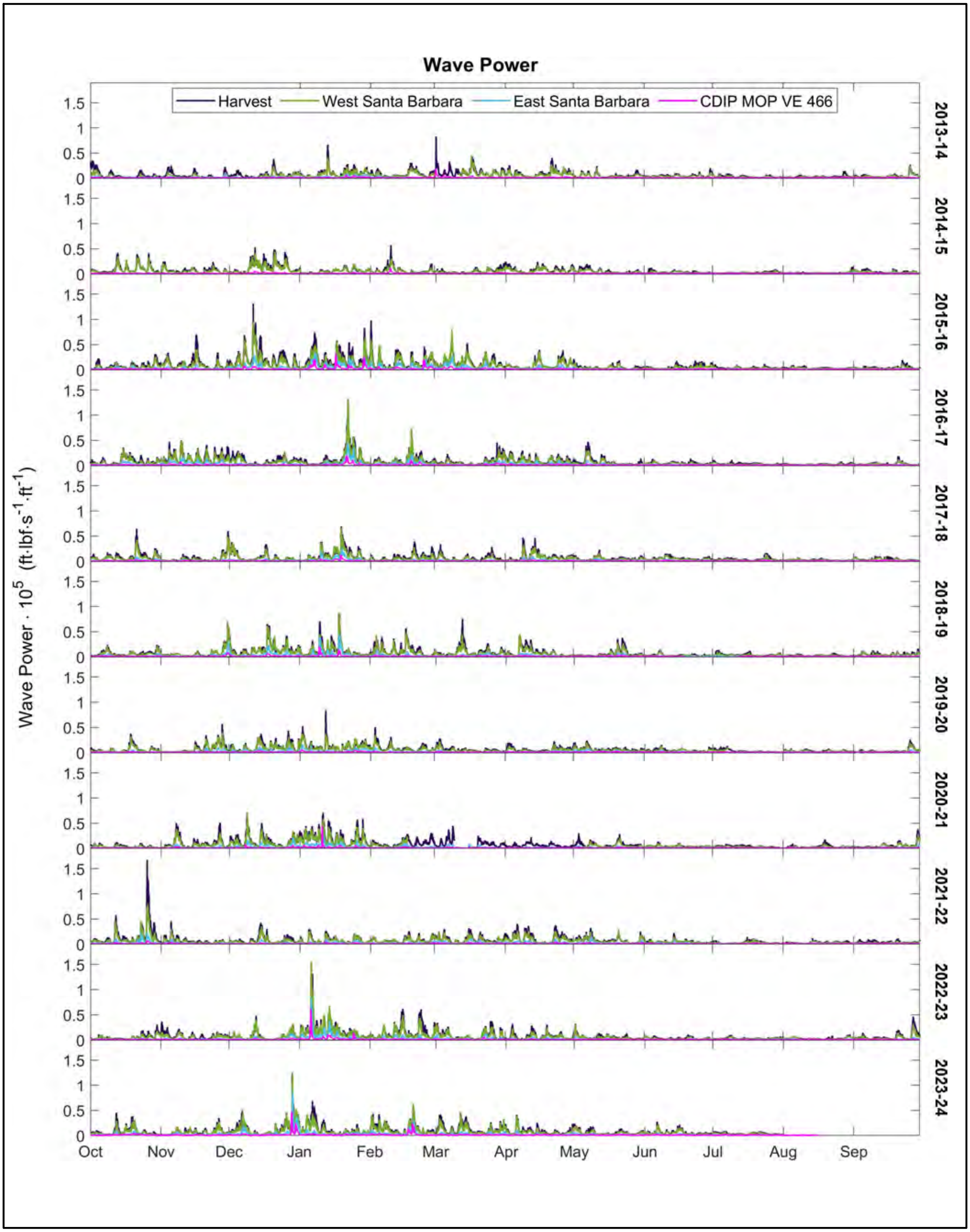


SOURCE: NOAA, CDIP, ESA, 2024

Surfers' Point Monitoring Spring 2024

Figure 7
Wave Directions for CDIP MOP VE 466 and NOAA NDBC Harvest, East Santa Barbara, and West Santa Barbara Buoys
January 2014 to August 2024



SOURCE: NOAA, CDIP, ESA, 2024

Figure 8
Wave Power for CDIP MOP VE 466 and NOAA NDBC Harvest,
East Santa Barbara, and West Santa Barbara Buoys
January 2014 to August 2024

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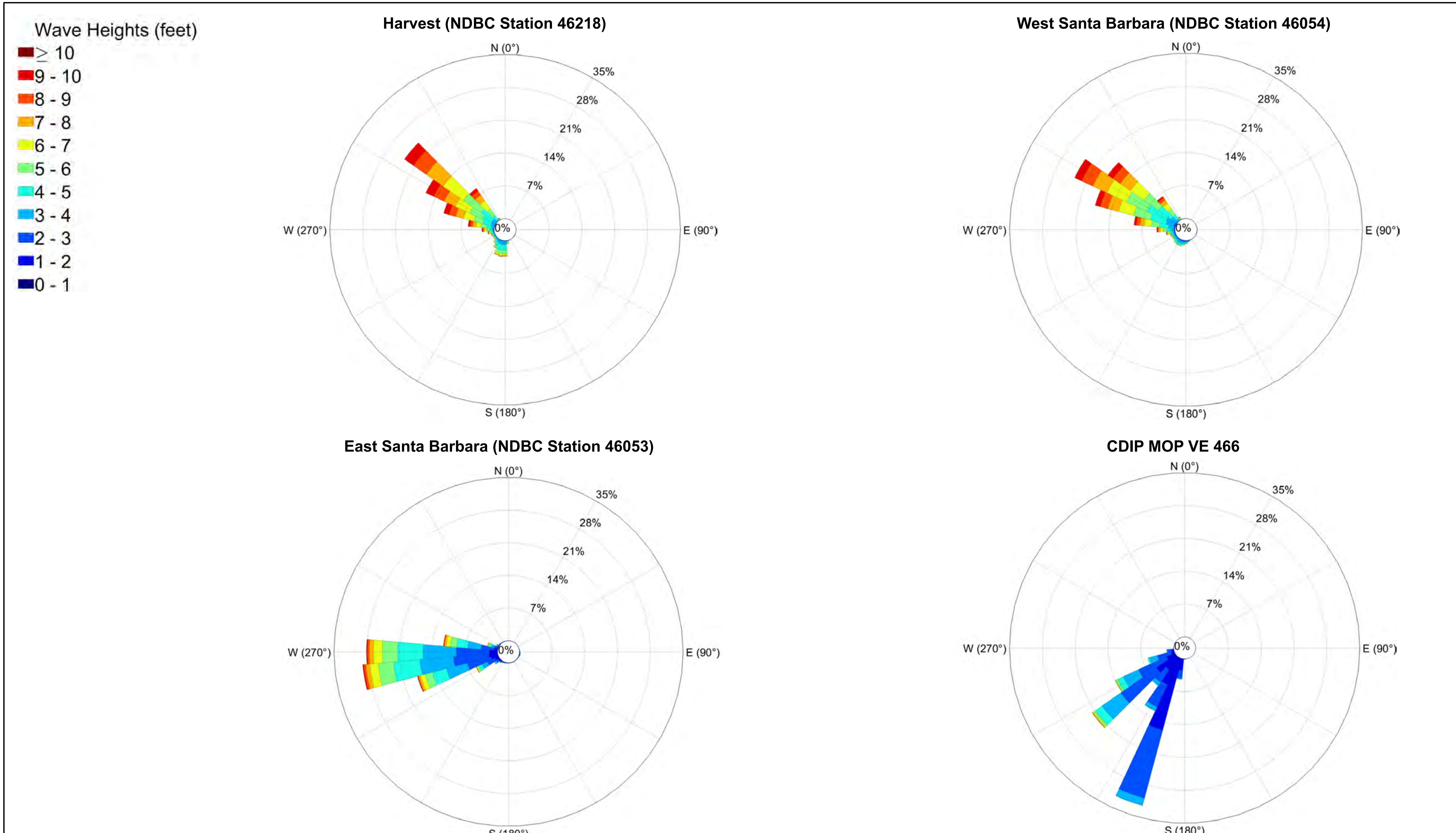

SOURCE: NOAA NDBC, ESA, 2024

Figure 9
Wave Roses for CDIP MOP VE 466 and Harvest, West Santa Barbara, and East Santa Barbara NOAA NDBC Buoys
01/01/2014 to 08/16/2024

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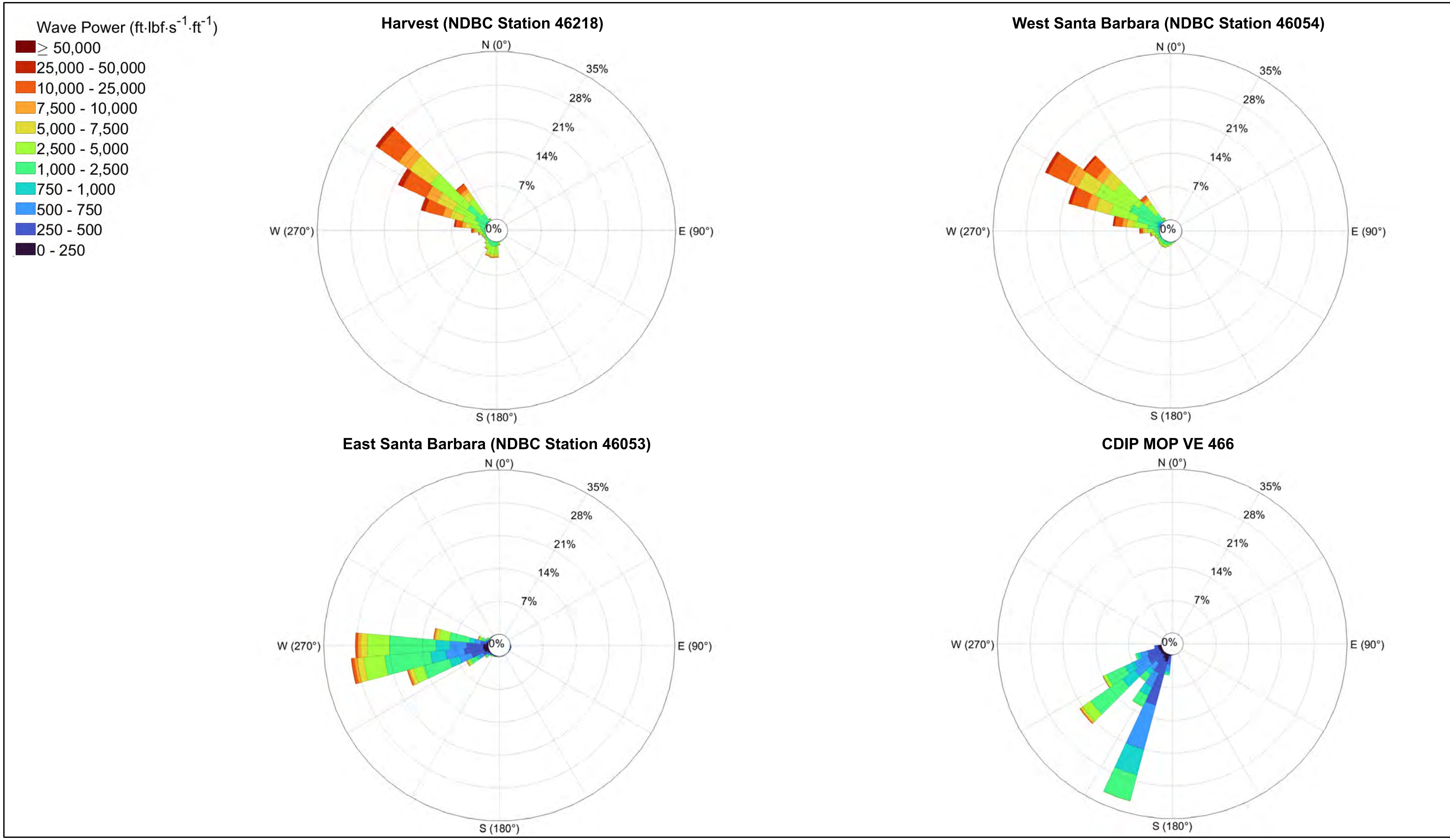

SOURCE: NOAA NDBC, ESA, 2024

Figure 10
Wave Power Roses for CDIP MOP VE 466 and Harvest, West Santa Barbara, and East Santa Barbara NOAA NDBC Buoys
01/01/2014 to 08/16/2024

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3.1.4 Wind

Figure 11 shows the wind rose for the Oxnard Airport station over the 2014-2024 monitoring period. Typical wind speeds during the decade were less than 12 mph, with the highest wind speeds associated with the winter and spring seasons. Maximum wind speeds exceeding 40 mph were observed during winters 2014, 2016, 2021, and 2023. Based on the wind rose in Figure 12, winds predominately arrive from the west, with northeasterly winds occurring less frequently and with lower magnitude wind speeds. As discussed in the 2016-2017 monitoring report, the wind approaches the shore at Surfers' Point at an oblique angle for typical conditions, influencing the movement of sand and creation of dune ridges. The area void of vegetation and managed as a recreational area provides the largest source of sand available for wind-blown transport, which was observed on many visits to have blown landward onto the bike path, and also onto the adjacent dune restoration area, burying the dune vegetation (ESA 2018).

Figure 12 shows the hourly wind direction and speed for the Oxnard Airport station for the 2023-2024 monitoring period. The maximum wind speed over 2023-2024 occurred on February 21, 2023 (40.3 mph at 280 degrees) and February 22, 2023 (35.7 mph at 270 degrees). Other notable events occurred on January 26, 2023 (34.5 mph at 80 degrees), January 1, 2023 (32.2 mph at 270 degrees), and March 23, 2024 (32.2 mph at 260 degrees). Note that the January 26, 2023, wind event was from the east while the other highest wind events during the monitoring period were from a westerly direction. Each of these major wind events were directed on an east-west basis causing cross shore winds at the project site.

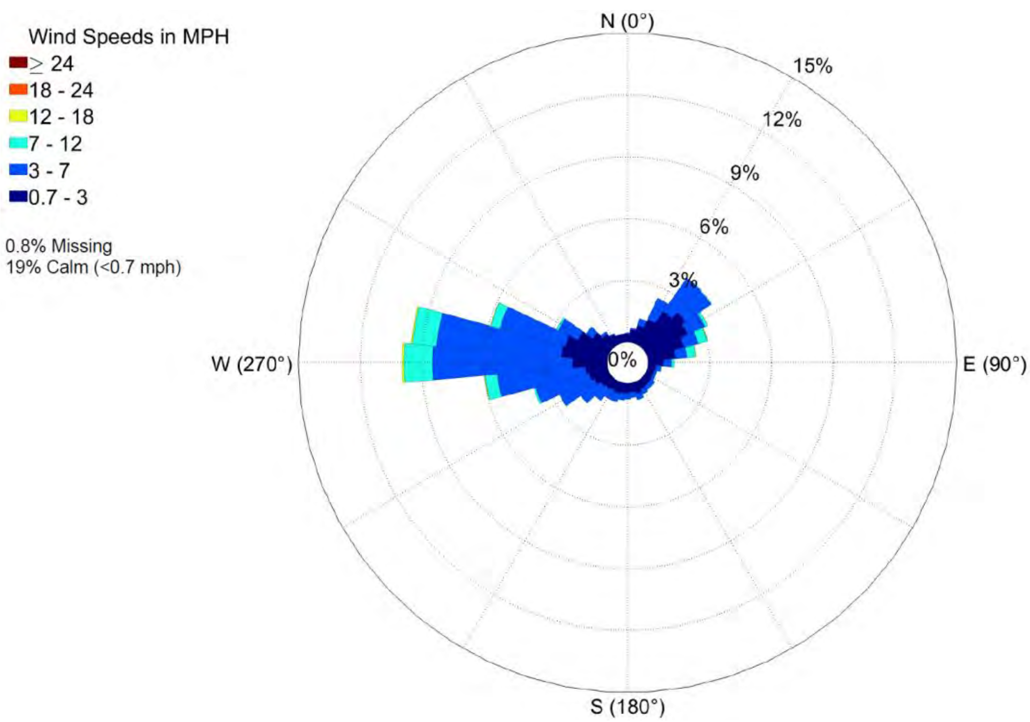

Figure 11.
Wind Rose at Oxnard Airport (OXR) 01/01/2014 to 08/16/2024

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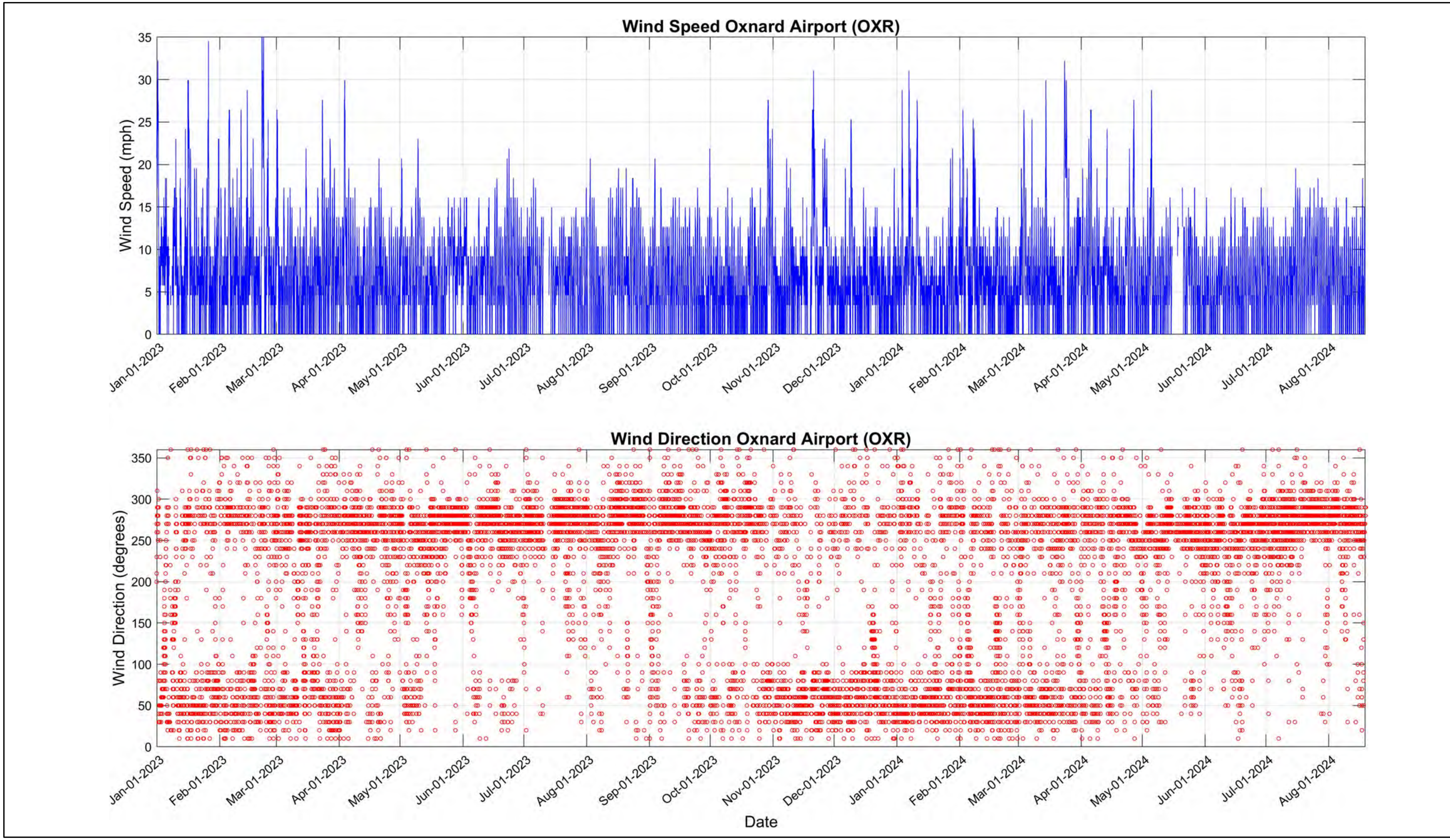

SOURCE: ISU, OXR, ESA, 2024

Figure 12
Wind Data at Oxnard Airport (OXR)
01/01/2023 to 08/16/2024

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3.1.5 Streamflow

Figure 13 shows the discharge of streamflow in the Ventura River for the 2014-2024 monitoring period. The majority of the higher streamflow events occurred during the winter and spring months, as typical for the Ventura Watershed and Southern California. The figure illustrates the highly intermittent nature of the large flow events on the Ventura River, where some years have no significant flows and others have very high flows on the order of 10,000 to 20,000 cubic feet per second (cfs). The January 9, 2023 event peaked at 34,700 cfs. These flow events move sediment out of the watershed and through the estuary, delivering cobble and sand to the Ventura River delta. Appendix D shows aerial imagery of the project site and the morphological response of the estuary and the shore to the January 2023 events (i.e., wave event on 1/5/23 and river event on 1/9/23) using pictures from August 2022 and February 2023.

