Appendix A
Constraints and Feasibility Analysis

[REVISED DRAFT]

City of Carpinteria
Dune and Shoreline Management Plan
Constraints and Feasibility Report

Prepared For:

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Acronyms and Abbreviations

BEACON	Beach Erosion Authority for Clean Oceans and Nourishment
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CDP	Coastal Development Permit
CFA	Constraints and Feasibility Analysis
CLUP/G	Coastal Land Use Plan/General Plan
cm	centimeter
CRC	Coastal Restoration Consultants
CSP	California State Parks
DBAW	Department of Boating and Waterways
DOGGR	Division of Oil, Gas, and Geothermal Resources
ESHAs	Environmentally Sensitive Habitat Areas
ft	feet
GIS	Geographic Information System
in	inch
LCP	Local Coastal Program
LUP	Land Use Plan
m	meter
M&N	Moffatt & Nichol
MARINe	Multi-agency Rocky Intertidal Network
MHHW	Mean Higher High Water
MHTL	Mean High Tide Line
MLLW	Mean Lower Low Water
NAVD88	North American Vertical Datum of 1988
NFWF	National Fish and Wildlife Foundation
NHPA	National Historic Preservation Act of 1966
NOAA	National Oceanic and Atmospheric Administration
OPC	Ocean Protection Council
RFP	Request for Proposal
RWQCB	Regional Water Quality Control Board
SBCFD	Santa Barbara County Flood Control District
SCCBEP	South Central Coast Beach Enhancement Program
SHPO/THPO	State Historic Preservation Officer/Tribal Historic Preservation Officer
SLC	State Lands Commission
SLR	Sea Level Rise
SLRVAAP	Sea Level Rise Vulnerability Assessment and Adaptation Project
USACE	United States Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VA	Vulnerability Assessment
yr	year

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1. Introduction

Carpinteria experiences coastal flooding along the beach neighborhood (between Ash and Linden Avenues) and farther inland along the east margin of Carpinteria Salt Marsh (at Ash Avenue and 3rd Street). Historic flooding occurred at the beach neighborhood in the 1982-83 El Niño winter. The City of Carpinteria's (City's) response was to regularly erect a winter dike along this reach to minimize wave overtopping of the beach. Flooding also occurs farther inland along Ash Avenue at 3rd Street during combined high tides and rainfall when the area is unable to drain (example event was in January 1995). This problem is a different process than that along the beach neighborhood but needs to be considered as well for solutions.

The City has initiated the Dune and Shoreline Management Plan (Project) as the first step towards adaptation in response to coastal erosion and sea level rise (SLR) since the completion of the Sea Level Rise Vulnerability Assessment and Adaptation Project (SLRVAAP, City of Carpinteria 2019). The project is also included in the General Plan Update as a policy implementation measure. The Project is intended to plan shoreline management and begin development of a dune complex system (i.e., living shoreline) along the City shoreline to protect landward resources while enhancing habitat value and maintaining public beach access.

A living shoreline is a shoreline management feature that is designed to mimic natural coastal processes related to seasonal erosion and rebuilding of beach and dune habitats while protecting inland areas from coastal flooding. Living shorelines use natural materials (sand and cobble) and native vegetation to restore resilient dune, foredune, and beach habitats. The interaction between plants and aeolian (wind-driven) sand transport can help dunes grow higher over time and increase the resilience of the shoreline. In addition to providing shoreline protection, living shorelines provide habitat for many species of plants and animals that rely on these ecosystems. The proposed dune system will be designed with the intent to buffer the shoreline from storm-wave attack and SLR while increasing habitat values.

A naturally functioning dune system can reduce coastal flooding during extreme events. Maintaining naturally functioning dunes is reliant upon maintaining a natural beach that can serve as a sediment source for aeolian dune building and act as a dissipator of wave energy in most years by eroding and rebuilding naturally. At sites that do not have enough space between the shoreline and infrastructure to support natural beach and dune processes, beach re-nourishment may be required over time as a maintenance action.

Overall Project goals include, but are not limited to, providing flood protection while maintaining environmental benefits and public access. According to the City's Request for Proposal (RFP), Project objectives are to:

1. Build on existing local SLR adaptation planning efforts to advance the planning of a specific adaptation strategy that would decrease vulnerability including a predominantly bedroom community, historic downtown, and public infrastructure.

2. Develop a conceptual design for a living shoreline to increase the resiliency of a particularly vulnerable area in Carpinteria.

3. Model the effectiveness of a living shoreline to decrease potential flood and erosion hazards to landward development and infrastructure.

4. Develop a Dune and Shoreline Management Plan for long-term shoreline management designed to reduce known vulnerabilities to critical infrastructure and public resources.

5. Facilitate outreach to community residents and stakeholders to determine adaptation priorities, implementation timelines, and identify possible funding sources to increase the resilience in preparation for future SLR impacts.

This study, and other supporting technical studies as part of this Project, are intended to determine the potential success and resilience of the living shoreline in the face of SLR and the feasibility of permitting, funding, and construction. In addition, this and other related studies are intended to inform living shoreline design, quantify maintenance and enhancement of beach width, dune volume and height, and identify the potential need for sediment retention. The ultimate project could include some combination of green and hybrid living shoreline structures, sand retention structures, and a beach nourishment program.

The purpose of this particular study, as stated in the RFP, is below:

> *The Constraints and Feasibility Analysis Report is to identify priority project sites in locations where living shorelines may be feasible based on appropriate shoreline conditions, supportive policies, and locations where built assets could be protected. The Constraints and Feasibility Analysis Report is to also summarize the process of identifying the priority pilot project sites based on feasibility and describe and quantify public benefits of the proposed living shorelines.*

The City's initial expectation was to have this Constraints and Feasibility Analysis (CFA) Report be based on coastal hazard modeling results of existing conditions and future conditions with a living shoreline in place. The project team advised the City that the modeling should be deferred to a later task after conceptual living shorelines have been identified, and that this CFA Report could be useful in developing the concepts for analysis. Therefore, with concurrence of the City and the project team, the order of tasks was revised to move this CFA Report up front in the process and move the concept development of alternatives and modeling to occur after this CFA Report task.

As mentioned above, the Project will culminate in a Final Dune and Shoreline Management Plan to be supported by the following three dune-specific studies detailing key perspectives for implementation:

- CFA Report;
- Coastal Hazards Modeling Report, and
- Conceptual Living Shoreline Design Report.

This CFA Report is a standalone document to provide technical back-up to the Final Dune and Shoreline Management Plan and supporting studies to view the whole picture. As stated, this CFA Report needs to:

1. Identify priority project sites in locations where living shorelines may be feasible based on appropriate shoreline conditions, supportive policies, and locations where built assets could be protected, and

2. Summarize the process of identifying the priority pilot project sites based on feasibility and describe and quantify public benefits of the proposed living shorelines.

Toward that end, the front portion of the CFA Report addresses existing conditions, policies, and assessment of locations for the living shoreline, along with examples of other living shoreline projects to consider for conceptualization of this one. Section 2 presents existing conditions and policies that affect the project, and Section 3 presents existing similar projects that can inform Project concept design. Section 4 identifies potential constraints, including environmental and anthropogenic constraints. The rear portion of this CFA Report describes project feasibility and quantifies public benefits, to the extent possible prior to numerical modeling, of proposed living shorelines. Section 5 presents preliminary information on the feasibility of potential actions by considering items such as project success criteria, regulatory requirements, construction considerations, monitoring, maintenance, and funding. The report culminates in a discussion of conclusions and next steps.

2. Existing Conditions and Policies That Affect the Project

2.1 Project Area

The Project area extends from the Carpinteria Salt Marsh Inlet in the west, to Tarpits Park in the southeast (Project Area, Figure 2.1). Within this area, four reaches have been identified, each with unique characteristics that affect potential living shoreline designs. The reaches were identified by the project team during the initial site visit and reflect the uniformity of conditions within certain lengths of the project coastline, and/or by natural changes in conditions, features, structures, etc.

Reach 1 is entirely revetted and is bounded by the Salt Marsh inlet upcoast and Ash Avenue downcoast. It is visually different from all other reaches. Reach 2 is an urbanized neighborhood that is entirely developed with private properties and bounded by City streets (Ash and Linden Avenues) on the upcoast and downcoast ends. Reach 3 is entirely within the State Beach Park and is undeveloped and bounded on the downcoast end by Carpinteria Creek. Finally, Reach 4 is the remaining shoreline downcoast of Carpinteria Creek and is mainly backed by bluffs. Sand qualities at the beach along each reach are similar due to the same natural sources supplying the sand and the same physical processes working to distribute the sand. More detail of each reach is provided below:

- **Reach 1 – Carpinteria Salt Marsh Inlet to Ash Avenue –** The Sandyland Cove residential community is located along the back beach throughout this reach. The area is not within the City jurisdiction and is instead located within the Santa Barbara County jurisdiction. The shoreline is characterized by an engineered revetment, constructed of relatively large 3-ton quarry stone in multiple layers, aiming to protect development from erosion and flooding. A narrow sandy beach existed on the day of the site visit, which became wider from west to east. The beach is seasonal in its condition and is widest in the Fall season approximately from 0 feet at the west end to 100 feet wide at the east end, and narrowest in Spring from 0 feet at the west end to 25 feet wide at the east end. At the western end, a natural reef system creates a submerged headland just offshore of the Carpinteria Salt Marsh Inlet.
- **Reach 2 – Ash Avenue to Linden Avenue –** The beach neighborhood is located along and inland of Carpinteria City Beach throughout this reach. The City's winter sand dike program occurs within this reach. Several privately owned residences and businesses overlook the beach and ocean and maintain some formal beach access stairways and informal pathways. Typically, each residence possesses some sort of path to the beach. There are approximately 20 private access pathways from residences to the beach. Additionally, local streets lead to, and end at, the beach, providing public transportation pathways, parking, and beach access. There are three public accessways with one existing at each street end. The beach in this area fluctuates between an eroded (winter) and accreted (summer) condition. Beach width ranges from 75 feet in winter/spring to 200 feet in summer/fall (USGS 2008). Cobble material is known to underly sandy material, and coarse mudflow debris, placed from the 2018 southern California mudflows, is located approximately 150 feet seaward of Ash Avenue.
- **Reach 3 – Linden Avenue to Carpinteria Creek Mouth –** Carpinteria State Beach is located throughout this reach. The State Beach is managed by CSP and provides open space, facilities, and a campground for local and visitor recreational use. The southeastern boundary of reach 3 is Carpinteria Creek, a valuable natural resource to the region. The reach contains vegetated sand dunes and public accessways. The dunes are located at the rear of the beach set back from the

sea by between 125 to 175 feet, as estimated from an aerial image on Google Earth in August of 2019. Their height exceeds the elevation of the beach by approximately 3 to 6 feet, and they appear to be approximately 150-feet wide. The beach in this area fluctuates between an eroded (winter) and accreted (summer) condition and the beach width remains similar to that of Reach 2. Cobble material is known to underly sandy material.

- **Reach 4 – Carpinteria Creek Mouth to Tarpits Park –** Carpinteria State Beach extends from4th Street to Carpinteria Bluffs Trail in Tarpits Park. Park facilities and beach access are maintained by CSP. The shoreline naturally bends eastward in this area, while a natural reef system creates a small, submerged headland just offshore of the eastern end. The sandy beach tends to decrease in width towards the east, and the back beach transitions from a low elevation dune system into a higher elevation bluff system. Beach width is at maximum of nearly 200 feet wide in summer just south of Carpinteria Creek along the State Beach Campground and narrows to 15 feet at the east end near the historic tar seeps. The area is characterized by natural oil seeps (hence the name "Tarpits Park") that have further hardened portions of the bluff system.

A significant amount of information about the project, its conditions, and other relevant items that are presented herein are also presented in a draft memorandum to the City by Wood (2020).

moffatt & nichol

CITY OF CARPINTERIA
Dune and Shoreline Management Plan
Basemap

0 500 1,000 2,000 Feet

Horizontal Datum: CA State Plane Zone V; Vertical Datum: NAVD88; Unit: Feet
1 inch = 500 feet

N

Figure 2.1. Project Area

2.2 Site Conditions

2.2.1 General Geomorphology

The Project area once supported an extensive wetland and dune system, with a wide sandy beach and sand dunes extending from the mouth of Carpinteria Salt Marsh to the tar pits in the State Beach Park (Grossinger et. al. 2011). The large dune field historically present in this area provided a natural buffer to low-lying areas from wave attack and flooding. These historic wide sandy beach areas and widespread dune habitat are illustrated in Figure 2.2. At the south end of the dunes lie Carpinteria Creek and then the reach of coastal bluffs. It appears from the 1929 aerial photograph that homes and other structures/infrastructure were likely built within the dune field between the Salt Marsh mouth and Linden Avenue.

Figure 2.2. Carpinteria Historic Aerial, 1929

2.2.2 The Beach

The U.S. Geological Survey (USGS) has been monitoring this coast along Reaches 1 through 4 for over 20 years. Monitoring results show the following, as taken from their report (USGS 2008):

- The beach at Linden Avenue (Reach 2) has flattened from 1987-2005, with the mid-shoreline (at mean sea level) maintaining its position while the lower shoreline (lower low tide line) widening by 50 feet.

- Beach widths along the City of Carpinteria Beach have been relatively stable over time, ranging from 80 feet to 200 feet with no single event correlating to minimum or maximum beach widths.
- Beach width and shoreline change analyses show that there is a long-term trend of beach erosion in the west (Reach 1) and accretion in the eastern part (Reach 4) of the study area.
- The El Niño pattern of beach impacts is to preferentially erode the beaches in the west (Reach 1) and accrete the beaches in the east (Reach 4). Differences between the 1982-83 and 1997-98 events show that the erosion hotspot in 1982-83 migrated east onto the City of Carpinteria Beach during the 1997-98 El Niño. The construction of the revetment along Sandyland Cove following the 1982-83 El Niño event may have caused this migration.
- Correlation analyses of the sand volumes dredged from the Santa Barbara Harbor and the sand volume found on the beach at Carpinteria suggest a 4-year travel time for sediment to reach downdrift Carpinteria Beach.
- The consistent pattern among the El Niño beach response, the 138-year long-term shoreline change rates, and the 77-year long-term beach width changes provide evidence that El Niños play a major role in shaping the coastline of Carpinteria.
- Over the last 75 years there has been a trend of nearshore sediment loss and mild offshore gain, with the most substantial loss offshore of Sand Point (Reach 1).

A number of factors have contributed to the reduction and loss of these naturally occurring beach and dune systems over time, largely driven by human impacts. Loss of the natural sediment supply to the area is one such cause. Causes of reduced sand supply include installation of Santa Barbara Harbor that impounds sand, installation of flood control sediment catch basins upstream of the coast that impound sand and other materials, installation of shoreline protection structures (i.e., seawalls) that prevent sand from being delivered from the backshore, and lack of any new sand being placed by man. These factors are described below.

Generally, Patsch and Griggs (2006) estimate a 1,479,000 cubic yard (cy) sediment deficit for the Santa Barbara littoral cell, which encompasses Carpinteria. The most significant contributor to the reduction in sand supply was the installation of Santa Barbara Harbor in 1932. The Harbor initially trapped nearly all longshore sand transport through Santa Barbara and reduced the downcoast delivery. However, since initial impacts occurred, sand bypassing has resumed to a certain extent with some data indicating stability of downcoast beaches, albeit with narrower widths due to the interruption in sand transport. This effect is partially offset by harbor maintenance dredging by the U.S. Army Corps of Engineers (USACE), but the USACE only dredges and by-passes a portion of the sand trapped in the Harbor, estimated at approximately 315,000 cy annually (BEACON 2009). The remainder rests along West Beach in the harbor and continues to fill in the City's mooring and slip space. The City of Santa Barbara has also dredged a portion of the harbor of sand bar when it interferes with operations. This practice is not regular nor frequent but can be considered to increase sand supply downcoast if placed east of the harbor.

Also, coastal armoring throughout certain reaches within Santa Barbara and Carpinteria has reduced natural sand supply to the area beaches, estimated at 3,000 cy annually. In addition, damming of sediment supplying watersheds such as the Santa Maria and Santa Ynez Rivers and San Antonio Creek has contributed to sand loss at the site (BEACON 2009). The damming of rivers is estimated to impound 1,476,000 cy annually. Certain researchers also indicate sand loss at Point Conception that affects the downcoast littoral cell.

Finally, the USACE constructed debris basins in the Santa Monica Creek and Carpinteria Creek watersheds in the 1970s to prevent flooding of the Carpinteria community below and to protect flood prone areas downstream (Santa Barbara County Flood Control and Water Conservation District 2017). Though unintended, these projects resulted in the interception and export of coastal sediment from the watershed, resulting in a reduction of coastal sediment that could have replenished the marsh and even the ocean shoreline if it were to travel that far. Loss of natural beach cobble quantities is also visible along the beach neighborhood. The significance of this loss is that protective beach material, such as cobble and sand, has been significant within the Project area over time, rendering the area more vulnerable to coastal flooding during storm wave events. In addition, the "cluster storms" in the El Niño winter of 1983 stripped sand and cobble off of the beach along Carpinteria, as was confirmed by City Recreation Department staff (Personal Communication with Matt Roberts, January 2021), and may have moved it downcoast and potentially offshore as occurred in other regions (e.g., Oceanside Littoral Cell in San Diego County as determined by the U.S. Army Corps of Engineers (1991).

Though historic losses have occurred, Carpinteria State Beach currently includes an existing dune system that is approximately 5 acres, managed by State Parks, and integrated into the park's 2009 Carpinteria State Beach Interpretation Master Plan. Parts of this historic dune complex were planted with native back-dune species in the 2010s. This was done to help limit sand movements into built areas during high wind events, which resulted in costly maintenance by CSP in order to prevent future damages to the park and parking lot. Visual inspection shows the dune to be successfully colonized as habitat and stable in landform. No evidence of storm damage was observed, suggesting resilience over time. The success of this restoration project provides evidence of the potential efficacy of a dune system to enhance and protect land uses in the beach neighborhood and Carpinteria State Beach, assuming that existing constraints can be accommodated. It could serve as one model for dunes elsewhere. A boardwalk will likely not be included in a living shoreline concept at Carpinteria due to limited space and concerns for homeowners' privacy.

2.2.3 Waves

The Project Area is exposed to long-period waves from primarily the northern hemisphere between the directions of approximately 275 degrees (due west) and 240 degrees (southwest) relative to true north. Figure 2.3 shows wave approach windows. Waves are typically low in height due to significant protection afforded by the Channel Islands offshore. However, certain storms can deliver very high waves to this beach, but they are infrequent events. Average wave heights in summer are 2 feet with a period of 9 seconds and average wave heights in winter are 3 feet with a period of 12 seconds. Combined high tide and high wave conditions threaten the beach neighborhood with coastal flooding in the winter. The City erects a winter dike to provide protection, as is discussed subsequently in this report.

The offshore Carpinteria reef partially affects wave approach angles by refraction (bending of the wave crests over shallow shoals). This, in turn, results in a protrusion of the shoreline behind the reef at the location of the Carpinteria Salt Marsh mouth, and a realignment of the shoreline orientation from northwest to southeast upcoast of the mouth, to more west to east just downcoast of the mouth. This further reduces direct wave energy incident to shore and drives a relatively high net sand transport rate in one direction (downcoast, or to the southeast) along the Project reach.