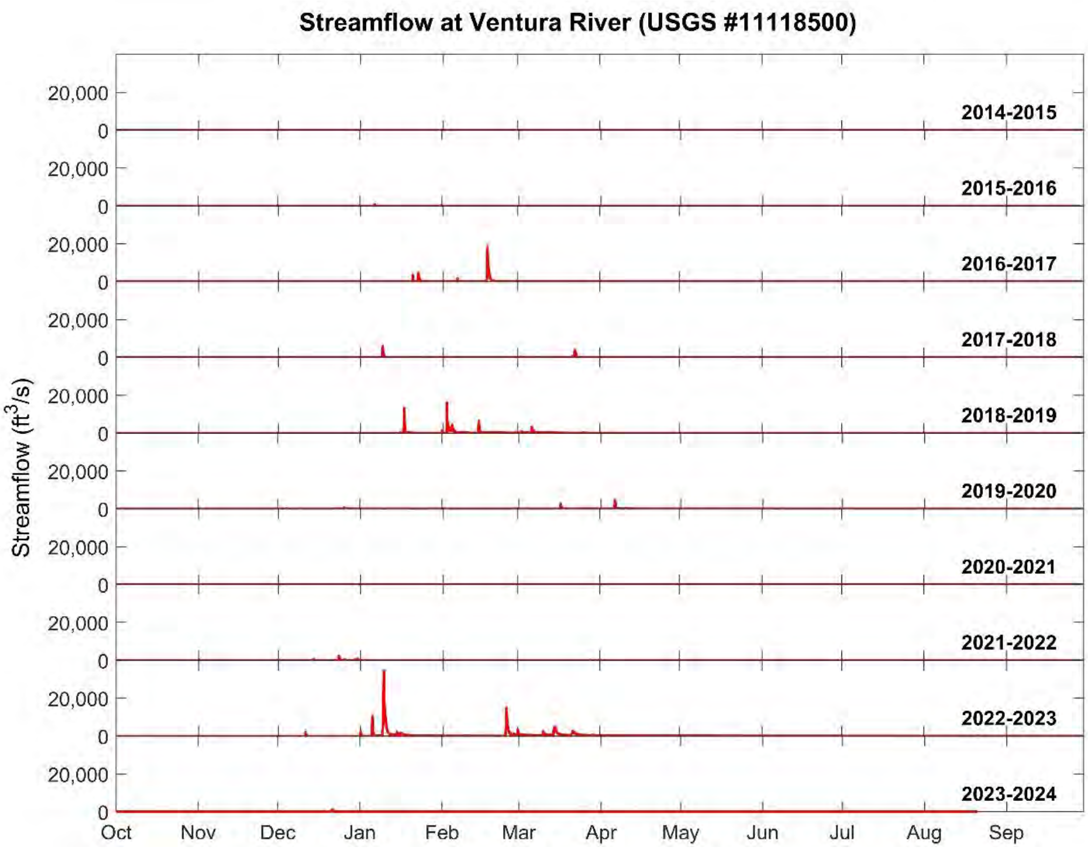

Figure 13.
Ventura River Streamflow Water Years 2014-2015 to 2023-2024

The monitoring period is punctuated by several large flood events, the most extreme of which produced over 34,000 cubic feet per second of flow in January 2023, nearly double the next largest flow. The top ten flood events during the observed time period are summarized in Table 3. Notably, 2017, 2019, and 2023 with five of the ten occurring in 2023.

TABLE 3. TOP TEN STREAMFLOW EVENTS IN THE VENTURA RIVER, OCTOBER 2014 TO AUGUST 2024

Date of Event	Maximum Flow (cfs)
February 17, 2017	18,500
February 18, 2017	8,460
January 17, 2019	13,300
February 2, 2019	16,000
February 14, 2019	6,570
January 5, 2023	10,700
January 9, 2023	34,700
January 10, 2023	17,800
February 24, 2023	14,900
February 25, 2023	10,800

SOURCE: USGS River Gauge #11118500

Stream flow in the Ventura River is critical for delivering sediment to the coast and directly influences beach width. Low stream flow from 2014 to 2016 had no major contribution to seasonal fluctuation in beach elevations. However, the prolonged streamflow in the winter events of January through March of 2017 and 2023 are due to the duration of the rain events that occurred, and result in greater delivery of sediment to the coast, including sand and cobble.

3.1.6 Precipitation

Figure 14 shows precipitation at the Camarillo CIMIS station from October 1, 2021 to August 16, 2024. The majority of precipitation occurred during the winter and spring months, as typical for the Ventura Watershed and Southern California. The major precipitation events during the monitoring period occurred on August 19, 2023 (2.52 inches), December 23, 2022 (1.69 inches), and December 14, 2021 (1.38 inches). The cumulative precipitation of the 2023-2024 water year as of August 16, 2024 is 8.14 inches, slightly lower than at the same time in the 2022-2023 water year (8.78 inches) and significantly lower than during 2021-2022 water year (13.09 inches).

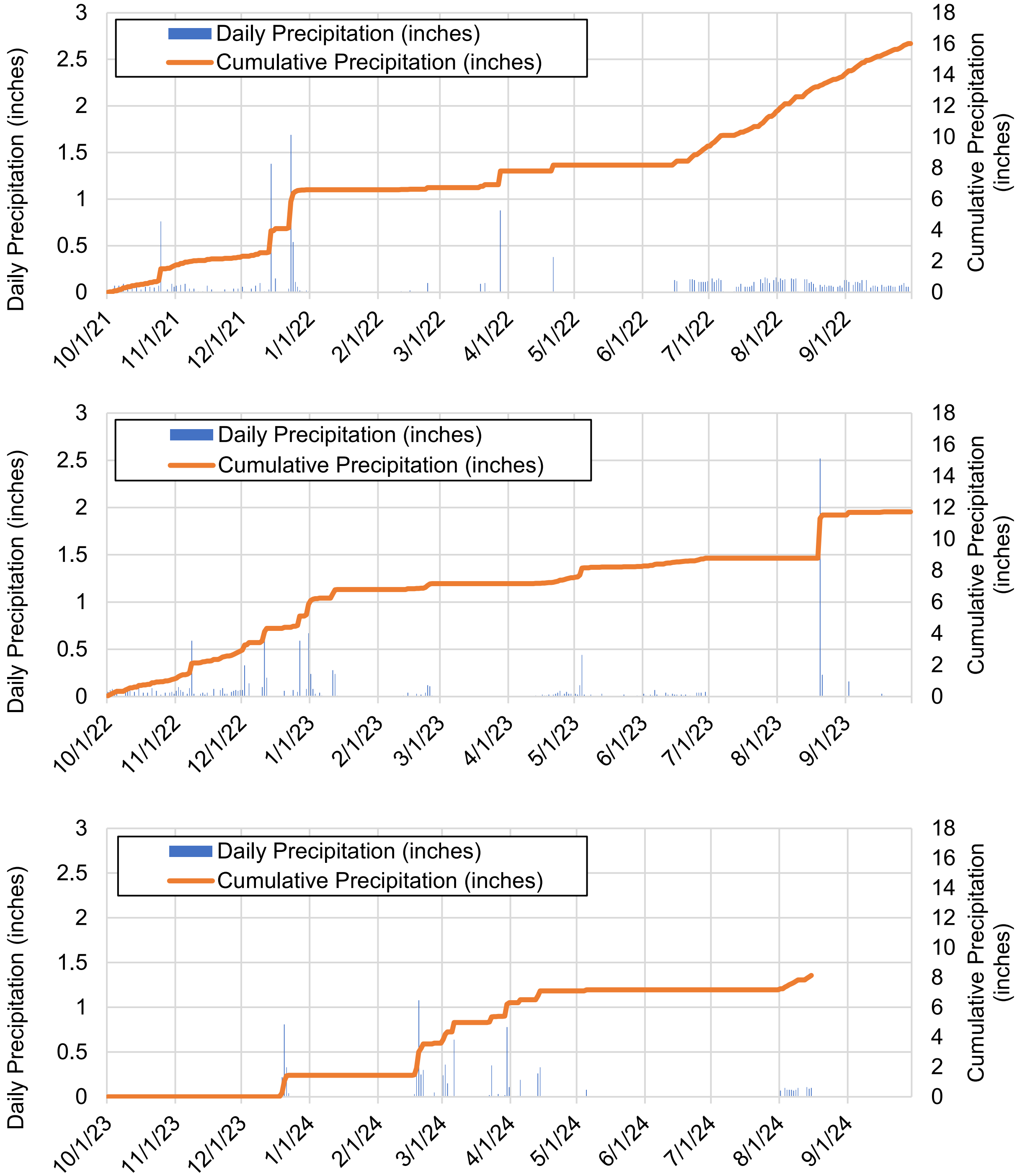

Figure 14.
Daily Precipitation in Camarillo During the 2021-2022, 2022-2023, and 2023-2024 Water Years

3.2 Elevation Profiles

The cross shore topographic surveys have been monitored to observe geomorphic changes and to determine when maintenance triggers are met. Appendix A shows the plotted profiles.

Typical beach changes are visible in the Phase 1 profiles for the 2023-2024 monitoring period. The beach shows an elevated profile during the spring and summer months, and the fall and winter months show a lower profile. Looking at the Emma Wood Reference Site, a raised profile at approximately Station 1+60 is visible for both the December 2023 profile and the May 2024 profile, which onsite appears to be a large and wrack bar created from the January 2023 coastal and fluvial storm events (Figure 15). From the same events, a similar cobble and wrack bar is visible on Profiles A, B, and C around Station 2+20, and Profile D around Station 2+40. This bar is further discussed in Section 3.3.

Figure 15.
Cobble and Wrack Bar Around Profiles A, B, and C (May 29, 2024)

In Profile I (previously Profile 6), located in the Phase 2 project area, significant erosion is visible in the beach profile. Comparing the December 2023 and July 2017 profiles, the parking lot/pedestrian walkway infrastructure eroded by more than 6 feet.

Looking at the project cobble berm design, the profiles are relatively visibly stable since June 2021, though Profiles A, B, and C show the most variability. The May 2024 Profile A appears about a foot lower than the June 2021 and March 2017 profile lines at the toe of the constructed cobble berm. The December 2023 and May 2024 profiles on Profile B have a higher profile than June 2021, the May 2024 profile sitting below the toe of the constructed berm by a couple feet. These variations appear to be consistent with the seasonal changes of the beach geomorphology. Maintenance triggers are discussed below.

Compared to the previous years, the dune hummocks appear to have moved slightly and grown. In Profile A, the dunes appear to have migrated slightly inland, though still within the 2012 footprint. The dune vegetation in the latest survey, May 2024 shows dune height growth In Profiles C and D. The top of the dunes between Station +20 to Station +80 appear to have diminished in Profile E, compared to previous years. Otherwise, there are not significant changes to the dunes in the beach profiles.

Maintenance triggers established for the project include the following:

- Lowering of the cobble berm below 13.0 feet NAVD within 40 feet from the path, and
- Inland migration of the berm crest to within 40 feet of the bike path. To minimize disturbance to the project in consideration of sand on top of the berm crest, the cobble berm face defined here to be the frontal slope below the crest of the cobble berm, generally in between the elevations of 14’ and 10’ NAVD88 may be used as a proxy to estimate the location of the berm crest.

The triggers identified were intended to raise awareness of potential issues and serve as an early warning (~1-3 years) indicator of potential future problems to the project. Specifically, once these triggers are met, there is an increasing urgency to initiate more detailed monitoring and planning for cobble and sand nourishment. The designed cobble section and the trigger lines are included in each of the figures of the surveyed profiles described in the following section. During the 2023-2034 monitoring period, none of the maintenance triggers were reached so no nourishment related activities are anticipated in the next few years. The western portion of the site should continue to be carefully monitored via Profiles A and B, and attention should be paid to the inland migration of the berm crest along Profile E.

3.3 Elevation Surfaces

Using the DSM data from two surveys collected from CSUCI, we developed an elevation change map that shows how site grades changed from September 2023 to May 2024 (Appendix B). The map shows accretion during by the color blue and erosion by shades of red. Areas of no change are the color white.

We note that the two data sets used likely need additional post-processing to correct for vertical adjustments to align the surfaces. As shown by the parking lot and levee at the west end of the site having a red hue in some locations, one or both of the surveys may have slight inaccuracies in the elevations, as the parking lot elevations should remain unchanged. Also, the surfaces contain areas with triangulation which is usually from interpolation between points. Nevertheless, several changes and trends are apparent through observing the map.

There is a landward movement of material, which is shown by the accretion on the shoreline, most apparent in the western half of Phase 1. It appears to represent the cobble and wrack that moved onshore during the winter, likely the effect of the winter wave events mobilizing the nearshore cobble and woody material and pushing it onshore to deposit on the intertidal zone and the beach. Another change evident is erosion in the intertidal zone at the eastern end of the project area near Phase 2, likely caused by waves. There is also erosion evident on the intertidal zone and the beach in front of the revetment and the river mouth. East of the windsurfing pad, the dunes appear to have a mixture of erosion and accretion, with the most accretion in the back beach, and the most erosion in the vegetated areas bordering the sidewalk.

3.4 Photo Documentation

Appendix C includes site photos taken in the summer of 2021, fall of 2023, and spring 2024. Photos were grouped according to their location within the study area: the southwestern extent of the project area (1E and 1W), the dunes between Profiles A and B (2E and 2W), the southeastern extent of the project area (5E and 5W), the eastern extent of the Phase II construction area on the beach (6W), and between photo locations 5 and 6 (XE and XW). During these monitoring efforts, photos were not consistently taken at the photo locations. However, important observations can be gathered from these photos as well as the aerial imagery in Appendix D.

3.4.1 Site Photos

At photo location 1 (see Figure 1) images taken in September 2021, during end of summer conditions at the site, show sand accretion with a cobble toe visible when facing East. In images taken in November 2023 during a strong El Niño cycle, wrack is visible facing East, and cobble is apparent in both directions due to beach erosion. Cobble and sand accumulated to create a berm that closes the lagoon from tidal influence. Images from May 2024 show post winter beach conditions with wrack on the back beach and cobble accumulated in the intertidal zone.

In May 2024 at photo location 2, during post winter conditions, dune hummocks and vegetation cover the surrounding area.

At photo location 3, images show clear differences between December 2023 (beginning of conditions) and May 2024 (post winter conditions). At the beginning of winter, the beach sand is showing signs of erosion from the winter swell with cobble and small amounts of wrack onshore. In the post winter conditions, there is a large wrack bar on the back beach and mid beach brough onshore during large winter storm events.

In May 2024 at locations XE and XW (between photo locations 5 and 6), post winter beach conditions in the Phase II monitoring area are showing eroded pavement and sea wall from winter storm events. Large amounts of cobble are dispersed on the beach. These same sea wall and pavement locations are intact in November 2023 prior to the winter storm events.

3.4.2 Aerial Imagery

ESA compiled aerial imagery for the project site from spring 2016 to fall 2024 with one to two images taken per year (Appendix D). Imagery from August 2022 (summer conditions) show significant sand accretion in the Phase I area, including build up in the intertidal area.

Imagery from February 2023 (winter conditions) shows the site during a strong El Niño cycle and following large fluvial and coastal storm events in January. The imagery shows erosion of the sand in the Phase I area, accumulation of cobble and wrack on the beach, and cobble accretion in the intertidal zone. The lagoon mouth is flowing around the rip rap revetment and is flowing out in front of the dunes to the west of the windsurfing pad. More erosion is evident in the Phase II beach area with no sand visible and cobble up to the sea wall.

Imagery from July 2023 (beginning of summer conditions) show sand beginning to accumulate on the beach in the Phase I area with cobble and wrack still present. Sand accretion is not visible in the Phase II area where cobble remains dominant. The lagoon mouth is closed.

Imagery from July 2024 (beginning of summery conditions) is similar. However, there is more sand accretion in the Phase I area than the prior year, and less cobble along the entire shore. The lagoon mouth is closed again.

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4. FUTURE MONITORING AND RECOMMENDATIONS

4.1 Nexus to BEACON's RCAMP

BEACON is developing the Regional Coastal Adaptation Monitoring Plan (RCAMP) that encompasses Santa Barbara and Ventura Counties. As an objective of the program, the RCAMP provides local management agencies with the information needed to assess whether changed conditions warrant new adaptation approaches and implementation actions are resulting in regional resilience benefits or impacts. The RCAMP contains monitoring topics including sandy beach shoreline change, storm events, damage, and emergency response, and combined coastal and fluvial flooding. Monitoring plan components are suggested for each of the topics, laid out by current and suggested data and monitoring, analysis, and products. One of the monitoring plan topics is the effectiveness of nature-based adaptation, specifically focused on future monitoring of Surfers' Point.