Wave conditions are relatively gentle at Carpinteria Beach compared to other more energetic sites. This relatively sheltered condition may serve well to enable application of a living shoreline to potential coastal flooding at this site.

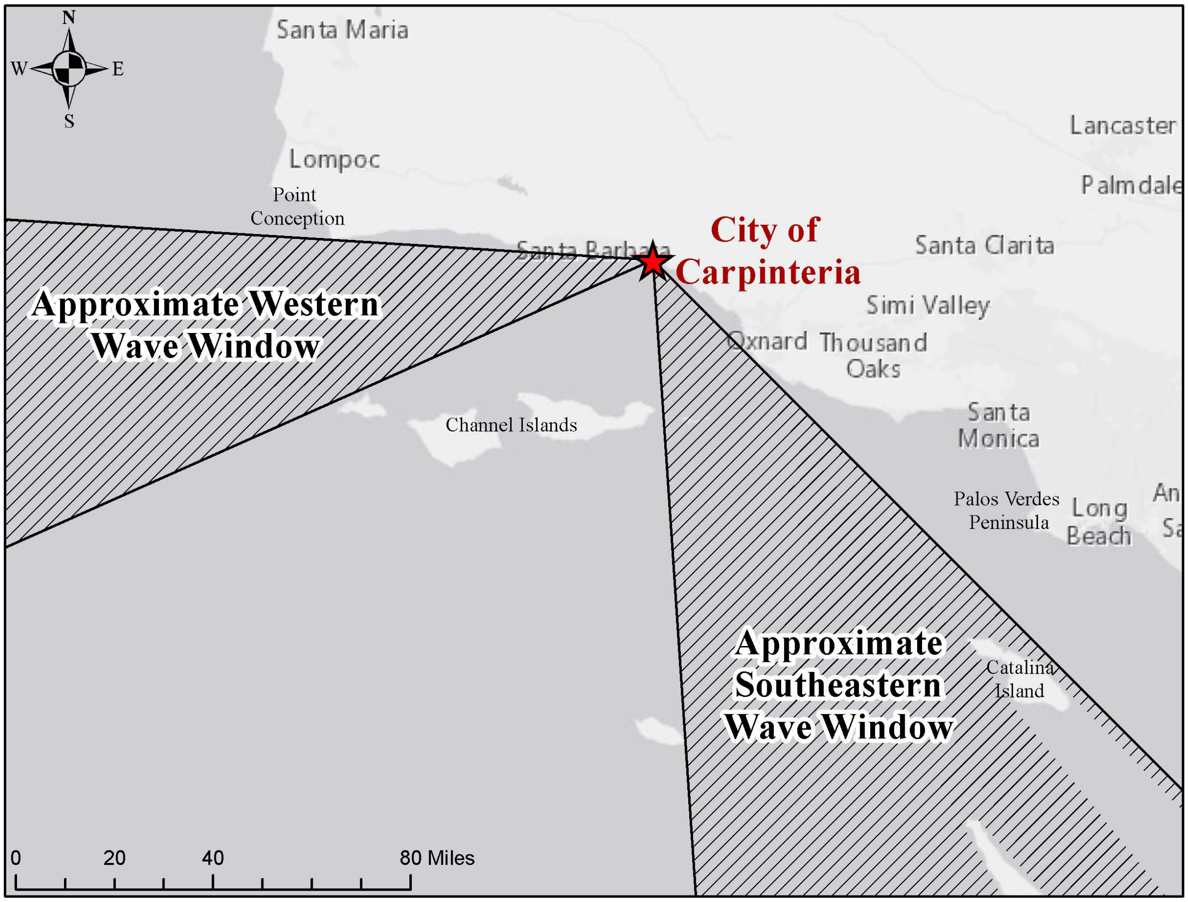

Figure 2.3. Wave Exposure of Carpinteria Beach

2.3 Policies that Apply: Carpinteria Sea Level Rise Vulnerability Assessment and Adaptation Plan and General Plan Update

The State of California (State) is on the forefront of agencies that are openly encouraging the application of living shorelines where possible as an adaptation strategy to protect the coast from erosion and SLR. The concept of a living shoreline is rapidly rising in popularity, and many State agencies such as Caltrans, the California State Coastal Conservancy, California Coastal Commission (CCC), and California Natural Resources Agency are looking to support them. Federal agencies are also consistently supporting these efforts including the National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish & Wildlife Service (USFWS), the USACE, and more. This Project is funded by the CCC and Caltrans and, therefore, has the State's financial support. It is driven by guiding principles of the California Coastal Act and the Safeguarding California Plan: 2018 Update. That plan requires agencies to acknowledge and address SLR, avoid significant coastal hazard risks, and design adaptation strategies according to local conditions and development. The Project is a community-driven strategy for building resiliency to SLR.

Local actions are reflecting State policies. Recent prior studies were done by both the County of Santa Barbara (County) and the City. The County recently conducted their Sea Level Rise Vulnerability Assessment (County of Santa Barbara 2017). Subsequently, and with use of the County data, the City recently completed an SLRVAAP report (City of Carpinteria 2019). The City study took results from the

County study, updated them, and drilled down deeper into the details of the City. Both documents provide a detailed summary of planning efforts to date and results that raise significant concerns for Carpinteria. The County and City reports both identified both the ways in which SLR could exacerbate existing management challenges within coastal areas of the City and methods to adapt habitats, land uses, and built infrastructure to rising sea level over time. Both reports examined potential SLR at three time horizons: 2030 (~1 ft SLR), 2060 (~2 ft SLR), and 2100 (~5 ft SLR) based on current best available SLR science and projections within California. The results are stunning in their graphic portrayal of areas that could be flooded in the City.

The City SLRVAAP document (2019) provides more detail of local issues and identified that increased water level elevations due to SLR are not projected to be the sole cause of future vulnerability and damage to City resources. The primary concern, particularly in the near-term, is that existing coastal hazards driven by severe storms will increase both in frequency and duration as a result of SLR. This includes coastal erosion, storm-related flooding, and inundation of coastal areas during high tides. Projected impacts become more severe over time as SLR increases. According to the study, at the 2030-time horizon (~1ft SLR) beach and dune erosion could result in coastal floods extending further landward than existing conditions, increasing the chance that infrastructure within Carpinteria State Beach and the beach neighborhood could sustain damage. By 2060 (~2ft SLR) increases in coastal erosion and flooding has the potential to impact structures, land uses, and infrastructure between Ash and Linden Avenues extending north of the Union Pacific Railroad, with coastal flooding beginning to encroach directly upon the beach neighborhood. At 2100 (~5ft SLR), routine monthly high tides could extend across significant portions of the beach neighborhood, resulting in regular inundation events. Figure 2.4 shows the predicted flooding from the report.

A broad range of adaptation strategies were developed as part of the SLRVAAP (2019), considering both potential hazard mitigation benefits as well as community values and priorities. Within this analysis the development of a living shoreline/dune restoration project was identified as a key adaptation strategy. The SLRVAAP specifically recommended creation of a vegetated dune system along the City Beach areas in order to create a first line of defense during a large storm event and protect landward development within the beach neighborhood.

Policies that support implementation of the Project are also proposed for integration into the City's Coastal Land Use Plan/ General Plan (CLUP/GP) Update. A Project objective is to transition the successful winter storm berm program to a permanent living shoreline dune system to protect landward resources from severe storms and coastal erosion.

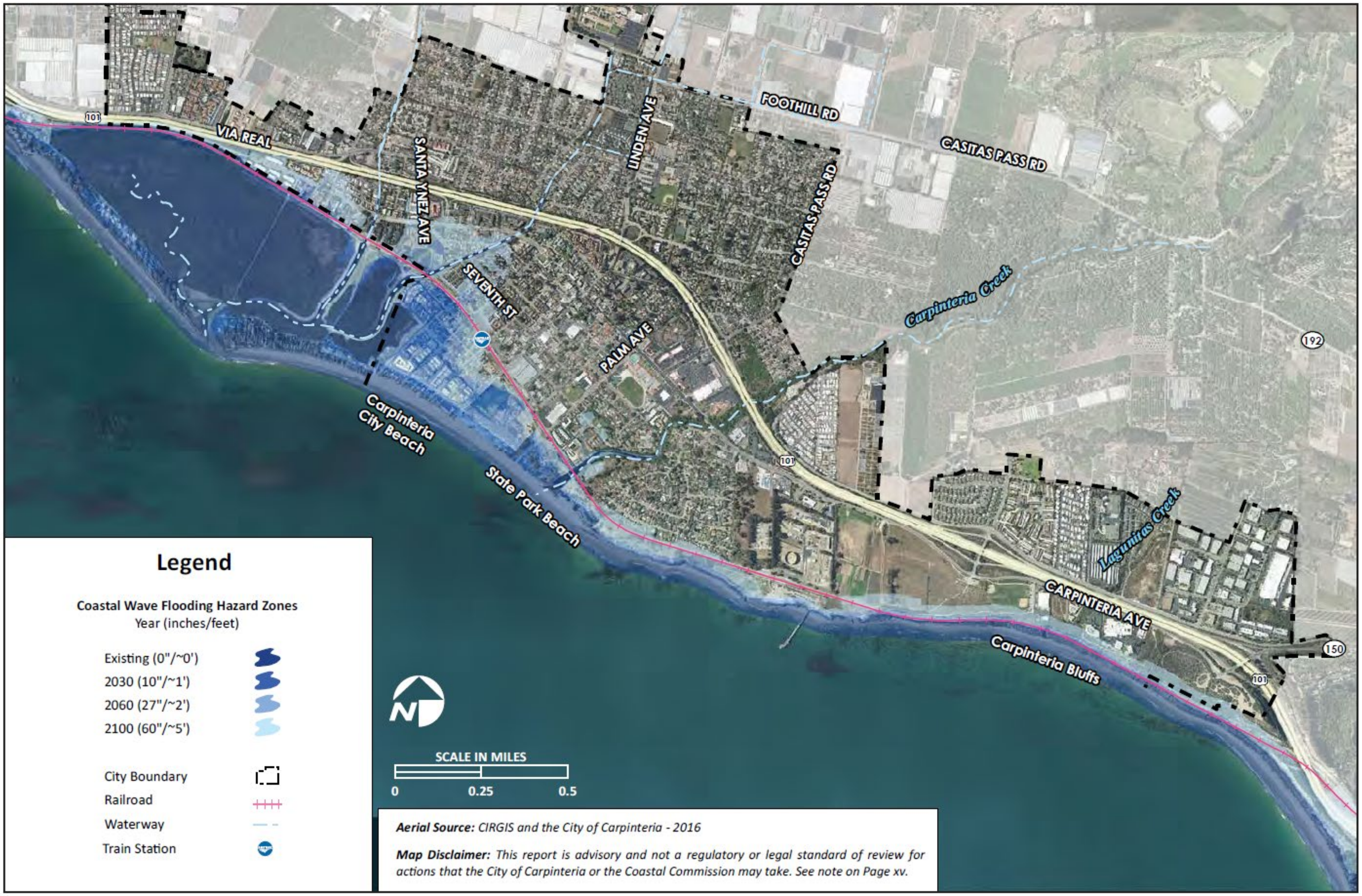

Figure 2.4. Areas of Predicted Flooding in the City During a 100-Year Coastal Storm Wave Event with Existing and Future Sea Levels (City of Carpinteria SLRVAAP 2019)

3. Other Existing Living Shoreline Examples in the Area for Reference

Examples of existing similar projects are presented below to inform Project concept design. From the field site visit in March of 2020 and team meeting on-site afterward, it was determined preliminarily that a living shoreline at Carpinteria will likely:

- Be relatively long and narrow;
- Lie linear along the shore, be set back from the sea but also separate from homes;
- Contain numerous pathways for access; and
- Be of appropriate elevation to block flooding, but potentially low enough to not entirely block first floor views.

Thus, these example projects were chosen because they possess some similar properties to a potential living shoreline at Carpinteria. They are pertinent examples to the living shoreline in terms of orientation, planform, proximity, function, materials, sand trapping methods, vegetation establishment approaches, success rate, etc. Design and construction of a vegetated dune system for coastal protection purposes is a relatively new approach to coastal engineering. The few constructed demonstration sites are used to draw parallels and learn lessons. The Carpinteria Coastal Hazards Modeling Report will provide a detailed, site-specific analysis of dune design criteria and concept design. The preliminary draft memo by Wood (2020) also presents similar information and includes several different sites as references.

3.1 Carpinteria State Beach Dunes

Perhaps the best evidence of the potential success and benefits of a dune system within the Project area is the existing natural dune system along Carpinteria State Beach. The dune and beach system provide a high and wide buffer between the park and the ocean, protecting from both storms and a certain degree of SLR. Vegetation is established throughout this dune system, allowing dunes to persist over time and providing coastal hazard mitigation benefits to State Park infrastructure (Figure 3.1). This existing dune system can provide a model for living shoreline design and construction, serving as a local “test case” that has stood the test of time within the Project area. Not all components of the State Beach dunes will apply, however, and conceptual design of the Project will vary across each reach according to their unique constraints. This is most true for the beach neighborhood due to the proximity of homes to the ocean, as compared to the State Beach Park where development is generally further from the water.

<u>Pertinence to the Carpinteria living shoreline</u> - The City living shoreline project can mimic the dunes at the State Beach with the following considerations:

1. The beach neighborhood is located closer to the ocean than the park behind the State Beach dunes. Therefore, the footprint of a City project along the beach neighborhood will be located closer to the ocean than the footprint of the State Beach dunes. This presents the problem of being more exposed to erosional processes associated with waves and tides. One way to provide sufficient protection for a City dune located closer to the ocean than the State Beach dune is to widen the beach fronting the City using beach nourishment and/or sand retention. Other approaches are to install the dunes closer to the sea and accept having to do more frequent repair and replacement, and/or install cobble cores within the dunes to render them more resistant to erosion and resilient over time.

2. Dunes along the City Beach would have to accommodate views from residences. The entire City Beach is backed by residential development and first floor views should be preserved as much as possible. The State Beach dunes rise to elevations of 3 to 10 feet above the existing beach. If the City Beach dunes reached the same elevation, they may partially or completely block first floor views. Therefore, the elevations of the City dunes may need to be lower than the State Beach dunes. That introduces the issue of potentially designing a lower dune that provides less protection than a higher dune. To compensate for a lower dune, the dune design could consider a wider footprint to provide a comparable level of protection. A wider dune may extend farther seaward than the State Beach dune. Combined with the fact that the dune will be forced farther seaward by development anyway (as mentioned above), the future City dune may be even more vulnerable than the State Beach dune and require further protection by a wider beach and potentially more maintenance and replacement efforts.
3. Dunes along the City Beach also need to provide access from residences along the beach neighborhood. There are multiple existing access points that residents use. These access points should be preserved and maintained to the greatest extent. Access points typically require a gap in the dune or lower portion of the dune crest to pass over on foot. Dune design may need to incorporate gaps or “saddles” to allow foot traffic. This also presents a vulnerability to the dune’s stability and effectiveness and needs to be compensated for by further widening of the dune footprint. In addition, the orientation of the accessways may need to be oriented at an angle to the beach to prevent direct wave uprush from flooding through the accessways.

Thus, this living shoreline along the City Beach is more complicated and will need to vary from the template provided by the State Beach dunes.

Figure 3.1. Carpinteria State Beach Dune System – April 2020

3.2 Carpinteria Winter Berm (Dike)

Seasonal construction of a sand berm featuring a high crest elevation during winter months has been utilized in the beach neighborhood area to protect coastal assets and infrastructure from increased erosive forces and wave energy (Figure 3.2 through Figure 3.4). The existing winter berm (diking) activities along the beach neighborhood demonstrate the potential effectiveness of a living shoreline project if it were to function similarly to the winter berm or were able to be supplemented with sand each winter to function as the berm while still remaining as a perpetual dune. Conceptually, it is possible that this version of the feature would be a hybrid living shoreline for the most landward dune habitat area supplemented by an annual maintenance feature of a sand berm across its western edge to further fortify the beach neighborhood from flooding. The goal of the living shoreline project would be to provide multiple benefits, such as providing:

- Hazard mitigation benefits on a year-round basis without the need for seasonal construction activities or at least reduced or minimal seasonal construction activities;
- Improved habitat conditions; and
- Maintenance of public views, accessways, and public use of the beach to the reasonable extent possible.

Pertinence to the Carpinteria living shoreline - The proposed City living shoreline will have similarities in orientation (long, linear, and parallel to shore) but differences in cross-section to the City winter dike. The winter dike is intended to *temporarily* block wave run-up to the greatest extent and to dissipate wave energy. As a temporary feature, it is not intended to be self-sustaining nor resilient. However, it’s shape and location are helpful when considering how a living shoreline might function at the site. Due to its temporary nature, it may be higher at its crest than the living shoreline and block more views and be a bit narrower. A living shoreline would provide more and improved habitat areas compared to the winter dike, whose construction and removal each year disrupts and destroys habitats. The landward footprint of the feature is important to follow because it lies outside of the private beach property line, which is also where the longer-term living shoreline should lie. The trade-off between protection and views is this:

1. A lower crest elevation provides greater views but requires a significantly wider base to be protective; and
2. A higher crest blocks more of the views but can require a much narrower base to be protective.

Access is another complicating factor in living shoreline design. Providing completely unimpeded access may not be realistic but will be most like the existing conditions when the dike is not erected. Access may need to be funneled to fewer access points, and those points may need to be designed at angles to the protective feature and with a high enough crest to minimize wave overtopping. A compromise may need to be struck between views, protection, and access.

Figure 3.2. City of Carpinteria Winter Dike, North End at Ash Avenue – January 2021, Showing Continuous Alignment Across First Floor Views

Figure 3.3. City of Carpinteria Winter Dike, South End at Linden Avenue – January 2021, Showing a Slightly Lower Relative Height but Still Obstructing Views

Figure 3.4. City of Carpinteria Winter Dike, Mid-Reach at Elm Avenue January 2021, Showing Modest "Saddle" in the Crest for Access

3.3 Cardiff Beach Living Shoreline

A City of Carpinteria living shoreline may take the form of the Cardiff Beach Living Shoreline Project in Encinitas, CA. The sites are very similar in length, width, and elevation and share the desired function of resilient, green protection.

Pertinence to the Carpinteria living shoreline - The reason that the Carpinteria project may need to be so similar to the Cardiff project is that they may both possess these common properties:

1. Oriented linear and relatively narrow to protect a backshore feature while constrained to a narrow footprint due to a seasonally narrow fronting beach;
2. May include hard material as a foundation or toe protection to extend the lifespan and render them more protective than entirely soft structures;
3. May need to possess a low enough crest elevation to maintain views; and
4. May need to provide access at multiple points through the feature.

The Cardiff living shoreline was constructed in Fall 2018 through Spring 2019, and was designed to provide protection of Highway 101, habitat improvement, and improved public access. The project is composed of a vegetated sand dune with a buried revetment and cobble toe. The dune system was constructed with a crest height of approximately +21 ft NAVD88, and a cross-shore width of approximately 60 ft (Figure 3.5, Moffatt & Nichol 2018). The project was paired with a beach nourishment project that initially increased beach widths by up to 150 ft. Since construction in 2018-2019, the project has persisted, experienced minimal erosion through 2020, and rapid growth of vegetation. Figure 3-6 shows the project in 2019.