The purpose of monitoring built nature-based adaptation projects is to better understand their effectiveness, benefits, and limitations, which is important to inform and refine future nature-based project planning, design, and implementation both in the BEACON region and throughout California. For this Phase 1, the City of Ventura was required by permit to perform limited ongoing monitoring of Surfers' Point for a five-year period following construction through approximately 2017.

From 2020 through 2024, BEACON has funded continuation of the project design and expansion of the monitoring as part of a more comprehensive long-term monitoring program. This longer-term monitoring program is not currently in place or funded. More comprehensive monitoring of the Surfers' Point project and its effectiveness would benefit nature-based adaptation project planning, design, and implementation in the BEACON region and throughout California. Comprehensive monitoring would include continued monitoring at the adjacent Emma Wood reference site, Ventura River, and Phase 2 of the project, and potentially the shore extending down the point through the cove and to the wharf.

4.2 Suggested Analysis and Products

Minimum monitoring efforts would be those that meet the conditions of the Coastal Development Permit (CDP) for the project issued by the California Coastal Commission (CCC). We expect the required minimum monitoring to include repeat surveys of the Phase 1 and 2 areas approximately twice per year during representative summer and winter conditions, repeat photo points from selected locations that can be used to document the site, assessment of the dune vegetation and its successes and failures, and assessment of the project conditions relative to the selected trigger conditions for subsequent or mitigating actions.

Under an expanded scenario that includes efforts beyond the minimum required by the conditions of the CDP, the current monitoring, analysis, and reporting by the City, BEACON, and CSUCI could be continued and expanded to include supplemental surveys and monitoring in addition to the ongoing profile, LiDAR, and plant community surveys. The RCAMP suggests an expanded and integrated analysis of seasonal and interannual shore change, storm response and recovery, cobble movement, and dune processes and vegetation. Annual or regular reporting on shore change and project performance would provide information on long-term project performance as an ongoing nature-based project case study. We consider cobble tracking and movement a very important consideration that could provide significant value to the wider community in designing and implementing nature-based projects like Surfers' Point. We also recommend installing time-lapse cameras that can be used to track shore change, beach users, and others. Other possible efforts could include developing partnerships with entities such as Surfline, who owns and operates cameras that are installed at the site, and which are currently used to output surfing criteria associated with wave quality, surfing conditions, and public use.

With additional funding, additional data on shore change, water levels, waves, and wave runup, a mechanistic analysis of coastal processes, shore change, and project effectiveness could be performed to develop refined analysis tools and guidance for similar nature-based projects.

Ultimately, nature-based project analysis tools and guidance could be developed for BEACON and other regions. More comprehensive data collection and analysis could yield validated nature-based project analysis tools, proof of project performance and effectiveness, and guidance and lessons learned to inform similar projects in the BEACON region and throughout California.

5. REFERENCES

California Irrigation Management Information System (CIMIS), 2024, CIMIS Station ID: 152 Camarillo. Accessed online August 16, 2024: https://wwwcimis.water.ca.gov/

Environmental Science Associates (ESA), 2018, Surfers' Point Shore Enhancement Project 2016-2017 Monitoring Report. Prepared for City of Ventura, May 2018.

Iowa Environmental Mesonet (IEM), 2024. ASOS Network, Station Name: Oxnard Airport [OXR]. Accessed online August 16, 2024: https://mesonet.agron.iastate.edu/request/download.phtml?network=CA_ASOS

National Oceanic and Atmospheric Administration (NOAA) National Data Buoy Center (NDBC), 2024, Station 46053 – East Santa Barbara Historical Data. Accessed online August 16, 2024: https://www.ndbc.noaa.gov/station_history.php?station=46053

NOAA NDBC, 2024, Station 46054 – West Santa Barbara Historical Data. Accessed online August 16, 2024: https://www.ndbc.noaa.gov/station_history.php?station=46054

NOAA NDBC, 2024, Station 46218 –Harvest, CA (071), Information submitted by Scripps Institute of Oceanography. Accessed online August 16, 2024: https://www.ndbc.noaa.gov/station_history.php?station=46054

NOAA Tides and Currents. Tides/Water Levels, NOAA Tide Predictions. Station 9411340 (Santa Barbara, CA). Accessed online August 16, 2024: https://tidesandcurrents.noaa.gov/stationhome.html?id=9411340

Scripps Institute of Oceanography (SIO) Coastal Data Information Program (CDIP), 2024, Harvest, CA – 071. Accessed online August 16, 2024: https://cdip.ucsd.edu/m/products/?stn=071p1

United States Geological Survey (USGS), 2024, Ventura R NR Ventura – 11118500. Accessed online August 16, 2024: https://waterdata.usgs.gov/monitoring-location/11118500/#parameterCode=00065&period=P7D&showMedian=false

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6. ACKNOWLEDGMENTS

This report was completed for BEACON, with input and collaboration with executive director Marc Beyeler.

We acknowledge the support and contributions of the City of Ventura on the project, including collection of survey data and funding of prior monitoring efforts.

We also acknowledge contributions, spatial data sets and interpretations from Kiersten (Kiki) Patsch, PhD, of California State University Channel Islands.

We thank Bob Battalio, PE (ESA, Retired), for his review and interpretation of survey data.

We would also like to acknowledge contributions from Dave Hubbard of Coastal Restoration Consultants for his work on vegetation design, implementation, and monitoring, and Paul Jenkins of Surfrider for his engagement and leadership on the project from concept and planning through implementation and monitoring.

The following ESA staff contributed to this report:

Louis White, PE

Amber Inggs, PE

Bip Padrnos

Karl Kindall

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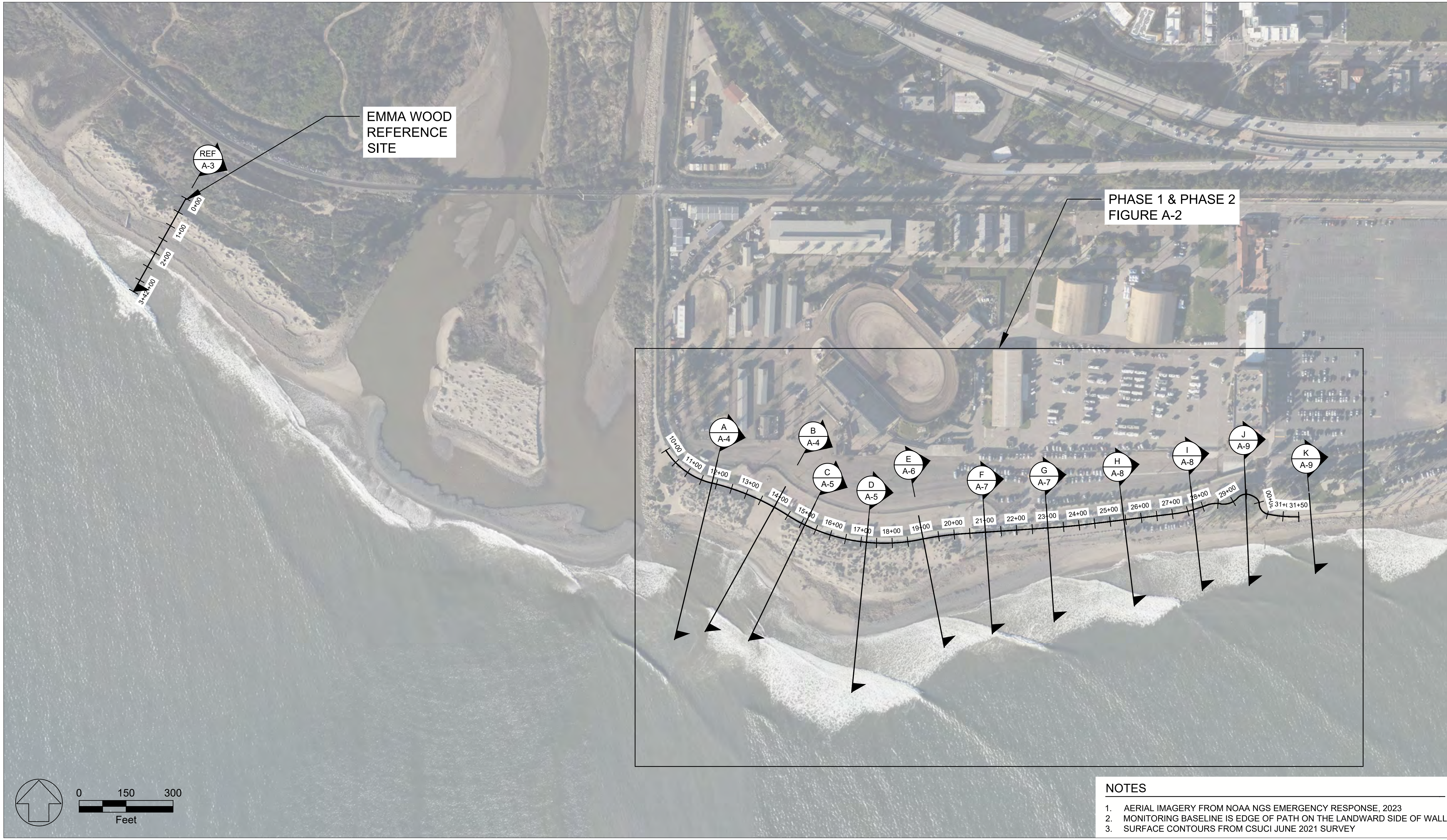
Appendix A.
Monitoring Profiles



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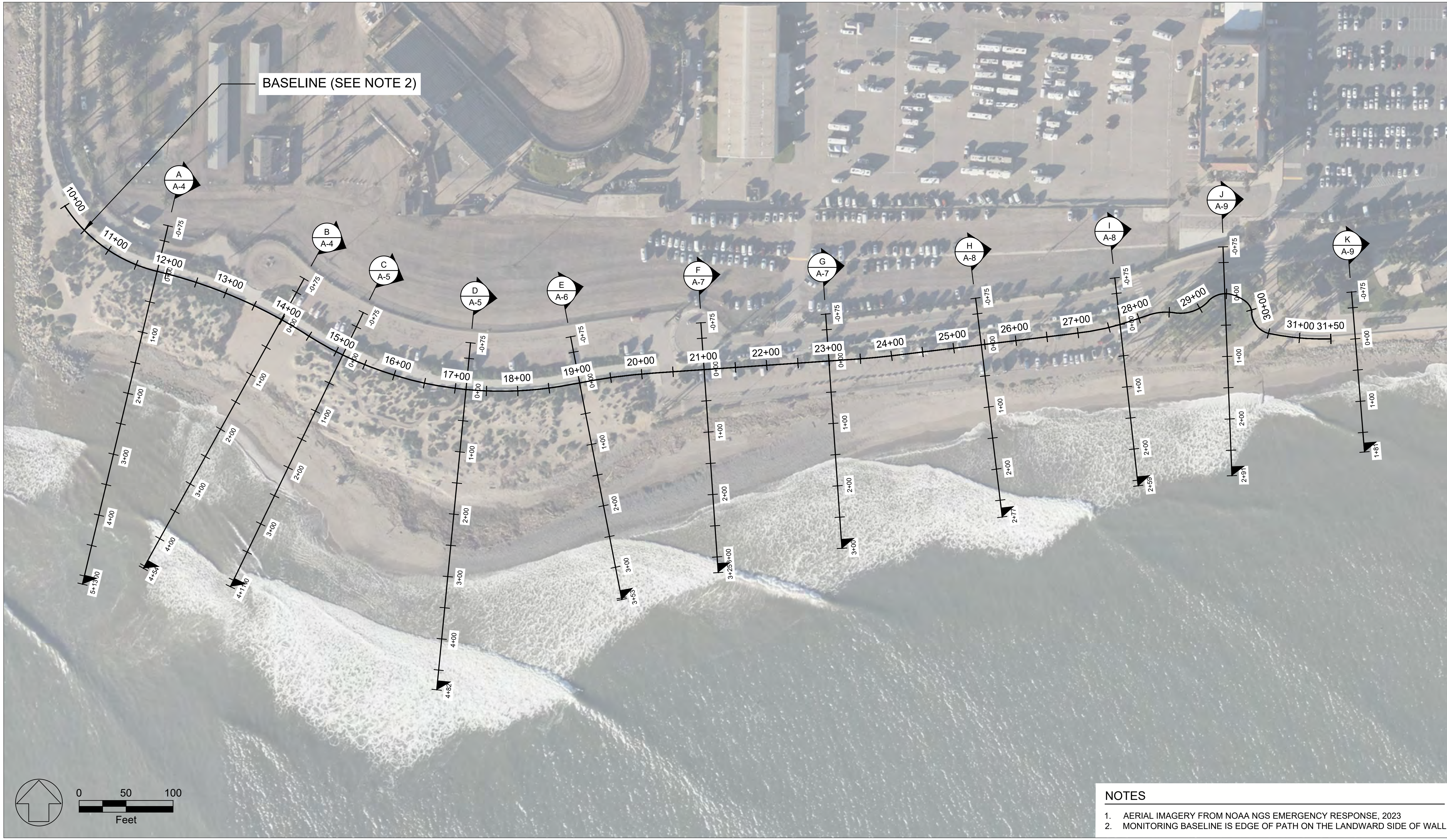
NOTES

1. AERIAL IMAGERY FROM NOAA NGS EMERGENCY RESPONSE, 2023
2. MONITORING BASELINE IS EDGE OF PATH ON THE LANDWARD SIDE OF WALL
3. SURFACE CONTOURS FROM CSUCI JUNE 2021 SURVEY

Figure A-1
Monitoring Transects

ESA



NOTES

1. AERIAL IMAGERY FROM NOAA NGS EMERGENCY RESPONSE, 2023
2. MONITORING BASELINE IS EDGE OF PATH ON THE LANDWARD SIDE OF WALL

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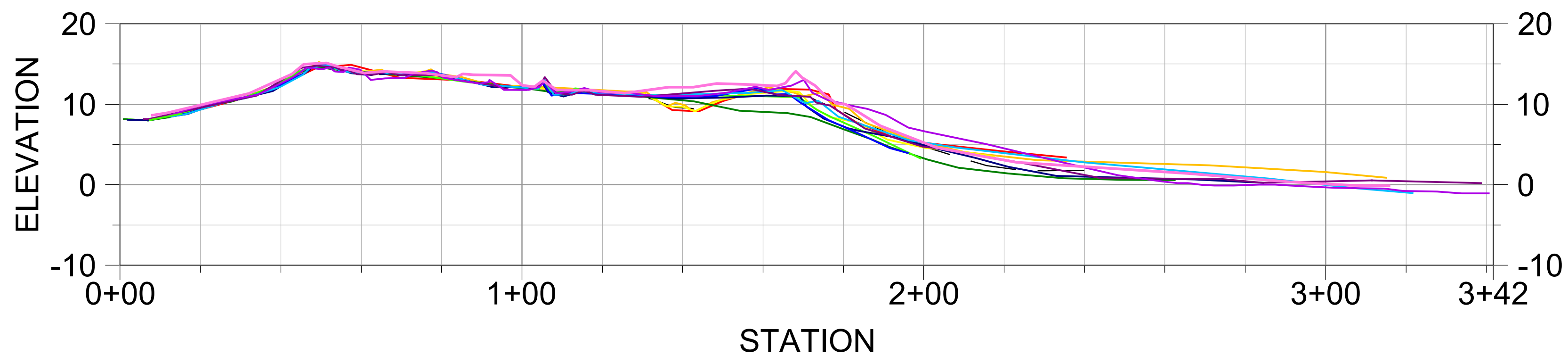
Surfers' Point Monitoring Spring 2024

Figure A-2
Monitoring Transects

ESA

LEGEND

dashed black	2010 (PRE CONSTRUCTION)
	2011-10-08
	2012-07-03
	2012-12-13
	2013-04-30
	2015-07-08
	2015-12-23
	2016-05-09
	2016-08-09
	2017-03-14
	2017-07-14
	2021-06-03
	2023-12-11
	2024-05-29



REF A-1 Emma Wood Reference Site

1" = 45', 2VH1

NOTES

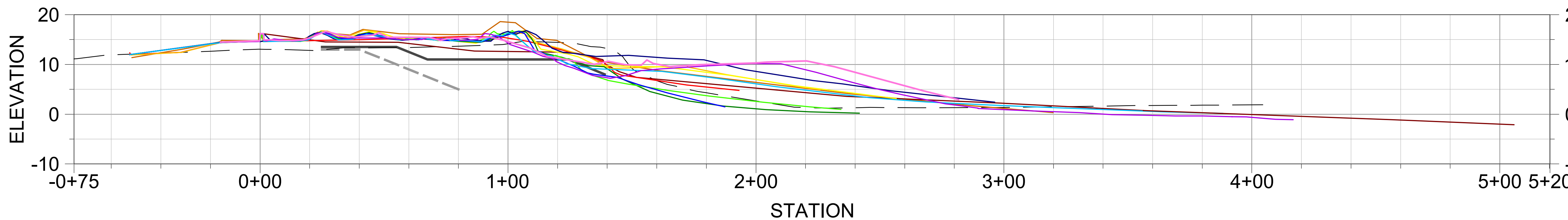
1. ELEVATIONS IN FEET RELATIVE TO NAVD

Figure A-3
Surfers' Point Monitoring Profiles
Emma Wood Reference Site

ESA

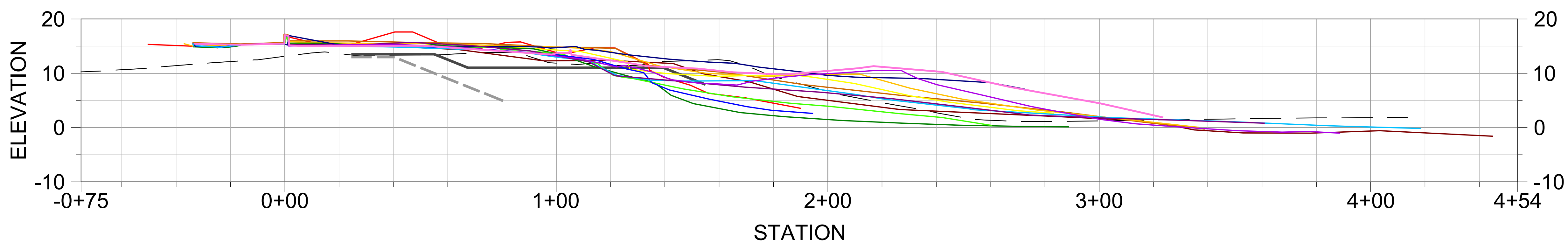
LEGEND

Black dashed line	2010 (PRE CONSTRUCTION)
Dark red line	2011-10-08
Red line	2012-07-03
Orange line	2012-12-13
Gold line	2013-04-30
Yellow line	2015-07-08
Dark green line	2015-12-23
Light green line	2016-05-09
Navy line	2016-08-09
Blue line	2017-03-14
Cyan line	2017-07-14
Purple line	2021-06-03
Violet line	2023-12-11
Pink line	2024-05-29
Thick dark grey line	COBBLE BERM DESIGN
Grey dashed line	COBBLE BERM TRIGGER



A / A-2 Phase 1, Cross Section A

1" = 45', 2VH1



B / A-2 Phase 1, Cross Section B

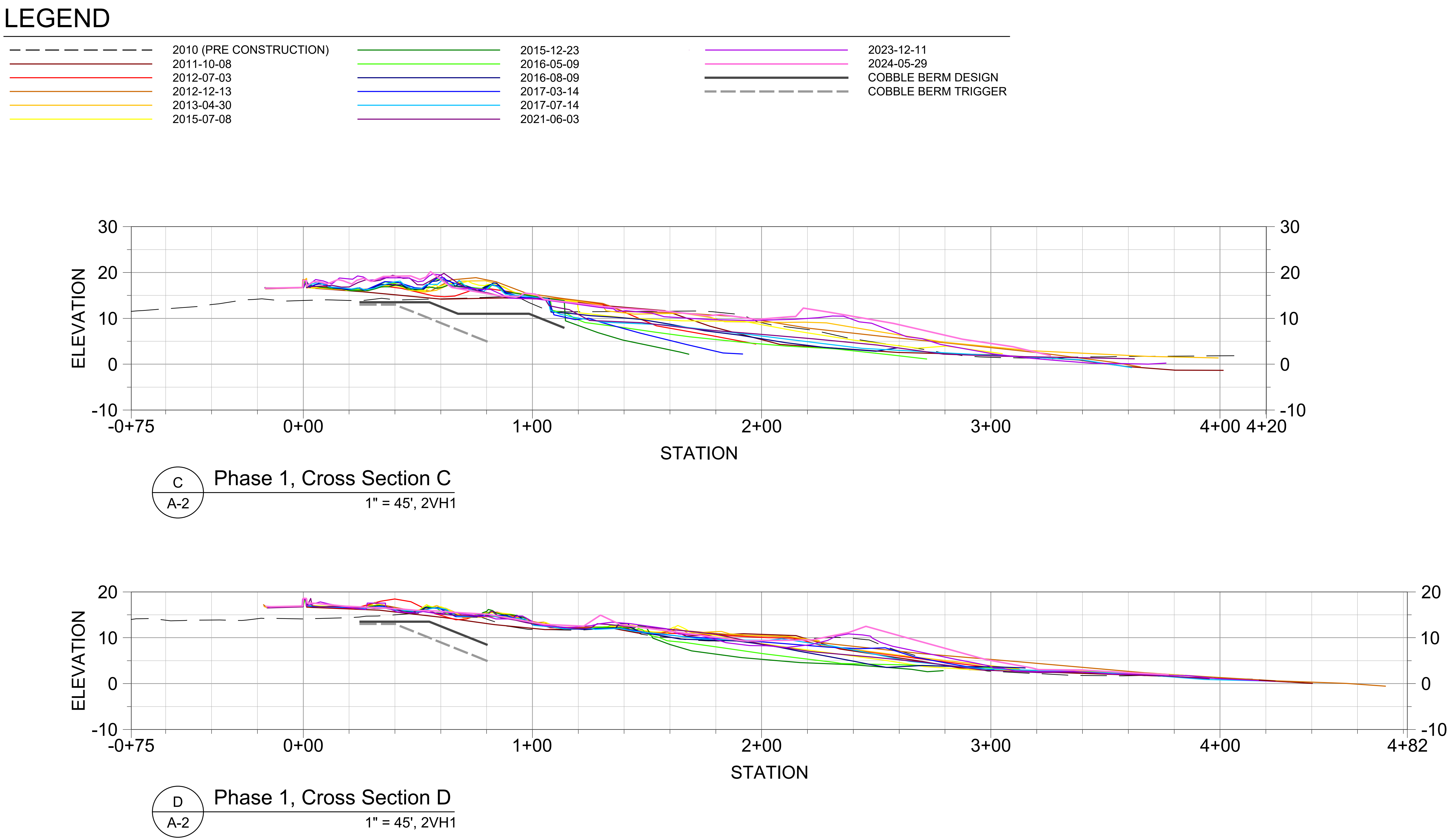
1" = 45', 2VH1

NOTES

1. ELEVATIONS IN FEET RELATIVE TO NAVD
2. STATION DISTANCE IN FEET RELATIVE TO EDGE OF PATH ON THE LANDWARD SIDE OF WALL (SEE BASELINE)

Figure A-4
Surfers' Point Monitoring Profiles
Phase 1, Cross Sections A & B

ESA



NOTES

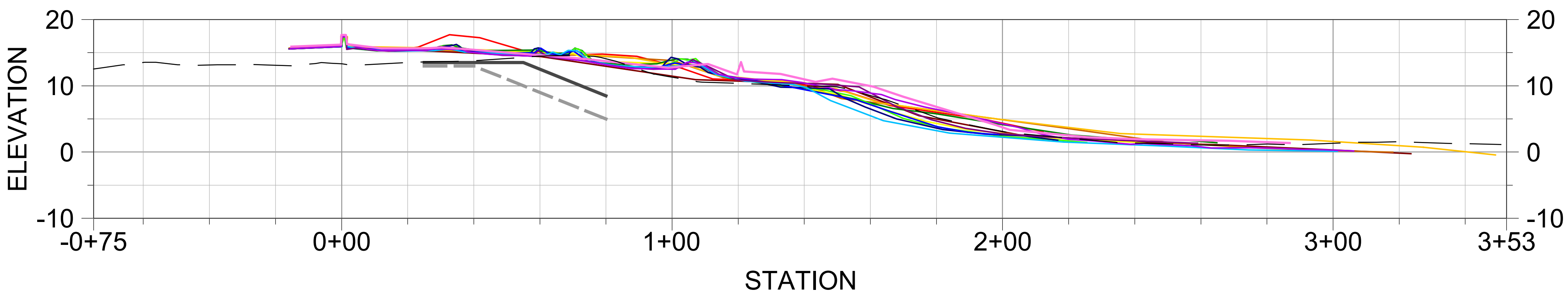
1. ELEVATIONS IN FEET RELATIVE TO NAVD
2. STATION DISTANCE IN FEET RELATIVE TO EDGE OF PATH ON THE LANDWARD SIDE OF WALL (SEE BASELINE)

Figure A-5
Surfers' Point Monitoring Profiles
Phase A, Cross Sections C & D

ESA

LEGEND

- 2010 (PRE CONSTRUCTION)
- 2011-10-08
- 2012-07-03
- 2012-12-13
- 2013-04-30
- 2015-07-08
- 2015-12-23
- 2016-05-09
- 2016-08-09
- 2017-03-14
- 2017-07-14
- 2021-06-03
- 2023-12-11
- 2024-05-29
- COBBLE BERM DESIGN
- COBBLE BERM TRIGGER



E / A-2 — Phase 1, Cross Section E

1" = 45', 2VH1

NOTES

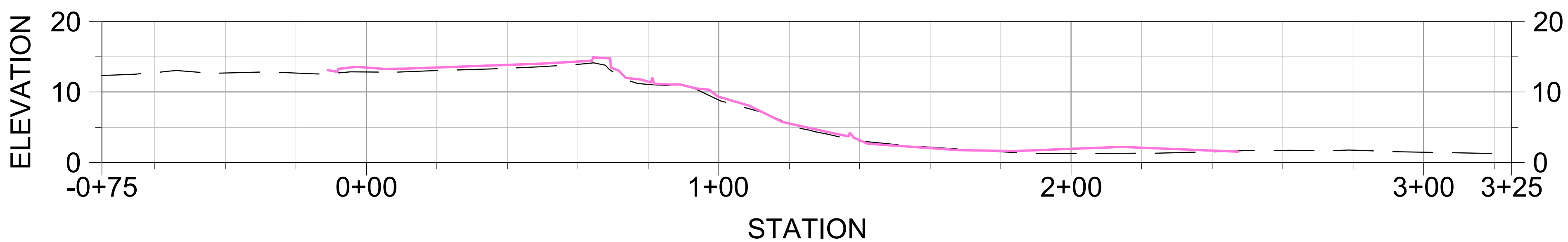
1. ELEVATIONS IN FEET RELATIVE TO NAVD
2. STATION DISTANCE IN FEET RELATIVE TO EDGE OF PATH ON THE LANDWARD SIDE OF WALL (SEE BASELINE)

Figure A-6
Surfers' Point Monitoring Profiles
Phase 1, Cross Section E

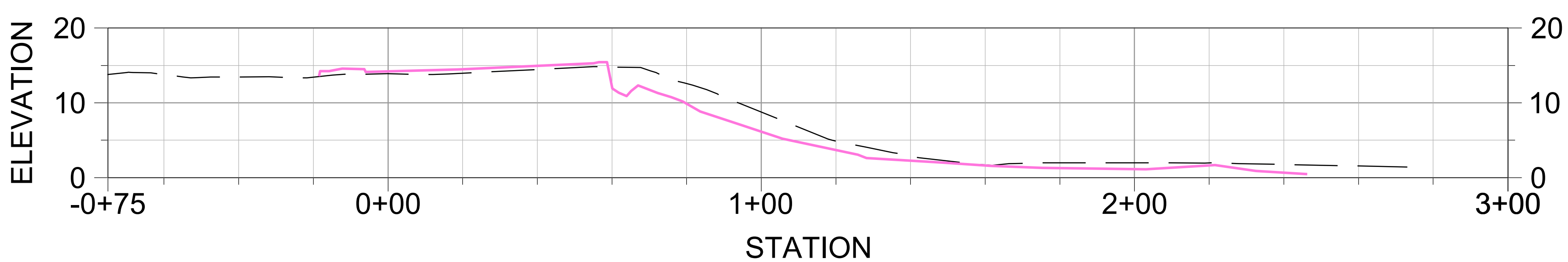
ESA

LEGEND

2010 (PRE CONSTRUCTION)
2024-05-29



F / A-2 Phase 2, Cross Section F
1" = 45', 2VH1



G / A-2 Phase 2, Cross Section G
1" = 45', 2VH1

NOTES

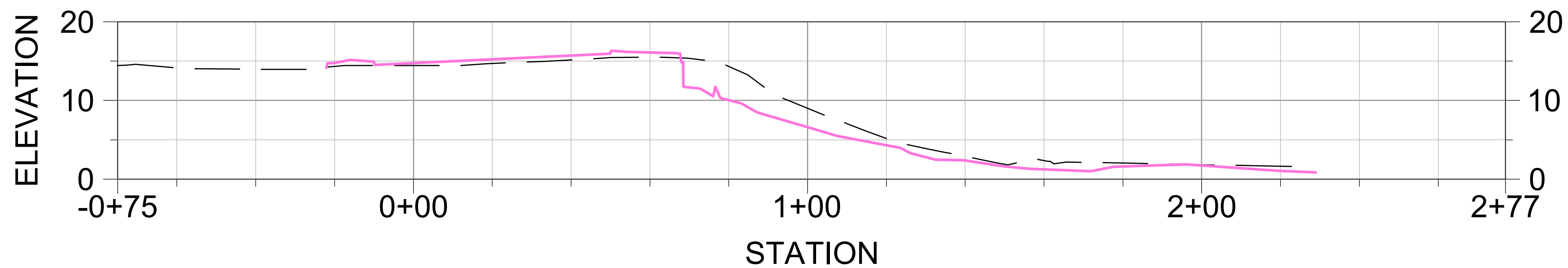
1. ELEVATIONS IN FEET RELATIVE TO NAVD
2. STATION DISTANCE IN FEET RELATIVE TO EDGE OF PATH ON THE LANDWARD SIDE OF WALL (SEE BASELINE)

Figure A-7
Surfers' Point Monitoring Profiles
Phase 2, Cross Sections F & G

ESA

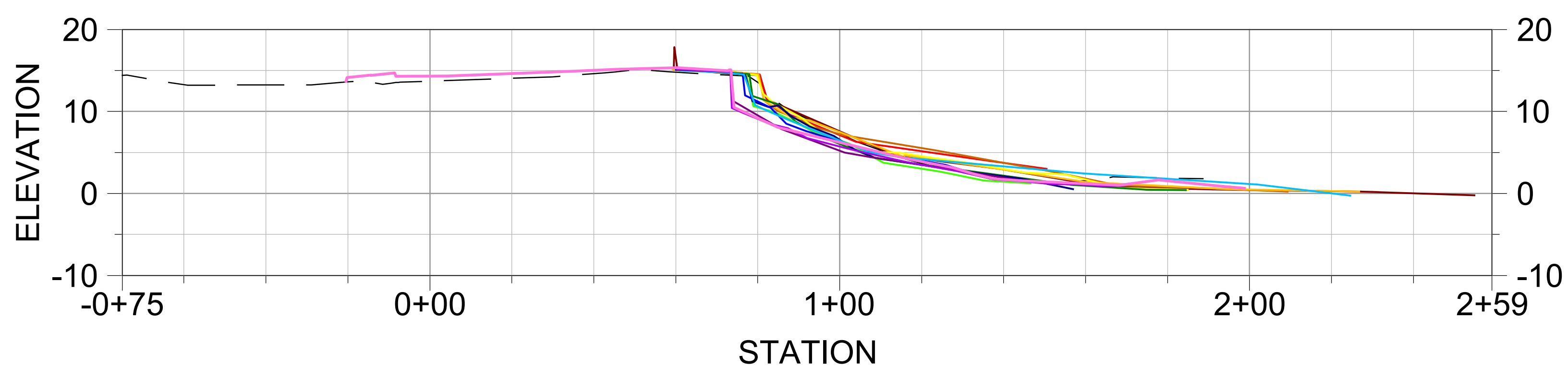
LEGEND

- - - - 2010 (PRE CONSTRUCTION)
2011-10-08
2012-07-03
2012-12-13
2013-04-30
2015-07-08
2015-12-23
2016-05-09
2016-08-09
2017-03-14
2017-07-14
2021-06-03
2023-12-11
2024-05-29



H / A-2 Phase 2, Cross Section H

1" = 45', 2VH1



I / A-2 Phase 2, Cross Section I

1" = 45', 2VH1

NOTES

1. ELEVATIONS IN FEET RELATIVE TO NAVD
2. STATION DISTANCE IN FEET RELATIVE TO EDGE OF PATH ON THE LANDWARD SIDE OF WALL (SEE BASELINE)

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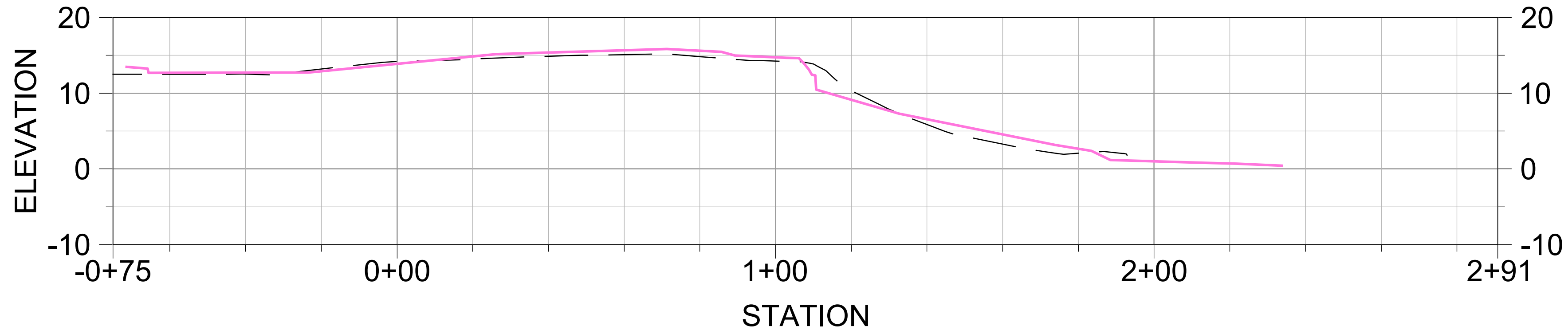
Figure A-8
Surfers' Point Monitoring Profiles
Phase 2, Cross Sections H & I

ESA

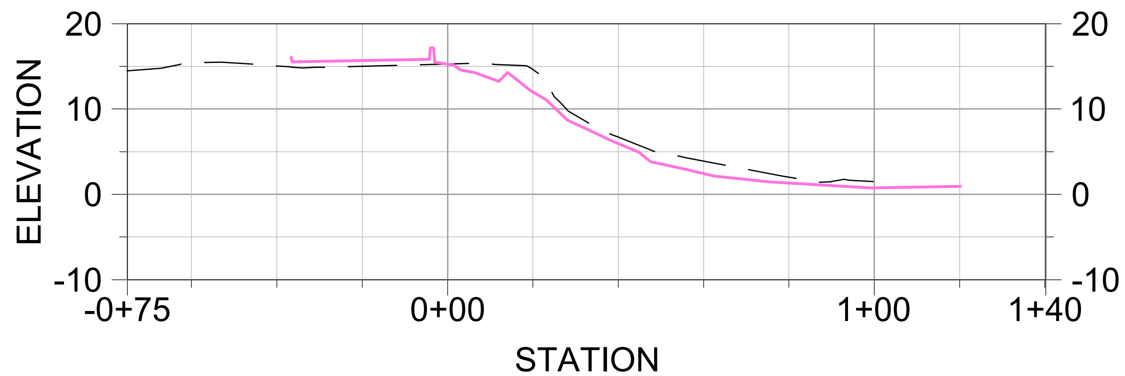
LEGEND

- 2010 (PRE CONSTRUCTION) (dashed line)
- 2024-05-29 (solid line)