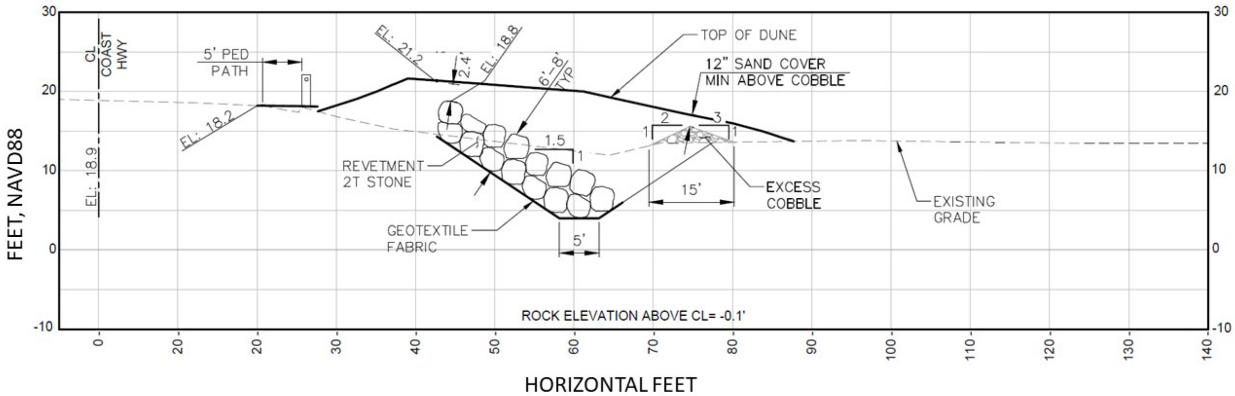

Figure 3.5. Cardiff Living Shoreline Project Typical Cross-Section (Moffatt & Nichol 2018)

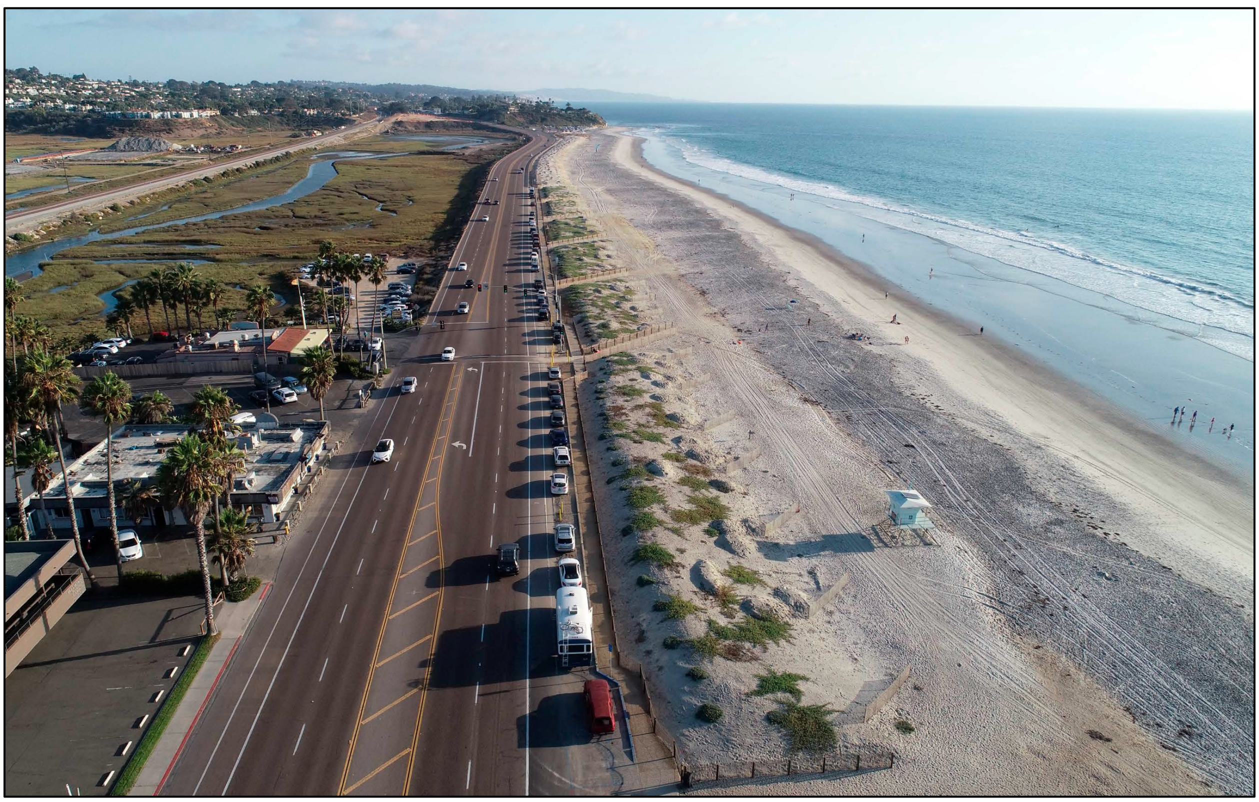

Figure 3.6. Cardiff Living Shoreline Project in 2019 (Nature Collective 2019 Monitoring)

Design of the Cardiff Living Shoreline was defined through model analysis of storm waves, beach erosion, and SLR. The approach for the Carpinteria Coastal Hazards Modeling Report is similar and was based on the work done for Cardiff. The work will identify site-specific dune design criteria for Carpinteria, such as level of protection, longevity, maintenance frequency and magnitude, resilience, etc. The Cardiff Living Shoreline was designed to protect from wave runup and overtopping, while providing a source of sand to the beach as it erodes. The project included dune habitat created from the import of beach compatible fill. The fill was placed in a hummock profile to mimic a natural dune system. The dunes were then planted and seeded with native plants and seed. Coarse to medium-grained sand was applied as the dune surface material to foster growth of native plants and use of the area by native fauna. This gradation is also ideal from a shore protection perspective.

However, erosion has occurred in 2021 and the toe has been exposed along the central reach of the feature. Photographs in Figure 3.7 and Figure 3.8 show the current condition. This project was intended to experience this type of erosion and should be able to recover when the beach naturally accretes in summer. It was also to receive an annual nourishment quantity of 35,000 cy of sand from a nearby lagoon inlet channel, but that material may or may not be available due to recent restoration activities. Maintenance repairs are needed at this site, similar to what may occur in the future at Carpinteria.

Figure 3.7. Cardiff Living Shoreline, Erosion Exposing Cobble Toe – February 2021

Figure 3.8. Cardiff Living Shoreline, Toe Erosion and Undermining of the Dune Fencing – February 2021

3.4 Surfer's Point Living Shoreline

The Surfer's Point Living Shoreline in Ventura, CA. Although a classic living shoreline project, the Ventura Surfer's Point project is not oriented linear alongshore, but more as a protruding dune field over the southern edge of a relic cobble river delta, as shown in Figure 3.9. There is more space at the Ventura site between the dune and the water, and the shoreline is oriented at an angle to wave approach, so waves break along the shore rather than straight toward the shore. This wave "refraction" can reduce the amount of energy directed towards shore in wave run-up; this location is exposed to such high levels of energy in winter that conditions can be fairly damaging during combined high tides during high waves.

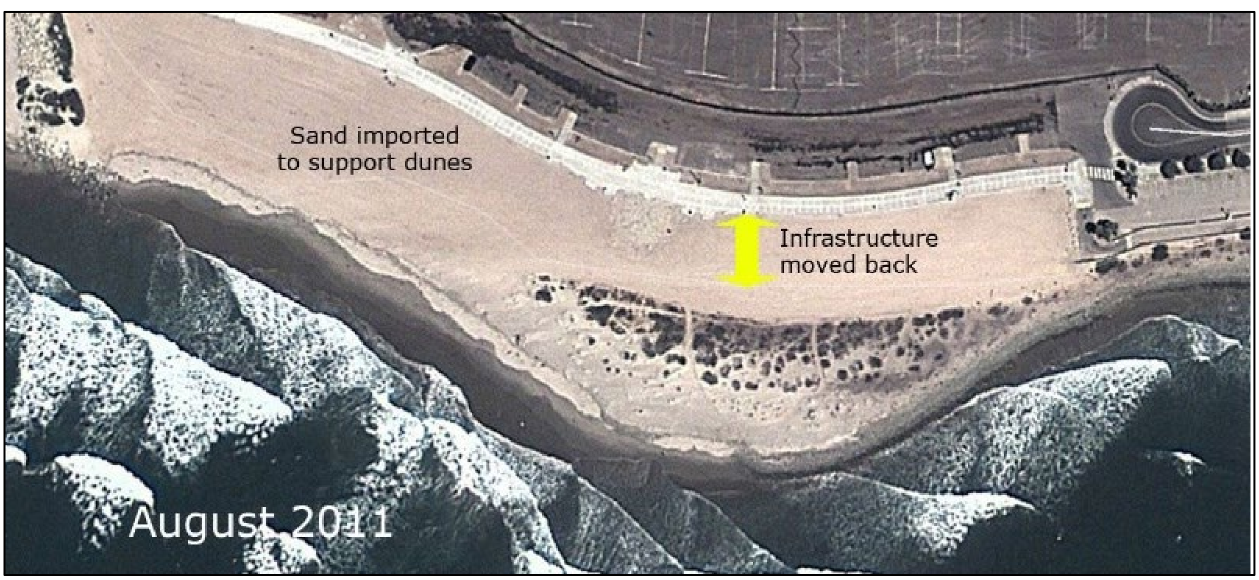

Figure 3.9. Ventura Surfer's Point Living Shoreline Layout

Pertinence to the Carpinteria living shoreline - There are aspects of this project that are similar to the Carpinteria model that can be applied, such as the:

1. Materials used to construct it;
2. Design of dune hummocks;
3. Habitat to be established;
4. Cobble included in the design for a foundation and toe protection;
5. Littoral cell of its location; and
6. Self-sustaining recovery performance.