J / A-2 — Phase 2, Cross Section J

1" = 45', 2VH1



K / A-2 — Phase 2, Cross Section K

1" = 45', 2VH1

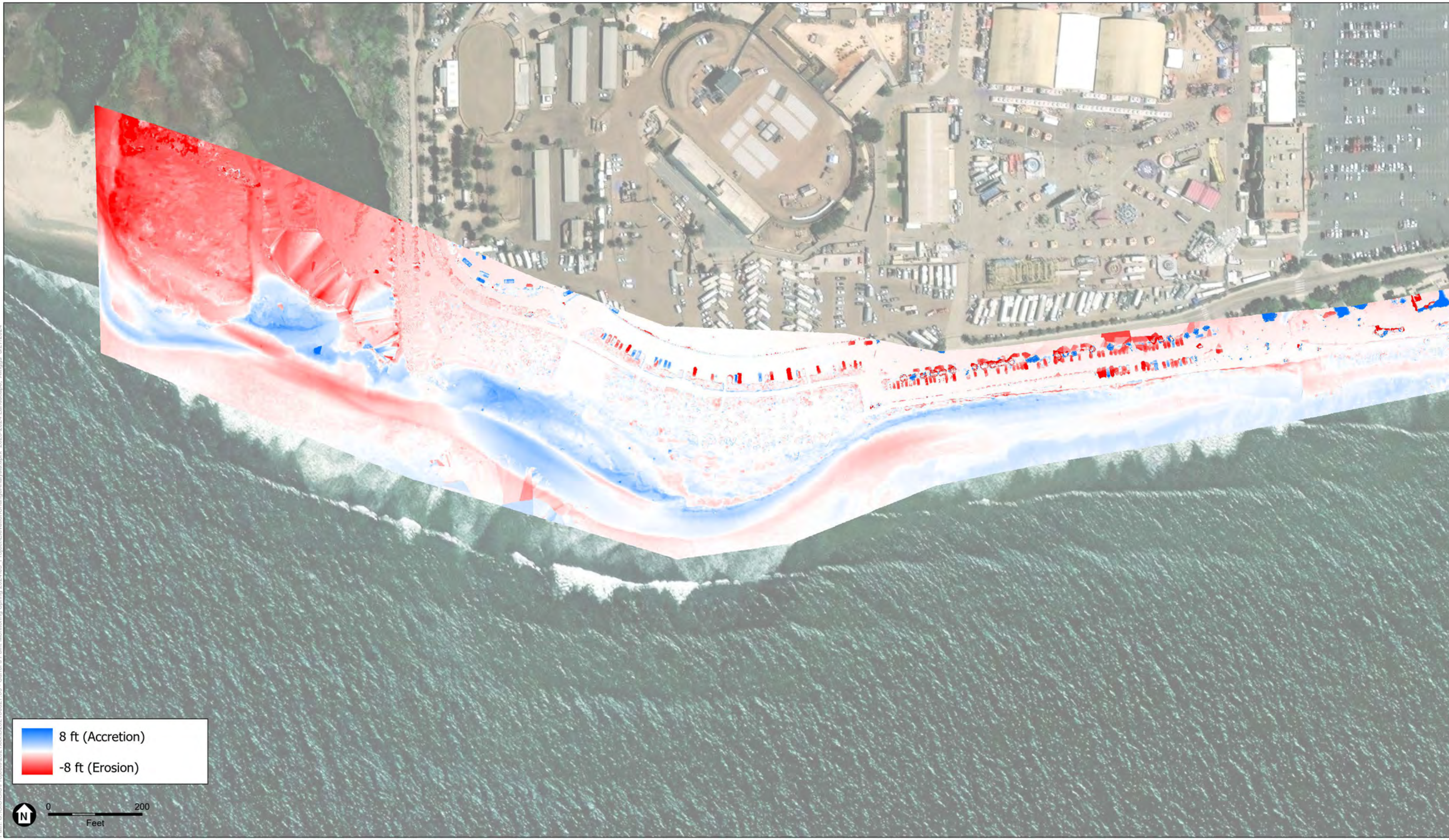
NOTES

1. ELEVATIONS IN FEET RELATIVE TO NAVD
2. STATION DISTANCE IN FEET RELATIVE TO EDGE OF PATH ON THE LANDWARD SIDE OF WALL (SEE BASELINE)
3. PATH ENDS BEFORE XS 11, 0 AT XS11 IS SET AT THE LINEAR EXTENSION FROM THE END OF THE PATH

Figure A-9
Surfers' Point Monitoring Profiles
Phase 2, Cross Sections J & K

ESA

Appendix B.
Elevation Change



SOURCE: ESRI, CSUCI

Surfers' Point Monitoring Spring 2024

Figure B-1
Elevation change between September 2023 and May 2024
(2024 survey minus 2023 survey)

ESA

Appendix C.
Site Photos

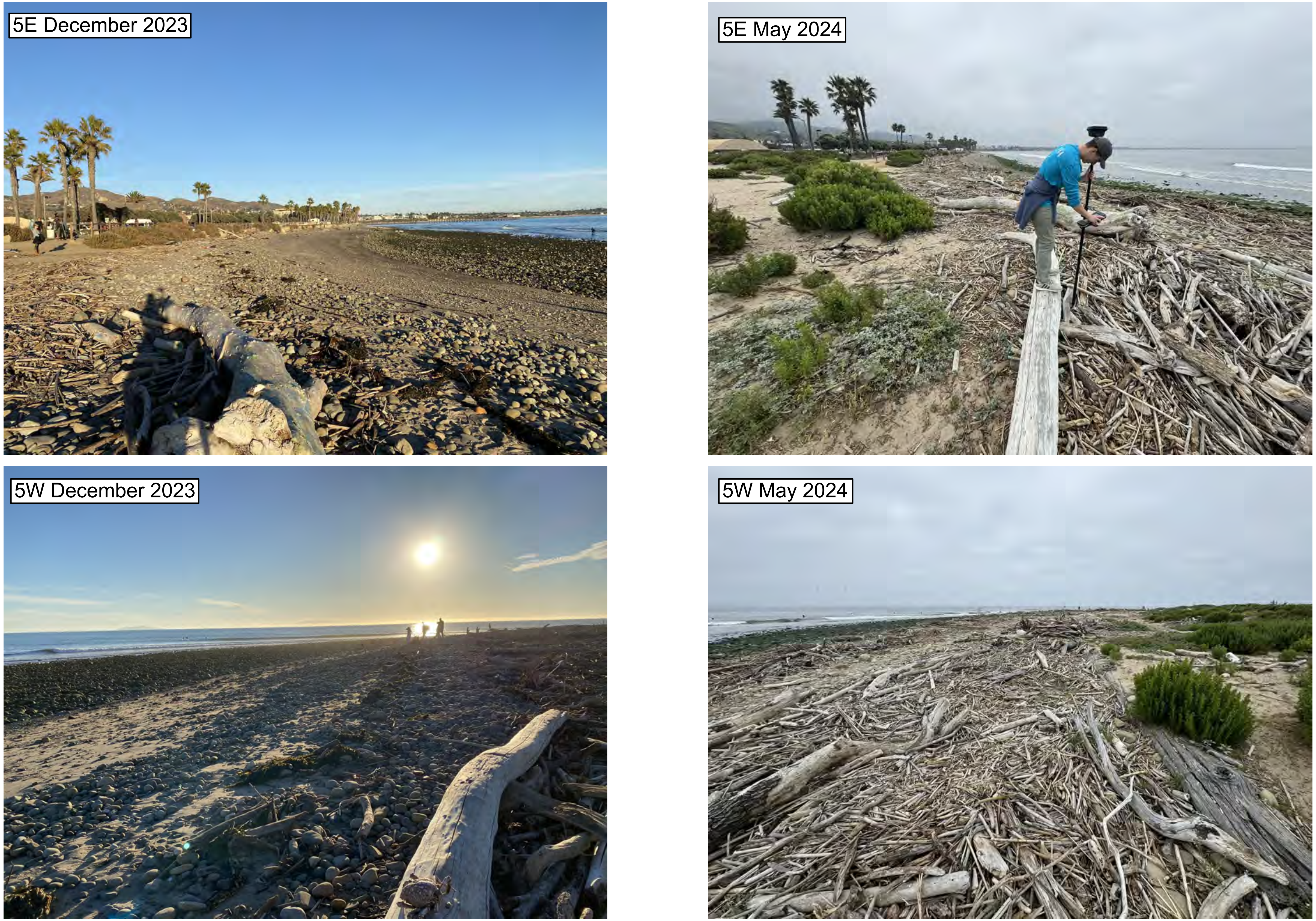
SOURCE: ESA, 2024

Figure C-1
Site Photos from 2021, 2023, and 2024

SOURCE: ESA, 2024

Figure C-2
Site Photos from 2024

ESA



SOURCE: ESA, 2024

Figure C-3
Site Photos from 2023 and 2024

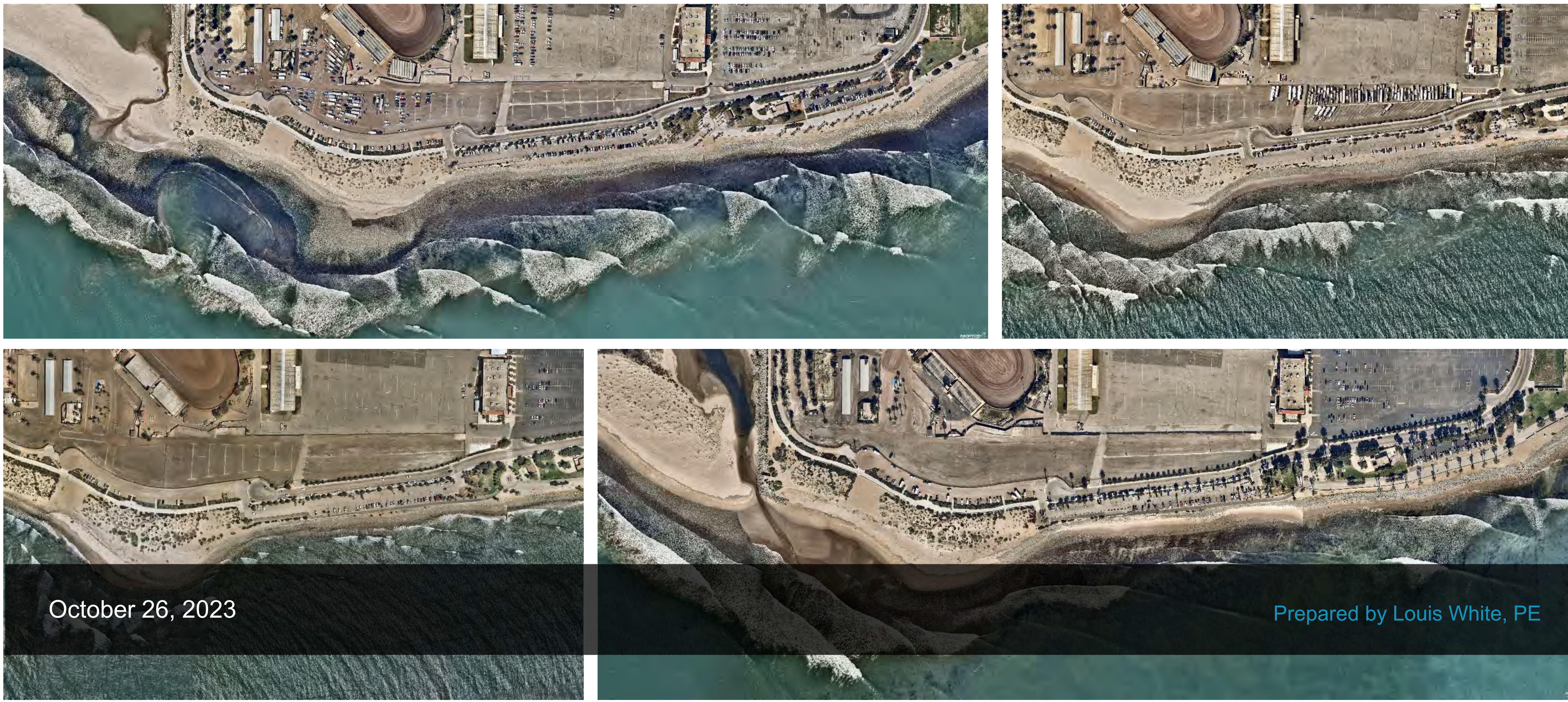
SOURCE: ESA, 2024

Figure C-4
Site Photos from 2023 and 2024

Appendix D.
Nearmap Aerial Imagery

Aerial Imagery from Nearmap

Surfers’ Point Aerial Imagery Timeline 2016 to 2024

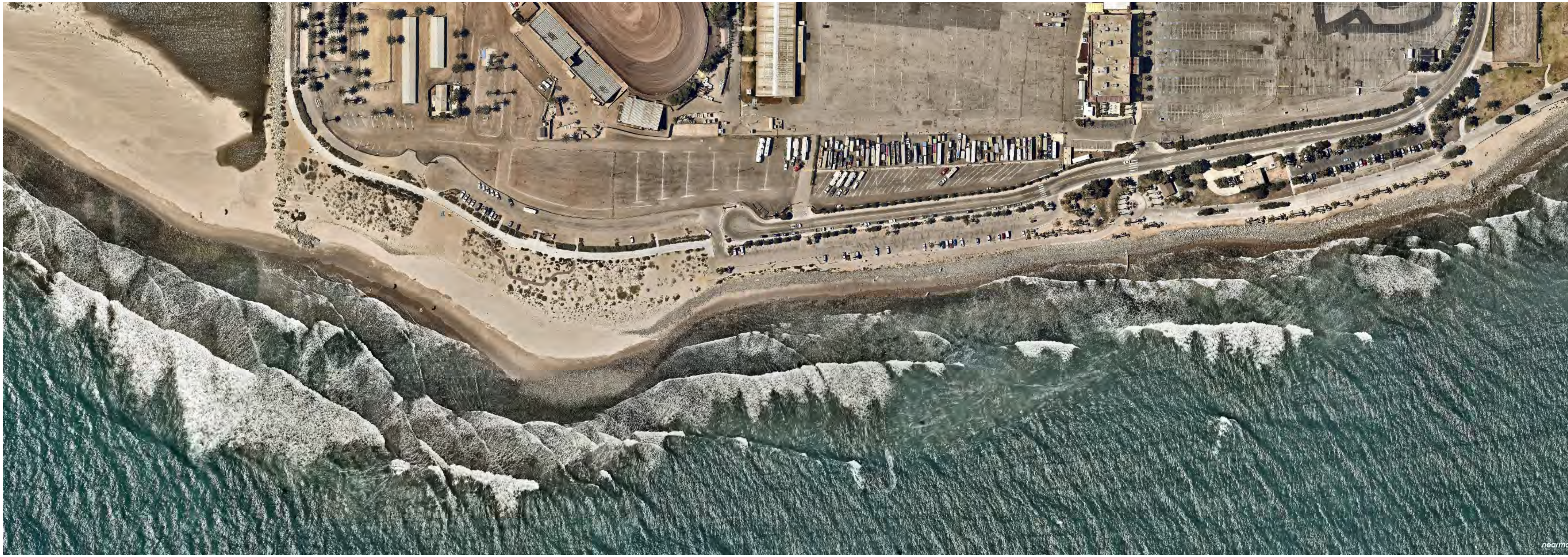


October 26, 2023

Prepared by Louis White, PE

2016-04-02

Nearmap Imagery



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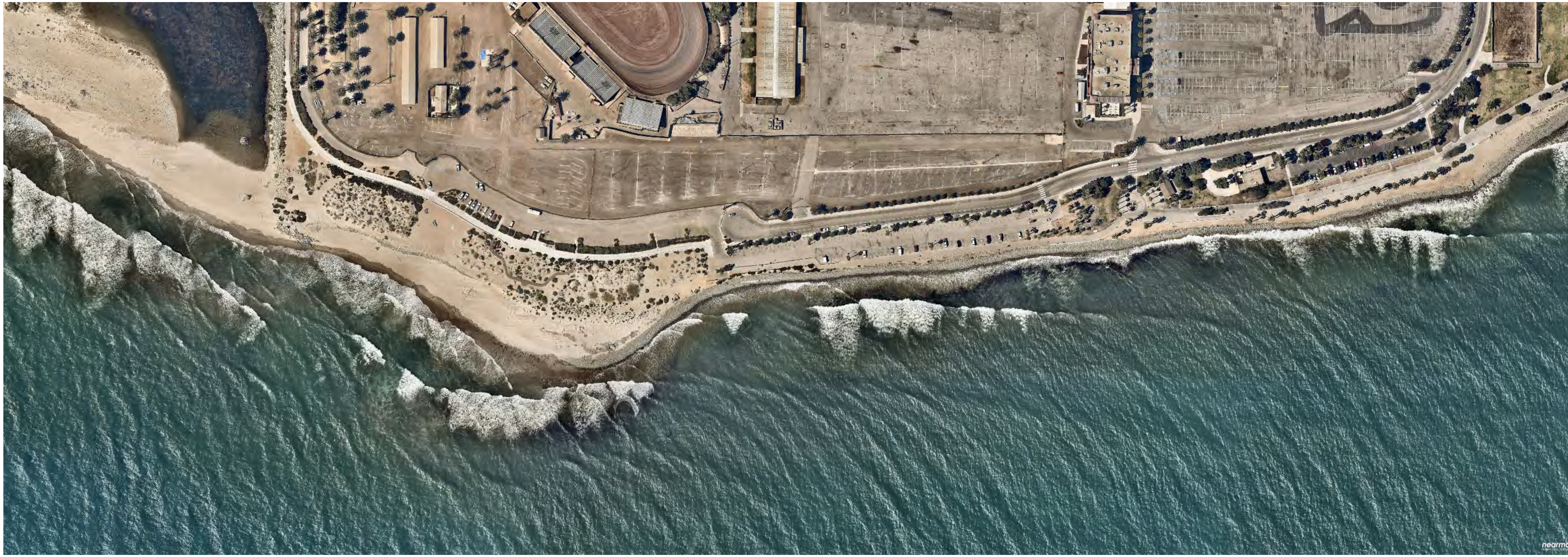
Nearmap Imagery



2017-08-26

Nearmap Imagery

2017-08-30

Nearmap Imagery

ESA

2018-07-14

Nearmap Imagery

2019-06-30

Nearmap Imagery

2020-08-27

Nearmap Imagery

2021-02-06

Nearmap Imagery

2022-02-06

Nearmap Imagery

2022-08-06

Nearmap Imagery

2023-02-15

Nearmap Imagery

2023-07-09

Nearmap Imagery

2024-07-16

Nearmap Imagery

ITEM 4
Surfers Point Project

Attachment 2

Article on Surfers Point Project

Surfers Point managed shoreline retreat project: Lessons from a cobble beach pilot on a dynamic delta

By

Bob Battalio P.E.,[1] Marc Beyeler,[2] David M. Hubbard,[3]
A. Paul Jenkin,[4] Kiki Patsch,[5] and Louis A. White, P.E.[6]

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5) California State University, Environmental Sciences and Resource Management, 1 University Drive, Camarillo, California, USA, 93012
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ABSTRACT

The Surfers Point Managed Shoreline Retreat Project in Ventura, California, USA, demonstrates an alternative to conventional shoreline armoring by using natural materials and geomorphic design to avoid the negative consequences associated with riprap and seawalls. This paper evaluates the physical performance of Phase 1 of the project, which constructed a dynamic cobble berm/sandy beach and dune system within the active delta of the Ventura River. The design replicated shore form and function while relocating infrastructure inland to restore space for coastal processes. The project met multiple objectives including erosion and flood mitigation, access and recreation benefits, and restoration of natural morphology and ecology. Implementation required extensive coordination among public landowners, managers, regulators, funders, stakeholders, and the public. The engineering design consists of a base layer of cobble, topped with sand and vegetated dunes, intended to respond dynamically to elevated waves and river flows, and variable sediment input from upcoast and the Ventura River. Monitoring from 2011 through 2024 shows a dynamically stable and resilient system. The project provides a valuable case study for cobble-based living shorelines in high-energy coastal environments. An applied geomorphology approach informed by reference sites is a valid basis for establishing the geometry and materials for cobble-boulder berms and vegetated dunes. Landward realignment of built infrastructure was required to provide sufficient space for natural processes. Setback distances were informed by wave run-up calculations. Parametric equations for wave run-up combined with engineering judgement can inform development setbacks. Native dune vegetation and low-relief foredune geometry have proven resilient within this coastal flood plain, with the cobble berm providing protection. The natural infrastructure has accommodated erosion events, dissipated wave run-up and recovered repeatedly with sand deposition since construction in 2012.

KEYWORDS: Coastal adaptation, cobble, living shorelines, managed retreat, vegetated sand dunes.

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The Surfers Point Managed Shoreline Retreat Project in Ventura, California, has been identified as a model for nature-based solutions to mitigate coastal erosion and flooding (Newkirk *et al.* 2018; Judge *et al.* 2017). Constructed in 2010-2012, the project relocated a damaged pedestrian trail and parking lot 80 feet inland and built an engineered shoreline that mimics the native geomorphology of the Ventura River delta. Previously placed quarry stone revetment and fill were removed and replaced with cobble and sand. Opportunistically sourced sediments were used to construct a cobble berm covered by sand and vegetated dunes based on nearby reference conditions. Funding limitations restricted initial implementation to approximately half of the 2,000-foot shoreline. The success of Phase 1 led to the funding and implementation of Phase 2 in 2024-2025 to address the ongoing erosion on the remaining 1,000 feet of shoreline. The popularity of the site for coastal access and recreation provides a highly visible public demonstration of the benefits of enhanced coastal resiliency in response to rising seas.

This paper focuses on the Phase 1 waterside "coastal engineering" component of the project, outlining the design approach and evaluating project performance using monitoring data gathered since construction. Phase 2 and the substantial landside component of both phases are addressed only for context. Each of the authors participated in one or more implementation phases (i.e., planning, design, construction, monitoring) of the project.

LOCATION AND SETTING

The Surfers Point project lies within the City of San Buenaventura (Ventura) in southern California, USA, within the Santa Barbara Littoral Cell at the Ventura River mouth (Figure 1). The Ventura River forms a prominent cobble delta formed by flood deposits eroded from the steep erodible mountains of the transverse range in the upper watershed. The project encompasses approximately 2,000 linear feet of south-facing shoreline beginning just east of the Ventura River mouth (Figure 2). Historically, the area now occupied by the Ventura County

Fairgrounds and Surfers Point comprised the eastern portion of the Ventura River estuary (Beller *et al.* 2011). The estuary was filled and graded and is now separated from the river by a levee and coastal jetty. A portion of the estuary remains intact upstream and west of the river mouth within Emma Wood State Beach.

The surf zone substrate consists of cobble and boulder discharged from the river and topped with sand from the river and littoral transport. Net littoral transport in this region moves predominantly eastward (downcoast), driven by prevailing northwest swell and oblique wave angles. Sand transport rates along the Ventura County shoreline are estimated to range from 130,000 to 390,000 cubic yards per year with additional deposits from the Ventura River totalling over 500,000 cubic yards per year, based on dredging records at Ventura Harbor (Patsch and Griggs 2006; BEACON 2009; Patsch and Griggs 2021). The shore in the area is eroding, in part due to reduced sediment supply (Patsch and Griggs 2008; Slagel and Griggs 2008).

The cobble-boulder and sand river mouth delta create breaking wave conditions favorable for surfing (Figure 3) and is a heavily utilized and well-known surfing area (Wright 1985; Surfer Magazine 2006; Surfline Ventura Point Surf Guide undated; PWA 2005). Ocean tides are mixed diurnal and semi-diurnal with an average diurnal tide range of 5.4 feet (NOAA Santa Barbara Tide Gauge 9411340). Long wavelength swells dominate the wave climate, approaching primarily from the west-northwest and south between the offshore islands, and refracting to arrive from the south-southwest (ESA *et al.* 2024). The 50-year wave height nearshore (depth of 30 feet) was estimated to be 20 feet (PWA 2005). The Ventura River mouth is seasonally closed by wave-driven sand deposits forming a lagoon, with winter flows breaching the mouth. Peak flows during wet years are typically in the 10,000 to 20,000 cubic feet per second (cfs) and 35,200 cfs computed for the 10-year event (ESA *et al.* 2024).

BACKGROUND

Public use of this portion of the Ventura shoreline, including Surfers Point and Seaside Park has been an active part of local community life for more than 100 years (Beyeler 2012). Over the decades, development of the Ventura County

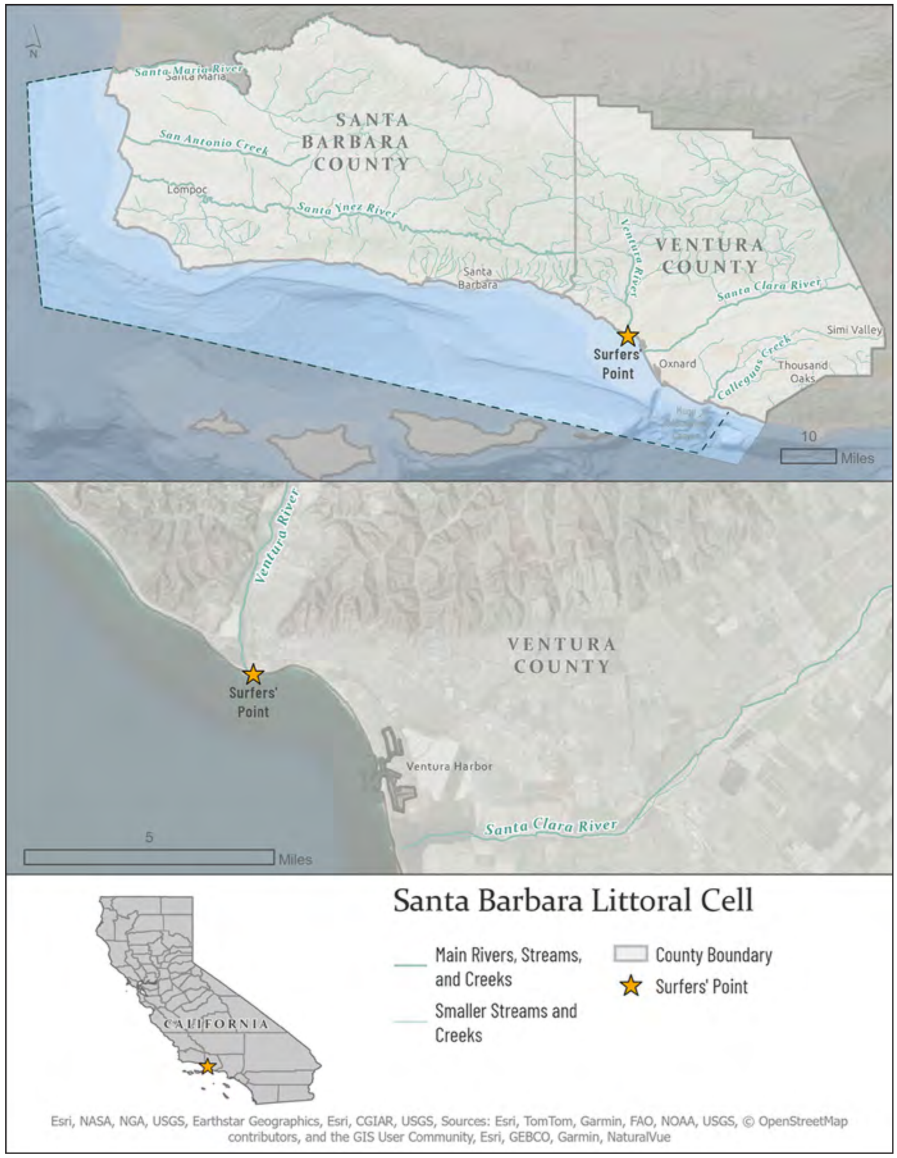

Figure 1. Map shows the Surfers Point project location within the Santa Barbara Littoral Cell. Source: Modified from Patsch and Griggs 2006.

Figure 2. Aerial photograph of Surfers Point Project vicinity. Source: Google Earth, 12 April 2018.

Figure 3. Large long-period swell refracts around Ventura Point, 22 December 2024. Source: Rich Reid/Surfrider Foundation.

Fairgrounds encroached into wetlands and along the shore. Despite community opposition, in 1989 a bike path and parking lot was constructed on an artificial fill directly adjacent to the active shoreline. Large winter swells in 1990-1991 eroded the shore and damaged the infrastructure constructed just a few years earlier.

A working group of stakeholders and agencies was convened to resolve conflicts over the appropriate response, with some desiring a seawall to maintain the infrastructure in place while others recommending relocation. The working group ultimately identified a strategy that included relocation of the damaged parking lot with shoreline protection consisting of an engineered cobble berm and sand dunes that mimicked the local natural shoreline morphology. The stated goals of the project were to "...protect Shoreline Drive and Bike Path from future erosion, replace lost parking, stabilize shoreline, relocate bike path, and restore area to a more natural setting." (City of Buenaventura and Rincon 2003). Figure 4 shows the alternative selected based on a concept developed by the Surfrider Foundation and analyzed in the final environmental impact report (EIR).

Permits were received in 2006, and engineering design was completed in 2008. Funding constraints necessitated a phased approach. Phase 1, the western half of the project (about 1,000 feet of shore; Figure 2) installed the waterside cobble berm and landside hardscape in 2010-2011, with vegetated dunes constructed in 2012. Phase 2 construction began in 2024 with completion scheduled by late 2025 (Surfrider Foundation undated; VenturaRiver.org 2025).

The City of Ventura (City) took the lead implementing the project in cooperation with the 31st Agricultural District/ Ventura County Fairgrounds and State Parks. Funding for the $3.5 million first phase of the project was split between the State of California (State Coastal Conservancy) and federal transportation funding through the TEA-21 program. The Ventura Chapter of the Surfrider Foundation advocated for the project as part of a larger ecosystem management vision that includes removal of the Matilija Dam from the Ventura River (Jenkin 2009a; 2009b; 2021). RRM Consulting Group was the project lead designer in charge of the landside and Philip Williams & Associates Ltd. (PWA) was the lead designer for the waterside. Coastal Restoration Consultants (CRC) led the vegetated dune design. Construction was accomplished by C.A. Rasmussen, Inc. (Rasmussen undated).

This paper addresses the performance of the Phase 1 waterside natural infrastructure components. "Waterside" was defined as the portion seaward of the edge of the new pedestrian trail along the shore, which was realigned about 80 feet landward of the previously constructed and damaged "bike path" (Figure 5). The waterside portion of the project included the demolition of a parking lot and bike path, excavation of underlying fill to an elevation of about 6-8 feet above low tide (10 feet below grade); removal of a 200-foot-long revetment; and construction of a cobble berm, covered with a sandy beach and vegetated foredunes. The cobble berm's nominal width is 60 feet (varies with location) with a crest elevation of 13.5 feet above mean lower low water (MLLW tidal datum elevation is close to the North American Vertical Datum in this location).

The Phase 1 cobble berm and beach required 33,000 cubic yards of cobble and

28,000 cubic yards of sand. An additional 16,500 cubic yards of sand was imported to create a vegetated sand dune above the cobble berm (PWA 2005, PWA 2008).

BASIS OF DESIGN

The Surfers Point Managed Shoreline Retreat project was formulated with the perspective that prior development was constructed too far seaward, and traditional shore protection was counterproductive toward maintaining coastal resources. A "nature based solution" was developed based upon the geomorphic setting on the cobble river delta at the mouth of the Ventura River exposed to Pacific Ocean swells. The design approach emphasized applied geomorphology for cobble berm and sand dune geometry, materials and location relative to the shoreline. A reference site was identified west of the Ventura River mouth at Emma Wood State Beach (Figure 6) and used to guide the design geometry and materials. Engineering equations were used to compute wave run-up which informed the setback to the seaward edge of new development. Standard public works construction specifications were adapted to the project.

Design criteria were compiled from prior city documents and supporting studies (Noble Consultants, Inc. 2002; City of Buenaventura and Rincon 2003; Everts 2000; CFC and IMC 2001; Everts *et al.* 2002). At the time, formal guidance for cobble berms was limited and evolving.

The sea level rise (SLR) design criterion was 0.5 feet, which is small relative to contemporary California guidance (OPC *et al.* 2024). The criterion was established based on nonregulatory SLR guidance circa early 2000s, an adaptive management framework, relatively low risk based on the trail and parking assets and hope for increased sediment supply following decommissioning of the Matilija Dam.

A key component of the Project was realigning infrastructure landward to reduce exposure to coastal erosion and damaging levels of wave run-up. The "setback" distance was defined relative to the existing pedestrian-bike path. The EIR identified an average setback of 64 feet. Realignment setbacks were subsequently evaluated by wave run-up calculations for the estimated 50-year event. The best available engineering methods were selected to approximate the extensive wave run-up resulting from long-period swell and wave groups on the California

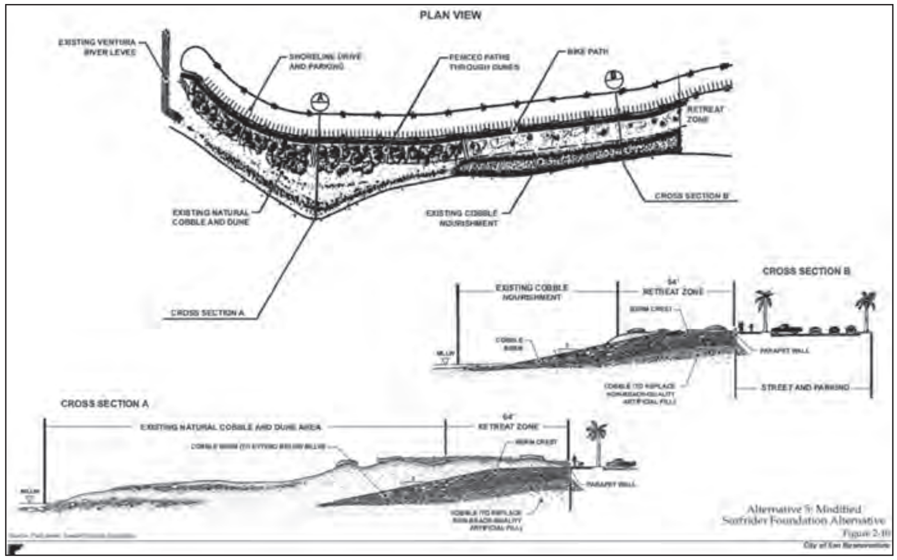

Figure 4. Project Alternative 5 selected in the EIR. Source: City of Buenaventura and Rincon 2003.

coast (FEMA 1991; Hedges and Mase 2004; PWA 2005), and subsequently vetted against newer approaches (Dean 2004; FEMA 2005; MacArthur *et al.* 2006; Stockdon *et al.* 2006). The effective coastal flood map for the area indicates similar wave run-up elevations for the 100-year coastal flood event (FEMA 2021). The landward extent of wave run-up was computed assuming overland travel of a wave bore (Cox and Machemal 1986). Based on the run-up analysis, setbacks were increased to an average setback of 80 feet for Phase 1 (King *et al*. 2018). The retreat distance was maximized relative to land use constraints.

Voids in the cobble berm were filled with sand to provide a stable substrate for sand cover, provide sand supply for

Figure 5. Aerial photographs Surfers Point Phase 1 (A) before (2009) and (B) after (2017) construction. The solid line indicates the seaward edge of development before construction. Source: 2009 imagery collected by USACE; 2017 imagery collected by Sierra Overhead Analytics.

Figure 6. Emma Wood reference site located west of Surfers Point. The dead trees indicate landward migration of the beach and cobble berm subject to wave run-up. Source: Bob Battalio, 2 December 2004.

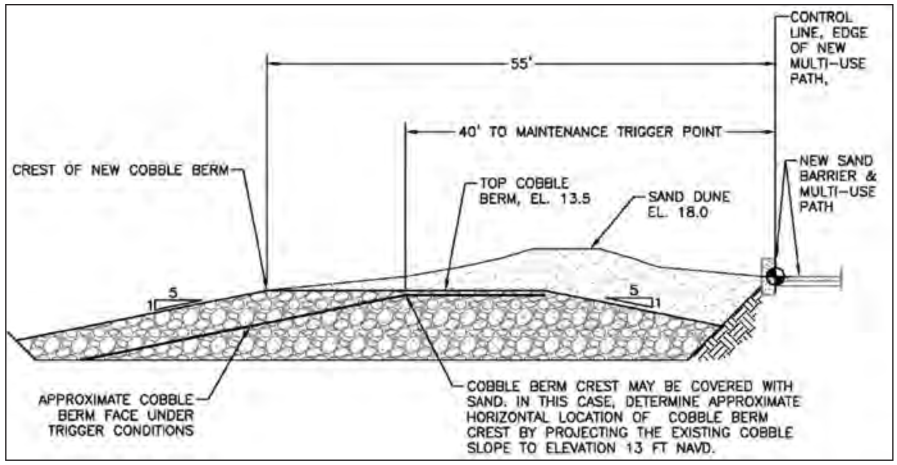

Figure 7. Schematic of cobble berm and sand dune with erosion threshold "trigger" for potential maintenance Source: PWA 2008.

dunes and facilitate pedestrian access to the water. The available river sand was nominally finer than the native beach and dune sand. Consequently, dunes were constructed with coarser sands opportunistically obtained from down coast in an area of excess sand deposition.

Design parameters are provided in Table 1. The cobble berm and dune design is represented by a typical section (Figure 7).

PERFORMANCE EVALUATION MONITORING

Performance monitoring was required by Coastal Development Permit 4-05-148 (CCC 2006; 2021) and has been conducted by the City of Ventura, ESA and CRC, and California State University, Channel Islands (CSUCI) with funding support from the Beach Erosion Authority for Clean Oceans and Nourishment (BEACON) (ESA 2021; 2024).

Objective and methods

The primary objective of the monitoring is to check for erosion of the cobble berm beyond limits identified as the minimum desirable to prevent damage to the backshore hardscape during the design event. Simplified metrics were developed to indicate this threshold in terms of cobble berm erosion (Figure 7). A secondary objective was to collect data to support a broader assessment of project performance and serve as a database to inform design guidelines. Monitoring consisted of the following elements:

- Evaluation of performance in terms of changes to cobble and dune geometry, erosion triggers and any damage to hardscape, including post-event (ocean and river) observations and assessments;
- Elevation surveys of terrain using ground-based survey transects and drone-based photogrammetric and Lidar remote sensing;
- Re-Photography (repeated at same vantage points) using hand-held cameras and georeferenced drone photographic surveys and digital terrain models;
- Comparison of recent and prior survey data (quantitative) and photographs (qualitative);
- Vegetation surveys (native / non-native percent cover; extents, density); and,
- Summary of environmental conditions (tides, waves, winds and river flows).