The Ventura example is successful in that the dunes are established and are resilient and self-sustaining. The native coastal dune vegetation habitat was established from seed and included installation of temporary and long-term sand stabilization devices (e.g., crimped straw and sand fencing), and pre- and post-project vegetation and topographic monitoring. The dunes continue to support natural levels of native vegetative cover while only receiving minimal maintenance. The restored dunes have eliminated nuisance-sand blowing on to the adjacent bike path and parking lot behind the site. The dunes have eroded in large winter wave events but protected landward infrastructure, only to naturally re-build themselves through the spring and summer. They were installed and are maintained using volunteers. The big difference between this project and the Carpinteria living shoreline is that Surfer's Point was constructed at the location of the Ventura River Delta so large quantities of cobble already existed, and more was approved for import. The City Beach at Carpinteria is not situated similarly and, therefore, less cobble should be used in its design and construction.

This project is a vegetated sand dune and buried cobble berm near the mouth of the Ventura River in Ventura, CA. The project was constructed in 2012 to restore the severely eroded shoreline just south of the Ventura River mouth. The project added 30,000 cy of cobble to the beach derived from the Santa Clara River, amounting to approximately 18 cubic yards per linear foot (cy/lf) of project length. The 6- to 18-inch diameter cobble was formed into an 8-foot-thick cobble berm. The cobble was then buried beneath 15,000 cy of sand that was then formed into dune features. The dunes were stabilized with native plant species and backed with a pedestrian trail and a parapet wall. The project also incorporated an element of managed retreat that reclaimed approximately 60 feet of land, which was previously occupied by a parking lot and a bike path. Since planting was completed in 2012, the dunes have been found to be stable and well-established with native species. The design cross-section is shown in Figure 3.10 and the progression of construction is shown in Figure 3.11. Sterile rice straw was used during planting to stabilize the sand while vegetation was being established. The dune planting has also been effective at preventing blowing sand. Surfer's Point was constructed prior to and successfully endured the 2015/2016 El Niño storm season, demonstrating the effectiveness of cobble material as natural erosion protection. The cobble mattress was barely exposed even during that year. The project is successful because the dunes have a naturally functioning beach in front of them and the dunes were able to eventually erode.

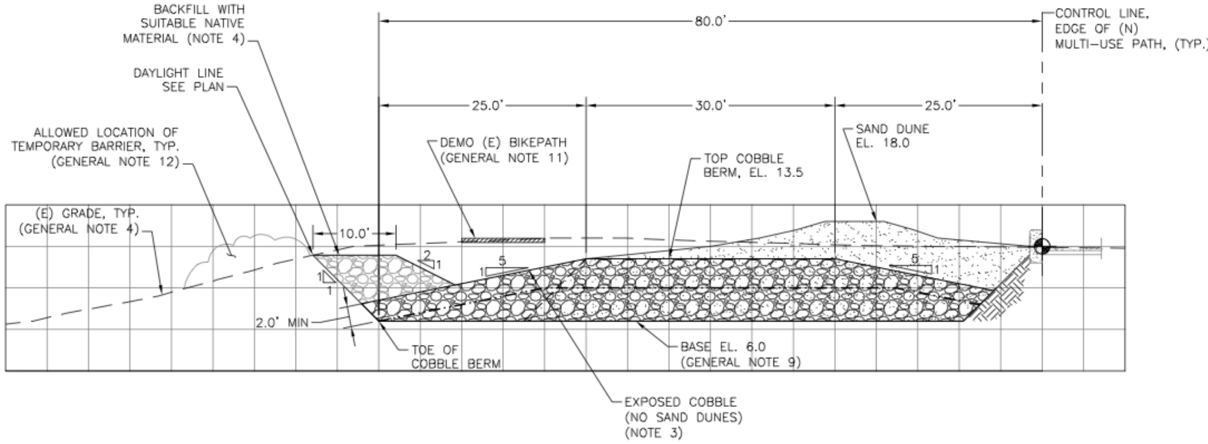

Figure 3.10.Surfer's Point Living Shoreline Cross-Section (City of San Buenaventura 2003)

Pre-Project Condition

Removal of Parking Lot

Excavation of Retreat Zone/Cobble Berm

Importing of 6- to 18-inch Diameter Cobble

Construction of Cobble Berm

Construction of Parapet Wall

Constructed Dune with Established Plantings

Sterile Rice Straw used to Stabilize the Sand while Vegetation Established

Figure 3.11. Surfer's Point Construction Photos

3.5 Cape Lookout Living Shoreline

A pilot project in Oregon provides information useful to understand dune resilience to wave attack and overtopping.

Pertinence to the Carpinteria living shoreline – This project includes the following, which are applicable to Carpinteria:

1. A foundation and toe protection layer of cobble overlain by sand and habitat; and
2. A crest elevation that may be overtopped that triggers maintenance and repair at a particular frequency.

The project was designed by well-renowned coastal engineers from Oregon State University. It is called the Cape Lookout Living Shoreline and it demonstrated the performance of a cobble berm and dune constructed in 2000 at Cape Lookout State Park, Oregon. The design consisted of a cobble berm and high vegetated back dune reinforced with sand-filled geotextile bags (Figure 3.12, Komar and Allen 2010). This project helped identify the usefulness of installing a cobble/rock toe for scour protection. Wave energy is higher at this location than in southern California, so conditions are more severe. The pilot dune was installed with a slightly lower crest elevation than was needed, so it was over-washed and damaged. From that, we can see the extent of repairs needed and the frequency of needed maintenance. All of this feeds information into our own designs for Carpinteria. Background information is provided below.

Construction monitoring of the berm and dune showed the crest height to be approximately 3.3 to 6.6 feet below the recommended elevation that was intended to prevent wave overtopping. Although the northern end of the design was overtopped multiple times, the berm and dune have generally remained stable and have effectively protected the campground backing the dune. Long-term monitoring of the project has shown a large reduction in the volume of cobbles following winter storms, as well as loss of sand and vegetation cover of the foredunes. The dune was nourished with sand in the summer of 2008 and the need for maintenance of the dunes was evident a decade after construction. Since then, it has been recommended to raise the dunes to the suggested elevation to prevent wave overtopping.

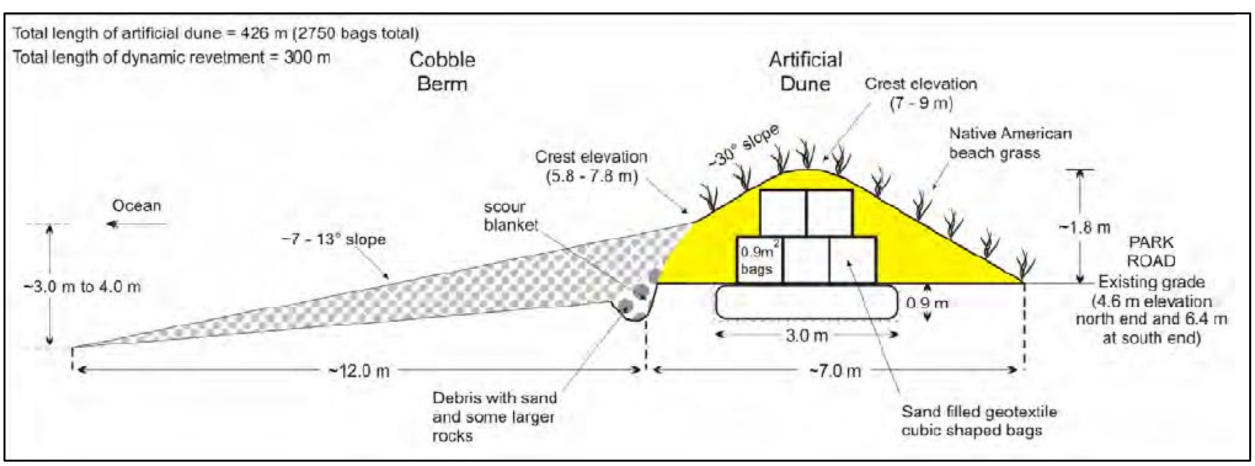

Figure 3.12. Cape Lookout Living Shoreline Cross-Section (Komar and Allen 2010)

4. Potential Constraints to a Project at Carpinteria

Constructing a highly visible project along the beach in Carpinteria may impact several aspects of the existing conditions of the City, both natural and man-made. Existing environmental conditions must be considered in the planning and design to prevent unintended impacts. Existing anthropogenic conditions (land ownership, property boundaries, transportation, public access and viewshed, utilities, and coastal structures) may conflict with the proposed Project, as the beach draws a diverse set of public and private interests. These potential constraints are discussed below in order to identify the potential challenges to Project planning.

4.1 Natural Constraints

Potential natural constraints within the Project area are illustrated in Figure 4.1 and discussed in the sections below.

4.1.1 Biological Resources

Determination of Project impacts to existing biological resources would depend on the location and extent of the proposed Project footprint, proposed materials and methods, and construction techniques and modeled interactions with neighboring areas. Coastal Restoration Consultants (CRC) visited the study area on 15 September 2020 to perform a preliminary assessment of existing resources and shoreline zones; this section was prepared by them. Observations and environmental data in the City's Geographic Information System (GIS) were used to inform a preliminary assessment of constraints on living shoreline projects in the study area. The presence of resources should not be interpreted as a reason to avoid work in any specific area because the resources may be degraded and might benefit from restoration actions, but the planning and permitting process may be more complex in areas with certain biological resources.