Table 1:
Design parameters for Surfers Point cobble berm and sand dunes.

Coastal hydraulics
Ocean water level 8.5 ft. mean lower low water
Offshore wave height of 20 ft., peak spectral period 9 to 25 seconds
Wave run-up 50-year return period and eroded shore profile
Development setback landward of design wave run-up
Target functional life: 50 years.

Cobble
Reference site geology, density, color, hardness, rounded subangular to oblate spheroid
Diameter: Nominal 8 to 10 inches; 4-inch minimum; 18-inch maximum

Cobble berm sand fill and cover
Opportunistic local river source, selected pre-construction.

Cobble berm geometry
Crest elevation: 13.5 ft. MLLW
Seaward slope: 5 horizontal to 1 vertical
Landward slope: 3 horizontal to 1 vertical
Foundation elevation: 6-8 ft. MLLW
Width: 80-100 ft.

Sand dunes
Local beach and dune sand, selected pre-construction
Fore dune geometry with low-relief sand mounds, light compaction
Native dune plants (cuttings and seeds)
Hay straw cast for erosion control
Seasonal planting, initial watering
Post-planting weed removal
Symbolic pedestrian barriers
Educational signs

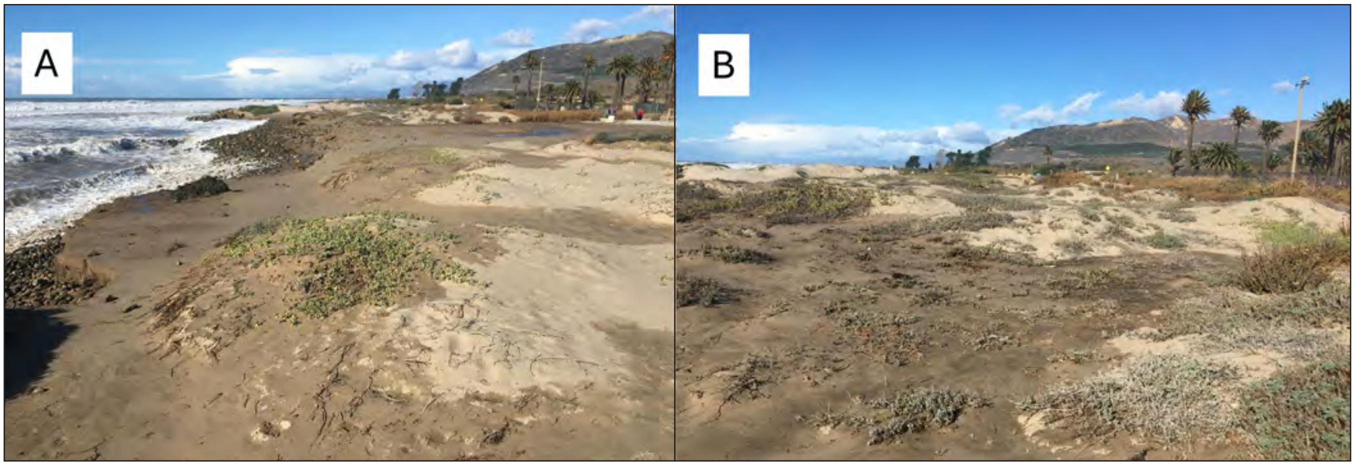

Figure 8. Photographs following large-swell event 11 December 2015. (A) Shore erosion and exposed cobble. (B) Wet sand and wrack indicating extent of wave run-up across vegetated dunes. Source: Photos Paul Jenkin/Surfrider Foundation, 11 December 2015.

Extreme wave events (event observations, land-based photo monitoring)

The project has experienced multiple large swell events, computed at a 35-foot depth to range from 10 feet, 17 seconds to 17 feet, 20 seconds (CDIP 2025). The large swell event of December 11, 2015, resulted in coastal erosion, flooding and structural damage in Ventura (ESA 2016). Recorded water levels at the Santa Barbara gauge reached 7 feet NAVD, offshore waves were approximately 24 feet high at 18-second periods, and nearshore wave conditions were computed to be 17 feet at 20 seconds. These conditions are similar to but less than the design criteria used to compute the 50-year wave run-up event (PWA 2005). A review of annual maximum wave run-up calculated using available data from 1904 to 2021 (ESA 2022) indicates a return period of approximately 30 years. Wave run-up propagated into the dunes at Surfers Point (Figure 8), but didn't reach the backshore hardscape except at the gap in the dunes provided for kite board equipment staging and rigging. The low relief vegetated dunes reduced the landward extent of wave run-up by about 20 feet without scarping or vegetation loss and appeared to facilitate sand deposition. The event eroded the beach and cobble berm forming an erosion scarp, but the

Figure 9. Photographs of erosion by large-wave event on 11 December 2015 and subsequent recovery. (A) March 2016 eroded shore with exposed cobble. Source: Paul Jenkin/ Surfrider Foundation. (B) November 2017 recovered shore with sand covering cobble. Source: ESA *et al.* 2018.

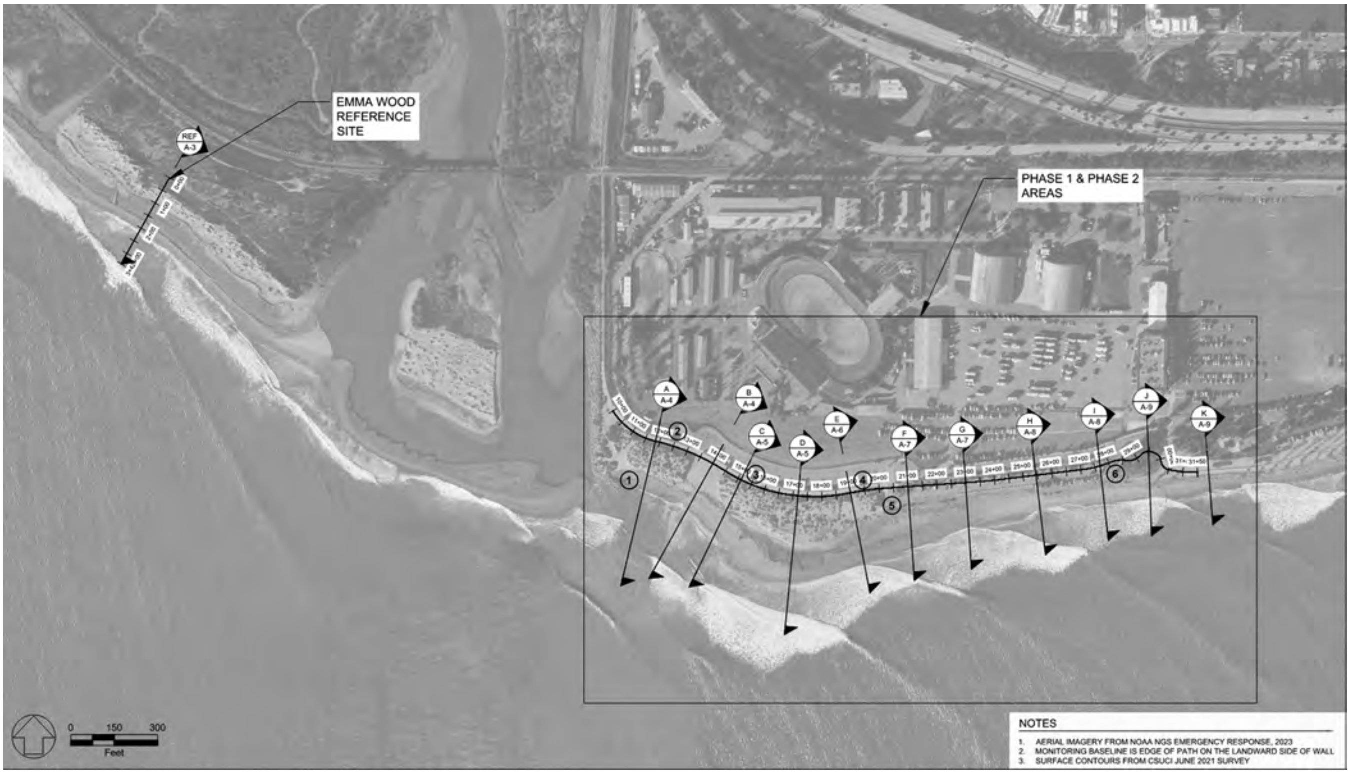

Figure 10. Elevation survey transects (Profiles A-J and REF) at Surfers Point Phase 1 (A-E), Phase 2 (F-J) and the Emma Wood reference Site (REF). The shore-parallel line is a station line along the new pedestrian path. Source: ESA *et al.* 2024.

shore recovered sufficiently to bury the cobble by November 2017 (Figure 9). The greatest erosion has occurred at Transects B and C (Figure 11; Transect locations are shown in Figure 10). The erosion triggers were not reached. In addition to the 2015 event, the period 2021-2024 produced seven of the top 20 extreme wave events computed for the period 2003-2025 (CDIP 2025), indicating the resilience of the cobble-dune system.

Land-based elevation surveys

Survey transects were established to provide temporal comparison of the waterside improvements (Figure 10). These shore profiles (Figure 11) illustrate the changes in the dune, cobble berm and beach width since the project was constructed. The minimum beach width occurred in 2015-2017 directly following the extreme winter storms and during a prolonged drought, with erosion of a seaward portion of the cobble berm. The tremendous growth in beach width in 2023-2024 is the result of the 2023 flood which deposited large quantities of cobble at the river mouth enlarging the delta as

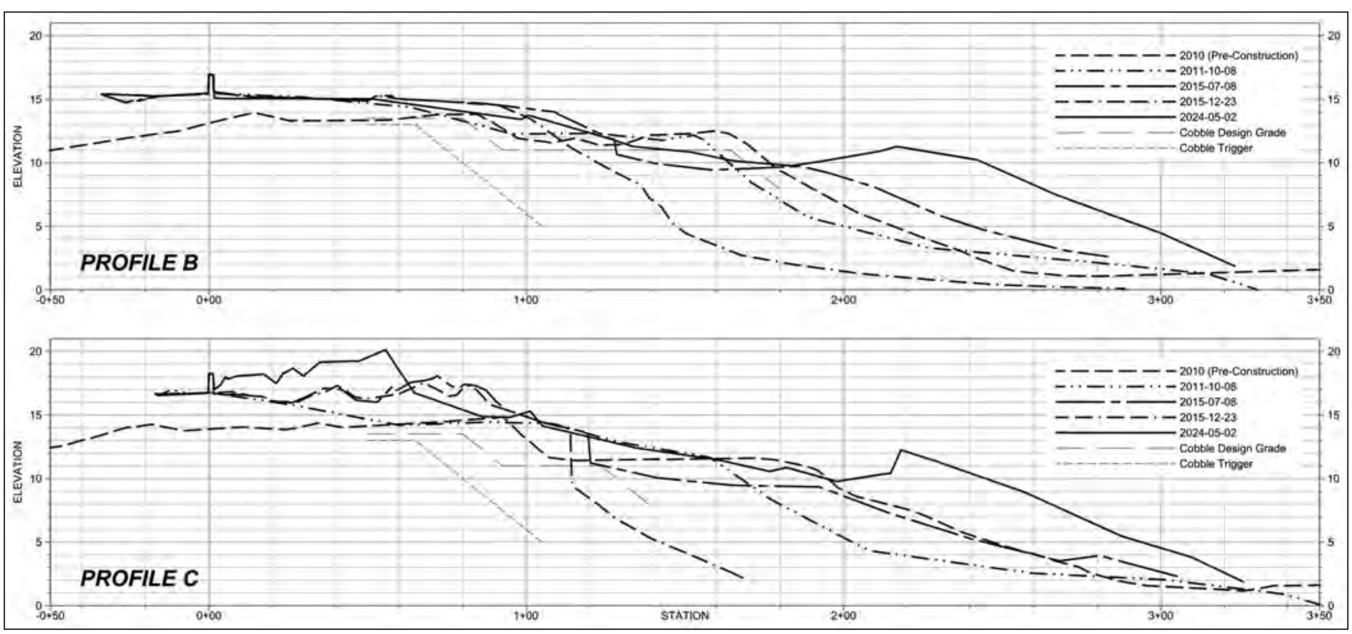

Figure 11. Changed shore elevations 2010-2024 along Profiles B and C where greatest fluctuations have occurred. The cobble berm extents and erosion triggers are also graphed. Dunes were not installed at Profile B, allowing a bare area for kite and sail board staging. Source: ESA *et al.* 2024.

sediment was transported downcoast through the project site.

Dune and vegetation monitoring

Vegetation monitoring was performed following project implementation to assess project success 2013 through 2024. Five shore normal (inland to seaward) transects with three replicates were used. The percent cover of each species of live plant (with at least green shoots) was estimated to the nearest percent, including native plants and non-native plants (weeds), and accounting for unvegetated ground.

The site-wide cover of native vegetation in the restored dune area at Surfer's Point Phase I increased from a minimum of 0% zero percent cover following construction in 2011 to a maximum of 21% in 2024 (Fig. 12, solid black line.) Vegetation cover varied with management zone type: fenced perimeter and/or paths through 2019, unfenced, and kite surfer launch area. Vegetative cover in the fenced areas reached a maximum of 27 percent in 2017 and has declined since the fencing was removed in 2020. Estimated vegetation cover in the kite launch area was zero until 2024, when it was estimated at 3.5%. (Kite surfers actively clear vegetation to prevent interference with their equipment.)

The cover of non-native plants (weeds) has been consistently low at the project site as a result of regular volunteer workdays sponsored by the Surfrider Foundation through 2019. In May 2024, the site-wide cover of non-native species was 1.4%. The extent of the vegetated zone at Surfer's Point Phase I doubled between 2015 and 2024 corresponding with increased beach width. The total cover of native plants has increased as the vegetated zone expanded beyond the original planted footprint (Fig. 13). This increase reflects natural recruitment of plants from seeds produced at the site and elsewhere, not the effects of active management.

Aerial ortho-imagery and topography

Unmanned aerial vehicles (UAVs; also known as Unmanned Aerial Systems [UAS] or drones) have enabled high-resolution, cost-effective coastal monitoring. Since 2016, CSU Channel Islands (CSUCI) has conducted annual and post-storm UAV surveys at Surfers Point. Flights were completed once or twice per year between 2016 and 2024, capturing imagery suitable for Structure-from-Motion (SfM) photogrammetry. These datasets produced 25-cm resolution digital surface models (DSMs) and orthomosaics used to assess sediment dynamics, beach width and volume, and dune migration. Ground control points and careful georeferencing ensured accurate change detection, following best practices described in Westoby *et al.* (2012), Smith *et al.* (2016), and Enwright *et al.* (2021).

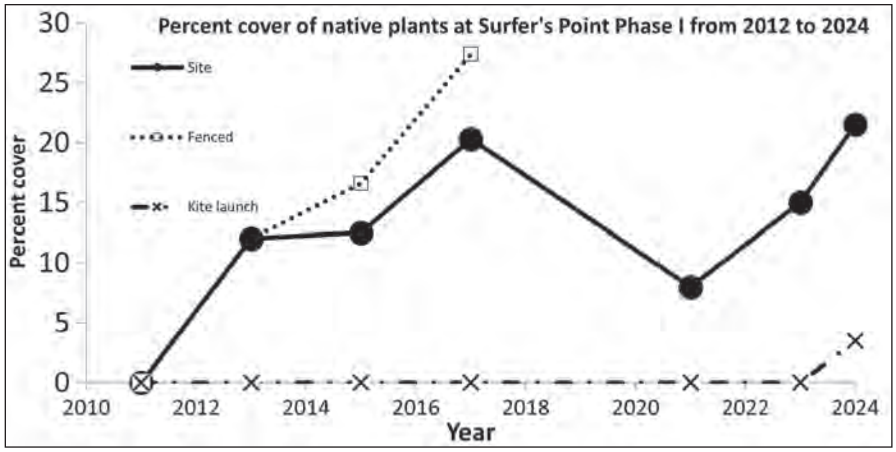

Figure 12. Percent cover of native plants, 2011 to 2024. Source: CRC 2024.

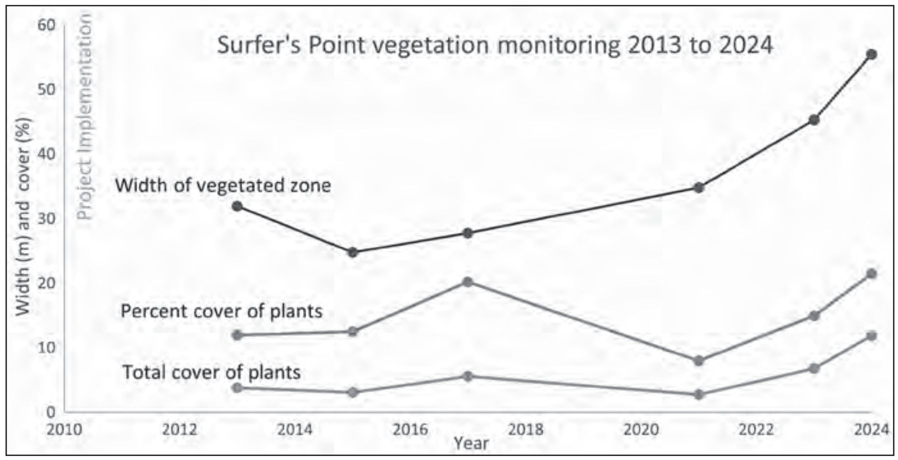

Figure 13. Three metrics for vegetation at Surfer's Point Phase I from 2013 to 2024: width of vegetated zone, percent cover of plants in the vegetated zone, total cover of plants. Source: CRC 2024.

Comparative analyses of these data 2016 through 2024 (Figure 14) document patterns of erosion and accretion, and show that the hybrid shore system has retained sediment and sustained natural processes over more than a decade of high wave exposure and a range of river discharge conditions (ESA *et al.* 2024).

Influence of the river mouth (aerial imagery)

Shoreline position and coastal sediment flux on a river delta are highly dependent on river hydrology. Climatic conditions in Southern California are characterized by years of drought punctuated by wet years, some of which generate significant flood events (10 yr recurrence or greater). Aerial photos provide the best illustration of the dynamic nature of the river mouth and delta which influence the project site (Figure 15). The shore was changed significantly by a large flood event that occurred in January 2023 (flowrate 34,700 cfs; USGS River Gauge #11118500), which scoured the shore but also delivered sediment (Figure 16).

CONCLUSIONS

Surfers Point Managed Shoreline Retreat Project is a valuable reference site to assess the utility of nature-based shore protection, approaches to coastal hazards, and to inform the design of similar projects. Project monitoring provided data to assess performance over time and enable adaptive management and learning.

In this location on an active river delta, a cobble berm, sandy beach and vegetated dune system has proven to be a viable approach to hazard mitigation and provides multiple co-benefits based on

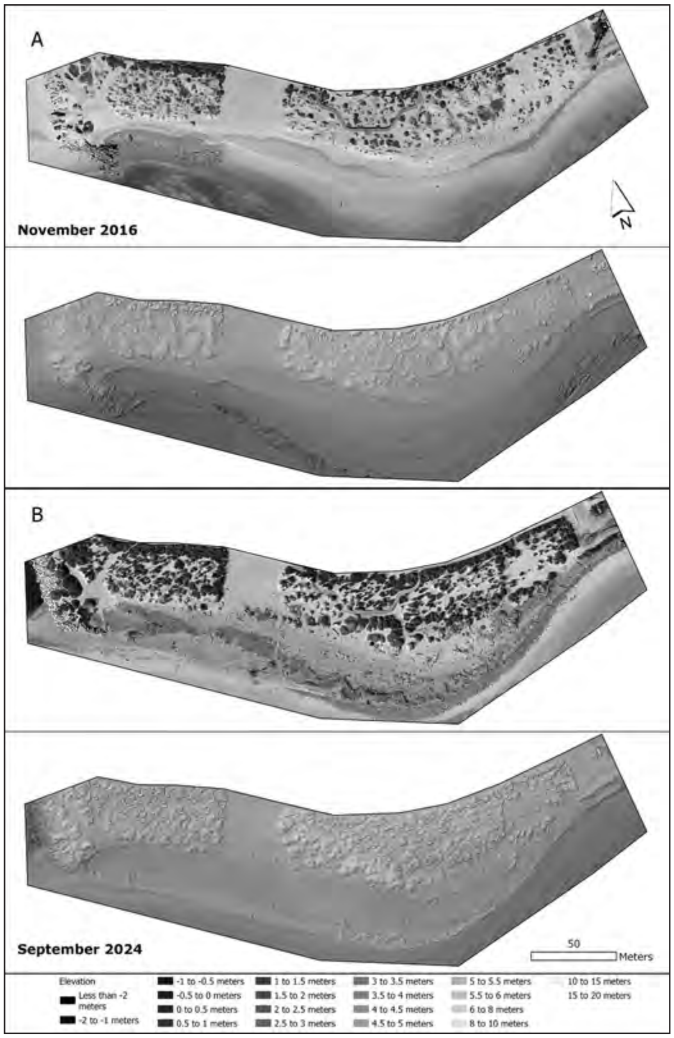

Figure 14. Example of aerial photogrammetry and digital terrain from drone surveys. (A) November 2016 photo (top) and terrain (bottom). (B) September 2024 photo (top) and terrain (bottom). Source: Kiki Patsch, CSUCI 2025.

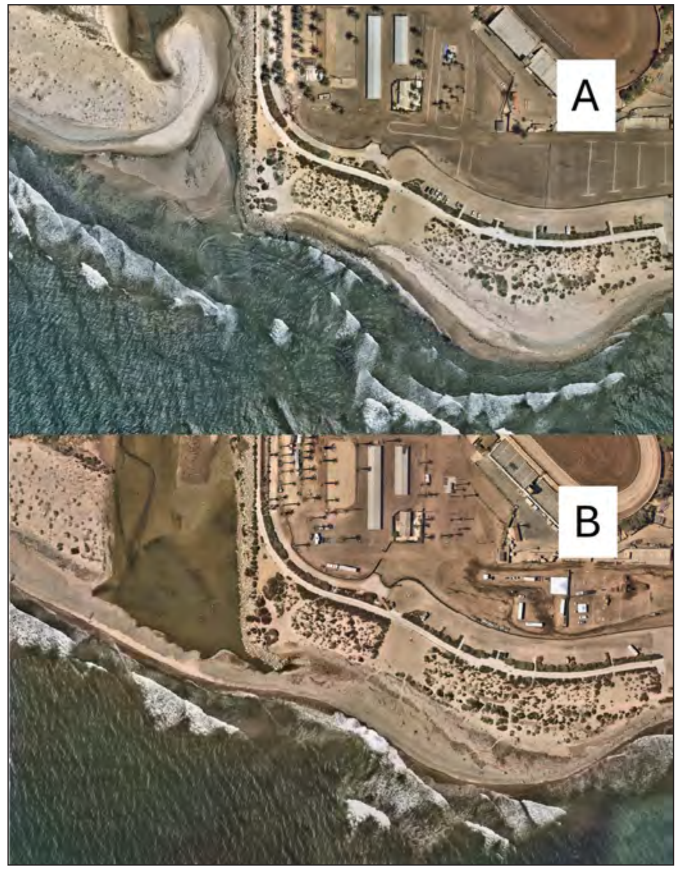

Figure 15. Aerial photographs showing the effect of Ventura River discharges on the shore. (A) 30 June 2019 eroded shore. (B) 9 July 2023 recovering shore following the January 2023 event (Figure 15). Source: ESA 2024. Photographs from Nearmap.

12 years of monitoring. So far, it appears that restoration of the coastal flood plain to the landward extent of extreme wave run-up is an effective hazard mitigation and adaptation strategy.

The Surfers Point Managed Shoreline Retreat project was implemented prior to a record dry period followed by significant floods. The project re-established a reasonable setback within which these natural variations in beach width could occur without damage to hard infrastructure. The constructed cobble berm and dune may be seen as "soft" infrastructure which increases resilience to extreme events by mimicking and reinforcing the natural shore morphology.

The constructed cobble berm and vegetated foredune natural infrastructure accommodated multiple high wave events without damage to hard infrastructure. Post-event monitoring documented erosion of a portion of the cobble berm, but maintenance triggers have not been reached, and the shore has recovered without intervention.

Sand fill of the cobble berm voids provided a stable substrate for the beach and pedestrian access. However, the sand fill reduced the porosity of the cobble mass and likely contributed to cobble erosion and scarp formation during large wave events, thereby reducing the resilience of the cobble berm. Also, the grain sizes of the opportunistically-sourced river sands were finer than desired resulting in excessive wind-blown sand. This condition was rectified by installation of vegetated dunes using coarser sand.

The use of reference sites to inform design is supported by project performance. Key parameters are the locations relative to the shoreline and wave run-up, geometry of the cobble berm and sand dunes, and the physical characteristics of the cobble and sand. The sourcing of local materials, including cobble, sand, and dune vegetation seeds and stock contributed to the success of the project.

The dunes were constructed to emulate native foredunes, which have low height and flat slopes forming irregular hummocks. This geometry and native vegetation are resilient to wave erosion events, dissipate wave run-up and limit scarp formation, and encourage deposition of sand and organic materials.

Landward relocation of built infrastructure (also referred to as "retreat") is a fundamental consideration for a nature-based adaptation project. This is (a) because the fundamental driver of coastal hazards is the location of development too far seaward, and (b) because nature-based approaches require space to accommodate environmental extremes and sufficient supply of sediment to recover from disturbances. The setback distance was established using relatively simplified engineering equations, although limited by practical land use

Figure 16. Ventura River mouth following the 2023 flood; view looking southeast toward the Surfers Point project, 18 January 2023. Photograph: Rich Reid/Surfrider Foundation.

considerations, and monitoring shows sufficient space for wave dissipation and other natural functions at this location.

The integration of aerial photography, UAV surveys and terrestrial LiDAR with on-the-ground photography and survey transects at Surfers Point provides a scalable framework for monitoring and adaptive management. These data help evaluate shoreline behavior in response to ocean swell and riverine flood deposition, contributing to improved understanding of cobble beach performance and nature-based shoreline adaptation. Post event observations to document changes and assess mechanisms inform performance assessments and adaptive management.

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- California State University-Channel Islands
- Ninyo and Moore
- Ocean Protection Council
- California State Coastal Conservancy
- Surfrider Foundation
- C.A. Rasmussen Construction
- Federal Highway Administration

REFERENCES

BEACON, 2009. "Coastal Regional Sediment Management Plan, Central Coast from Pt. Conception to Pt. Mugu." Prepared by Beach Erosion Authority for Clean Oceans and Nourishment. https://dbw.parks.ca.gov/?page_id=29337.

Beller, E.E., Grossinger, R.M., Salomon, M.N., Dark, S.J., Stein, E.D., Orr, B.K., Downs, P.W., Longcore, T.R., Coffman, G.C., Whipple, A.A., Askevold, R.A., Stanford, B., and J.R. Beagle, 2011. "Historical ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: An analysis of terrestrial, riverine, and coastal habitats." Prepared for the State Coastal Conservancy. A report of SFEI's Historical Ecology Program, SFEI Publication #641, San Francisco Estuary Institute, Oakland, CA. https://doi.org/10.13140/RG.2.2.15790.66886.

Beyeler, M., 2012. *Implementing Ecosystem-Based Management: Lessons from the Surfers Point Managed Retreat.* A Report to National Sea Grant College Program, NOAA. August 2012.

California Coastal Commission (CCC), 2006. "Surfers Point project application; staff report." 19 March 2006.

California Coastal Commission (CCC), 2021. "Surfers Point project application; staff report, permit amendments." 14 April 2021.

California Ocean Protection Council (OPC) and Ocean Science Trust, 2024. "California sea level rise guidance: 2024 science and policy update." https://opc.ca.gov/wp-content/uploads/2024/05/California-Sea-Level-Rise-Guidance-2024-508.pdf.

CDIP 2025. "Coastal Data Information Program, Largest Hs Events, Monitoring and Prediction (MOP) Site VE466." https://cdip.ucsd.edu/mops/?mop=OC466&xitem=tmap&xzoom=2&xgoogle=&xparam=Tp.

CFC and IMC (Coastal Frontiers Corporation and Inman and Masters Consultants), 2001. “Coastal engineering review of the plan for managed shoreline retreat at Surfers Point.” Prepared for Rincon Consultants, Inc., May 2001.

City of San Buenaventura and Rincon Consultants, Inc., 2003. “Surfers Point managed shoreline retreat, final environmental impact report.” March 2003.

Cox, J.C., and J. Machemehl, 1986. “Overland bore propagation due to an overtopping wave.” Technical note. *J. Waterway, Port, Coastal and Ocean Engineering*, 112(1), 161-163. https://doi.org/10.1061/(ASCE)0733-950X(1986)112:1(161).

CRC, 2024. “Surfer’s Point Vegetation Monitoring Summary 2011 to 2024.” Prepared by Coastal Restoration Consultants for BEACON.

Dean, R.G., 2004. “Wave Setup Determined by Direct Integration of Governing Equations.” Consulting report prepared for Northwest Hydraulic Consultants, Inc.

Enwright, N.M., Kranenburg, C.J., Patton, B.A., Dalyander, P.S., Brown, J.A., Piazza, S.C., and W.C. Cheney, 2021. “Developing bare-earth digital elevation models from structure-from-motion data on barrier islands.” *ISPRS J. Photogrammetry and Remote Sensing*, 180, 269-282. https://doi.org/10.1016/j.isprsjprs.2021.08.014.

ESA, 2016. “Surfers Point 2015-2016 monitoring report.” Prepared for the City of Ventura by Environmental Science Associates.

ESA, 2018. “Surfers Point 2016-2017 monitoring report.” Prepared for City of Ventura by Environmental Science Associates.

ESA, 2021. “Monitoring memo, Surfers Point project.” Prepared for Beach Erosion Authority for Clean Oceans and Nourishment (BEACON) by Environmental Science Associates, with assistance from Coastal Restoration Consultants, California State University Channel Islands, Surfrider Foundation Ventura Chapter and City of Ventura.

ESA, 2022. “Ventura Overhead bridge replacement project coastal hazards assessment. “Prepared for Caltrans, under contract with GPA Consulting, Inc. December 2022.

ESA, 2024. “Surfers Point monitoring spring 2024 — monitoring report update and synthesis 2011-2024.” Prepared for Beach Erosion Authority for Clean Oceans and Nourishment (BEACON) by Environmental Science Associates, with contributions by CSU Channel Islands, BEACON and Coastal Restoration Consultants.

Everts, C., 2000. “Cobble berm design guidelines.” Appendix C in Noble Consultants, Inc., “Surfer’s Point Park managed plan for shoreline retreat.” Prepared for the City of Ventura.

Everts, C.H., Eldon, C.D., and J. Moore, 2002. Performance of Cobble Berms in Southern California. *Shore & Beach*, 70(4), 5-14.

FEMA, 1991. “Investigation and improvement of capabilities for the FEMA wave runup model.” Dewberry and Davis, Inc., Washington, DC.

FEMA. 2005. “Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States.” Draft guidelines, FEMA Regions IX, X, and FEMA Headquarters, Washington, DC.

FEMA 2021. “Flood Insurance Rate Map, City of San Buenaventura. Number 060419. Panel0743F. Map 06111C0743F.” 29 January 2021. https://msc.fema.gov/portal/downloadProduct?productTypeID=FINAL_PRODUCT&productSubTypeID=FIRM_PANEL&productID=06111C0743F.

Jenkin, P., 2009a. “Managed shoreline retreat and dam removal: Ecosystem restoration to benefit coastal resources.” California and the World Ocean ‘02: Revisiting and Revising California’s Ocean Agenda. ASCE. p491. https://doi.org/10.1061/40761(175)46.

Jenkin, P., 2009b. “Managed Shoreline Retreat and Dam Removal: Ecosystem Restoration to Benefit Coastal Resources.” *Reef Journal,* 1(1).

Jenkin, P., 2021. “Ventura River ecosystem.” https://www.venturariver.org.

Judge, J., Newkirk, S., Leo, K., Heady, W., Hayden, M., Veloz, S., Cheng, T., Battalio, B., Ursell, T., and M. Small, 2017. “Case studies of natural shoreline infrastructure in coastal California: A component of identification of natural infrastructure options for adapting to sea level rise” (California’s fourth climate change assessment). 38 pp. https://www.slc.ca.gov/wp-content/uploads/sites/355/2018/10/NaturalShorelineCaseStudy.pdf.

King, P.G., Nelsen, C., Dugan, J.E., Hubbard, D.M., Martin, K.L., and R.T. Battalio, 2018. “Valuing beach ecosystems in an age of retreat.” *Shore & Beach,* 86(4), 45-59.

MacArthur, R.C., Dean, R.G., and R. Battalio, 2007. “Wave Processes In Nearshore Environment for Hazard Identification.” *Proc. 30th International Conference of Coastal Engineering*, 2006, 2, 1775-1787. https://doi.org/10.1142/9789812709554_0150?urlappend=%3Futm_source%3Dresearchgate.net%26medium%3Darticle.

Newkirk, S., Veloz, S., Hayden, M., Heady, W., Leo, K., Judge, J., Battalio, R., Cheng, T., Ursell, T., and M. Small, 2018. “Toward natural infrastructure to manage shoreline change in California.” California’s fourth climate change assessment. Sacramento: Natural Resources Agency: CCCA4-CNRA-2018-011. 70 pp. https://www.energy.ca.gov/sites/default/files/2019-12/Oceans_CCCA4-CNRA-2018-011_ada.pdf. .

Noble Consultants, Inc., 2002. Preliminary Coastal Engineering Design Criteria.

Patsch, K., and G. Griggs, 2006. “Development of sand budgets for California’s major littoral cells: Eureka, Santa Cruz, Southern Monterey Bay, Santa Barbara, Santa Monica (including Zuma), San Pedro, Laguna, Oceanside, Mission Bay, and Silver Strand littoral cells.” Report for California Coastal Sediment Management Workgroup. 115p. https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://s3-us-west-2.amazonaws.com/rikolti-content/media/26531/cuwr_conservancy_001_1195.pdf&ved=2ahUKEwjfidf3zu-QAxWsRjABHXaxG0kQFnoECBcQAQ&usg=AOvVaw0jV_hege4SemYZfdyG2z8k

Patsch, K., and G. Griggs, 2008. “A sand budget for the Santa Barbara Littoral Cell, California.” *Marine Geology*, 252(1-2), 50-61. https://doi.org/10.1016/j.margeo.2008.01.013.

Patsch, K., and G. Griggs, 2021. “California harbor dredging: History and trends.” *Shore & Beach*, 89(3), 13-25. http://doi.org/10.34237/1008932.

Patsch, K., 2025. “Aerial photogrammetry and digital terrain model images 2016-2024.” Prepared for BEACON by California State University, Channel Islands (CSUCI).

PWA, 2005. “Surfers Point managed shoreline retreat and access restoration preliminary design.” Prepared for RRM Design Group by Philip Williams & Associates, Ltd.

PWA, 2008. “Surfers Point monitoring plan.” Prepared for the City of Ventura by Philip Williams & Associates, Ltd.

PWA, 2009. “Surfers Point Phase 1 Waterside Improvements.” Construction documents prepared for RRM Design Group and the City of Ventura. October 2009.

Rasmussen, undated. Surfers Point Managed Retreat, https://carasmussen.com/surfers-point-managed-retreat/.

Slagel, M.J., and G.B. Griggs, 2008. “Cumulative Losses of Sand to the California Coast by Dam Impoundment.” *J. Coastal Research*, 24(3), 571-584. http://www.jstor.org/stable/30138682

Smith, M.W., Carrivick, J. and D. Quincey, 2016. “Structure from Motion Photogrammetry in Physical Geography.” *Progress in Physical Geography*, 40 (2). pp. 247-275. https://doi.org/10.1177/0309133315615805

Stockdon, H.F., Holman, R.A., Howd, P.A., and A.H. Sallenger, 2006. “Empirical Parameterization of Setup, Swash and Runup.” *Coastal Engineering*, 53(7), 573-588. https://doi.org/10.1016/j.coastaleng.2005.12.005

Surfline Ventura Point Surf Guide, undated. https://www.surfline.com/surf-report/ventura-point/584204204e65fad6a77096b1/spot-guide.

Surfrider Foundation, undated. “What does it take to save Surfers Point?” https://www.surfrider.org/what-does-it-take-to-save-surfers-point.

Surfer Magazine, 2006. *Guide to Southern California Surf Spots*. Chronicle Books, San Francisco, CA. 208 pp.

Surfers Point Managed Shoreline Retreat Project. https://www.venturariver.org/search/label/Surfers%20Point.

Westoby, M.J., Brasington, J., Glasser, N.F., Hambrey, M.J.and J.M. Reynolds, 2012 “’Structure-from-Motion’ photogrammetry: A low-cost, effective tool for geoscience applications.” *Geomorphology*, 199, 300-314. http://dx.doi.org/10.1016/j.geomorph.2012.08.021.

Wright, A.B., 1985. *Surfing California*. Mountain and Sea Publishing, Redondo Beach, CA. 256 pp.

Ventura River 2024. “Surfers Point phase two construction begins.” Last accessed September 2025. https://www.venturariver.org/2024/12/surfers-point-phase-2-construction.html

ITEM 4
Surfers Point Project

Attachment 3

ASBPA Award Presentation to Surfers Point Project

Dr. Jeannette Sanchez-Palacios, Mayor, City of Ventura
Leslie Conejo, Board of Directors, Ventura County Fairgrounds, 31st Agricultural District
Accept ASBPA Project Award for the Surfers Point Project
October 6, 2025