Generally, the existing biological resources in the study area are greatest in Reaches 1 and 3. Reach 1 includes Carpinteria Salt Marsh with intertidal wetland, tidal salt marsh, and State and federally listed species. Reach 3 includes Carpinteria State Park and is characterized by southern California coastal dune and beach habitats, wetlands and listed species at the Carpinteria Creek mouth, and rocky intertidal habitat. Each of the four reaches is described below for habitat constraints.

Reach 1 – A narrow and seasonally dynamic sandy beach exists. The sandy intertidal zone tends to become wider from west to east, and on the day of the site visit upper beach habitat was limited to the eastern and middle areas of the reach. High tides were reaching the rocks during this period and were limiting horizontal access along the shoreline and the range of ecological communities, and the amount of sand stored on the shoreline. No dune forms were present and no native dune plant species were found in this reach. The western limit of this reach is at the inlet of Carpinteria Salt Marsh. The functions of this regionally important estuary are dependent on tidal exchange through the inlet. The importance of the inlet dynamics must be considered when developing sediment nourishment approaches in the study area. Carpinteria Reef is a sub-tidal rocky structure about 0.25 miles offshore of the marsh inlet. The potential effects of nourishment approaches should consider possible effects on fish, invertebrates, and macro algae at this site.

Reach 2 – The beach neighborhood is located along the back beach throughout this reach. This reach is mechanically groomed to remove trash and seaweed. The winter berm was not present on the date of the Spring 2020 site visit. The upper beach ecological zone was present throughout this reach. No native dune plant species were present on City property and dune forms were absent.

Reach 3 – Carpinteria State Beach is located along the back beach throughout this reach. The dunes in this reach form a continuous foredune ridge and include an area near the west end with relatively high cover of native dune plants (particularly beachbur, *Ambrosia chamissonis*) and a more extensive area to the east vegetated with non-native ice plant (*Carpobrotus edulis*), myoporum, and eucalyptus. The beach is relatively wide and supports all ecological zones of the beach/dune system. This reach is not mechanically groomed. A beach berm typically blocks the flow of Carpinteria Creek for most of the year. The creek breaches the berm after significant rain events and stays open until longshore transport of sand driven by waves closes the inlet. The creek lagoon provides habitat for listed species including federally endangered tidewater goby and steelhead trout. Changes in beach width or sediment composition that alter the lagoon dynamics have the potential to alter important aspects of these species habitat and must be carefully considered.

Reach 4 – Carpinteria State Beach extends along the back beach throughout this reach along 4th Street to Carpinteria Bluffs Trail in Tarpits Park. The sandy beach tends to decrease in width towards the east as the shoreline bends and the back beach transitions from a low elevation degraded dune system into a higher elevation bluff system. At the western end of this reach, upper beach ecological zone and dune habitat is present. Rocky intertidal habitat is also present in this reach including a Multi-agency Rocky Intertidal Network (MARINe) long-term monitoring site with a data series extending back to 1992 (MARINe 2019). The design and implementation of shoreline projects in the area should consider potential impacts of sediment nourishment and other actions (sand retention) to rocky intertidal and other adjacent habitats.

Other potentially sensitive biological resources may occur throughout the site or just offshore. The sandy beach habitat may support spawning grunion, migratory and over-wintering shorebirds, and special status invertebrates. Nearshore habitats such as eelgrass beds and kelp forests were not mapped for this Project but do exist adjacent to the Project area. Potential impacts to all of these resources should be considered during Project design.

4.1.2 Insufficient Upcoast and Upstream Sand Supply

Natural sand supply to the City of Carpinteria was significantly reduced from historic conditions by installation of Santa Barbara Harbor and damming of major streams. The beach may have stabilized in position since the initial retreat and narrowing caused by the Harbor, but it is not wide enough to sustain a living shoreline and a wide sandy beach along the City beach in the opinion of the engineer.

Reach 1 – Possess a small and narrow seasonal beach in Summer and Fall seasons but loses most or all of its beach in Winter and Spring.

Reach 2 – Possesses a beach year-round and serves as the sand supply for the City winter dike, but it may not be enough to sustain a beach sufficient for a living shoreline.

Reach 3 – Possesses a wider beach than either Reaches 1 or 2 but is still seasonally narrow (winter season narrowing). As development is set back farther from the water than the City beach reach, it has had sufficient sand supply to sustain the dunes along the State Beach Park. This beach may be the model for the design target beach width for the Project at Reach 2.

Reach 4 – Possesses variable beach conditions but is not relevant because no actions are proposed there.

4.1.3 Topography – Narrow Beach and Low Backshore Area

As depicted in Figure 2.1, the City is a relatively low-lying community located between a saltmarsh to the northwest and bluffs to the southwest. Within the Project area, the back beach along the beach neighborhood lies at approximately +10-15 ft NAVD88. Along Carpinteria, the back beach is the prime location for a dune system, as the most successful dune systems are fronted by a relatively wide sand beach buffering the dune from storm wave impacts, providing a source of windblown sand for dune growth, and providing an area of relatively high elevation for dune vegetation to establish above the tide line. In order to better facilitate this, dune construction would be ideally paired with, or would closely follow, a significant beach nourishment project.

Within Reach 1, the existing beach is very narrow and low (approximately +5-10 ft NAVD88) and backed by a revetment and residential community (approximately +10-15 ft NAVD88). A dune within this area would be severely restricted by lack of space, a narrow beach, and encroaching development with the hardened last line of defense that is referred to as “coastal squeeze.”

Within Reach 2, the existing beach is wider and could potentially accommodate a dune system if sufficient space exists between private property lines and the beach. Three residences and Ash Avenue at the northwestern end of the beach neighborhood are at a substantially lower elevation than the beach, roadways, and development located to the southeast. Ash Avenue has been the site of localized flooding in the recent past due to its low elevation. As such, it could benefit from the combined widened beach and dune protection system.

Along Reach 3, the existing sand dune system sets a precedent for the continued use of the area as vegetated sand dune. Considerations of increasing existing dune width and height or enhancing the dune system with vegetation or fencing systems may be appropriate. One constraint lies in the existence of a pedestrian boardwalk along the top of the dune system, which restricts the dune crest elevation in that location. The presence of Carpinteria Creek at the south end of the reach represents a second constraint, as adding sand to the system may increase sediment deposition in the Creek Mouth that may have adverse impacts to wildlife, such as the federally endangered steelhead trout. The Project should aim to minimize potential impacts of grading and fill activities.

Along Reach 4, the shoreline orientation bends, the existing sandy beach width narrows, and elevations rise into the Carpinteria Bluff system towards Tarpits Park. At the northwestern boundary, the Carpinteria Creek Mouth should be considered in the same manner discussed in Reach 3. As the land elevation rises to a bluff system and beach widths narrow, the potential for a viable dune system is greatly reduced. It is not common for dunes to be located along bluff systems, unless supported by a wide fronting beach.

4.1.4 Environmentally Sensitive Habitat Areas

The Project area contains several Environmentally Sensitive Habitat Areas (ESHAs) as identified in the City SLRVAAP. ESHAs are designated protective areas within the coastal zone, which are regulated by the California Coastal Act and Local Coastal Programs (LCPs). Projects that may impact ESHAs endure a more onerous permitting process and may require mitigation action to offset any impacts. The most significant ESHA present is the Carpinteria Beach habitat that extends across Reach 2, Reach 3, and Reach 4 from Ash Avenue to Tarpits Park. Beaches in the area of Ash Avenue are primarily sandy in nature, while cobble material is also present in the vicinity of Linden Avenue. Rocky material is also present offshore of Carpinteria State Beach, home to a number of rocky intertidal species. Placement of beach fill and its subsequent dispersion can cover these rocky areas and habitats, leading to adverse but potentially insignificant impacts until natural littoral processes remove the new overlying sediment. Any turbidity plumes resulting from sand placement can also impact beach and tidal habitats, particularly if plumes occur over an extended period of time.

ESHAs are also present inland of the coastline. Carpinteria Salt Marsh Nature Park, part of the larger Carpinteria Marsh, lies along Ash Avenue within the beach neighborhood, extending inland to 3rd Street. This marsh habitat serves as important habitat for both shorebirds and migratory waterfowl. Carpinteria Creek and associated river mouth habitat is located at the transition point from Reach 3 to Reach 4 along Carpinteria State Beach, supporting fish species listed as threatened and/or endangered, including the Northern Tidewater Gobi and the Southern California Coast Steelhead. Sand placement upcoast of the creek mouth in areas such as Ash Avenue could potentially move downcoast and close the creek mouth, which could present a problem. Though not located directly within the Project area, Tar Pits Park is located immediately downcoast of Reach 4. Rookery habitat may extend across Reach 3 and Reach 4 at the Carpinteria Creek Mouth. The rookery currently lies east of the Carpinteria Pier, at the foot of Carpinteria Bluffs. Figure 4.1 shows the general location of the rookery, but there are no formal boundaries.

Figure 4.1. Carpinteria Rookery

4.1.5 Marsh and Creek Outlets

Implementation of beach fill and grading projects along the shoreline can affect the ocean connections to Carpinteria Salt Marsh and Carpinteria Creek. The entrance to Carpinteria Salt Marsh is at the upcoast end of Reach 1, while Carpinteria Creek is at the upcoast end of Reach 4. Both connections need to be preserved as functional with beach nourishment possible within Reach 1 and a living shoreline along Reaches 2 and 3.

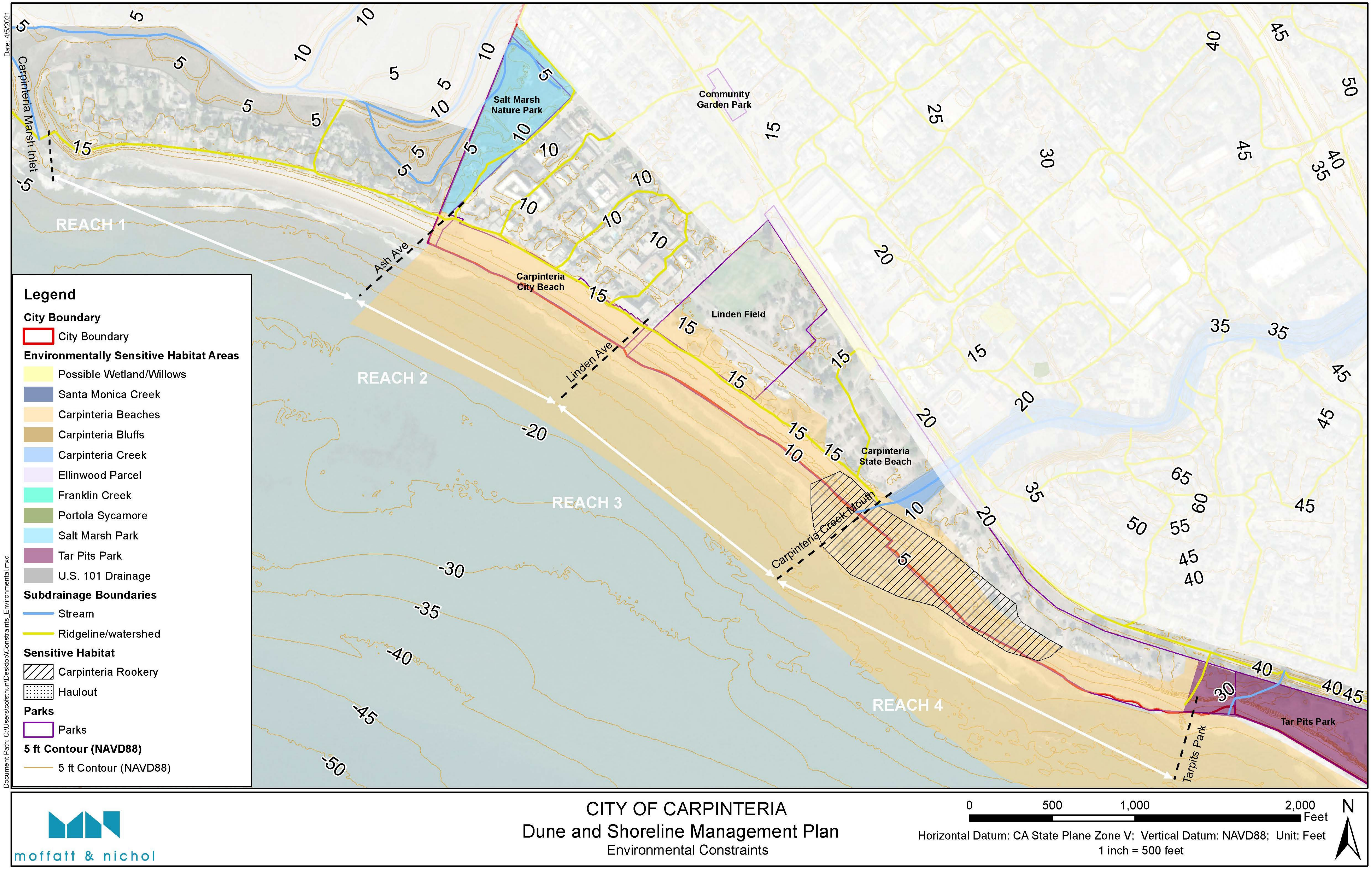

Figure 4.2. Natural Constraints within the Project Area

4.2 Anthropogenic Constraints

Potential man-made constraints within the Project area are illustrated in Figure 4.3 and discussed in the sections below. It is important to note that, although the existing conditions in the Project area may bring about certain constraints, ultimately the living shoreline project would serve as a protective, nature-based infrastructure for the City. The Project is aimed at reducing the vulnerability of infrastructure and resources throughout the City to coastal flooding, including residences, Linden Field, campgrounds, roadways, access ways, utilities, habitat, and more.

4.2.1 Land Ownership/Property Boundaries – Proximity to Homes

The City boundary along the coastline begins at Ash Avenue and extends downcoast across Reach 2, Reach 3, and Reach 4. Land ownership within each reach is summarized below. The main issue is homes are located close to the shore in Reaches 1 and 2, thus preventing the living shoreline from being located where it would function best, along the rear area of the beach where it can be protected from waves and protect the backshore.

Reach 1, including the Sandyland Cove neighborhood, is not located within the City boundary. The City boundary extends approximately 250 feet into sandy beach areas, though this is variable across the Project area based on overall beach width. Private parcels are present along the coastline in Reach 1 and Reach 2, made up of the Sandyland Cove and beach neighborhood areas, respectively. The potential for conflict along Reach 1 may arise should the Project propose to extend into the revetment area.

Along Reach 2, private parcels extend into the natural beach area. The obligations and allowances of the respective parties concerning use of public and private beaches, including addressing periodic erosion, view protection, etc., are addressed in the County of Santa Barbara Superior Court Roberts Judgement No. 79328 (Roberts v. City of Carpinteria 1974). The existence of parcel boundaries within the beach area stems from the determination that the "Judgement Line" be drawn parallel with and distant southwesterly 30 feet, measured at right angles, from the northeasterly line of Ocean Avenue. Ocean Avenue was a proposed 100-foot-wide oceanfront roadway that was never constructed in the City. Public beach is designated as seaward of the Judgement Line, while "private beach" is located landward of the line. See Figure 4.5 for a clip of the 4825 Sandyland Rd APN Map with the private beach outlined in red.

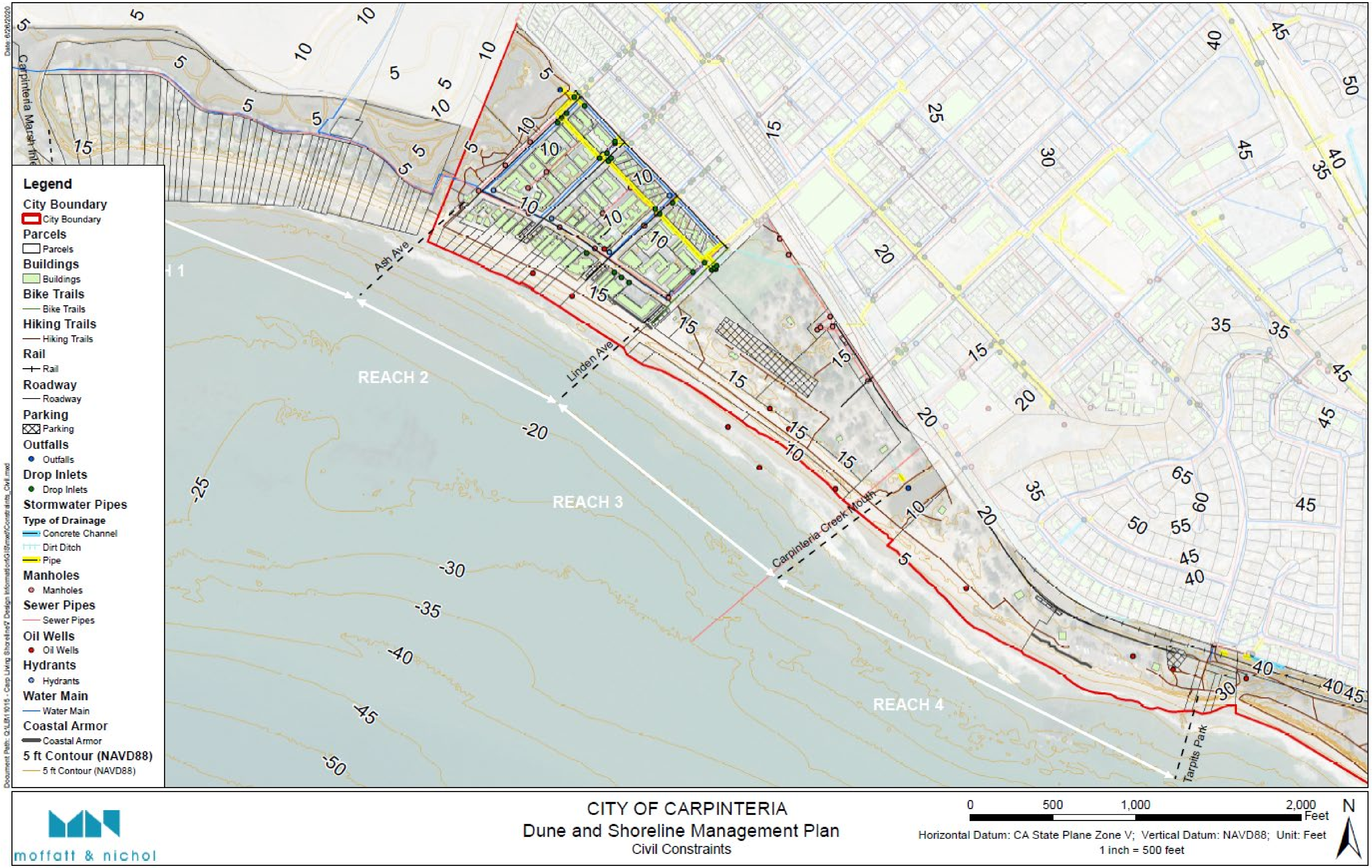

Figure 4.3. Anthropogenic Constraints within the Project Area

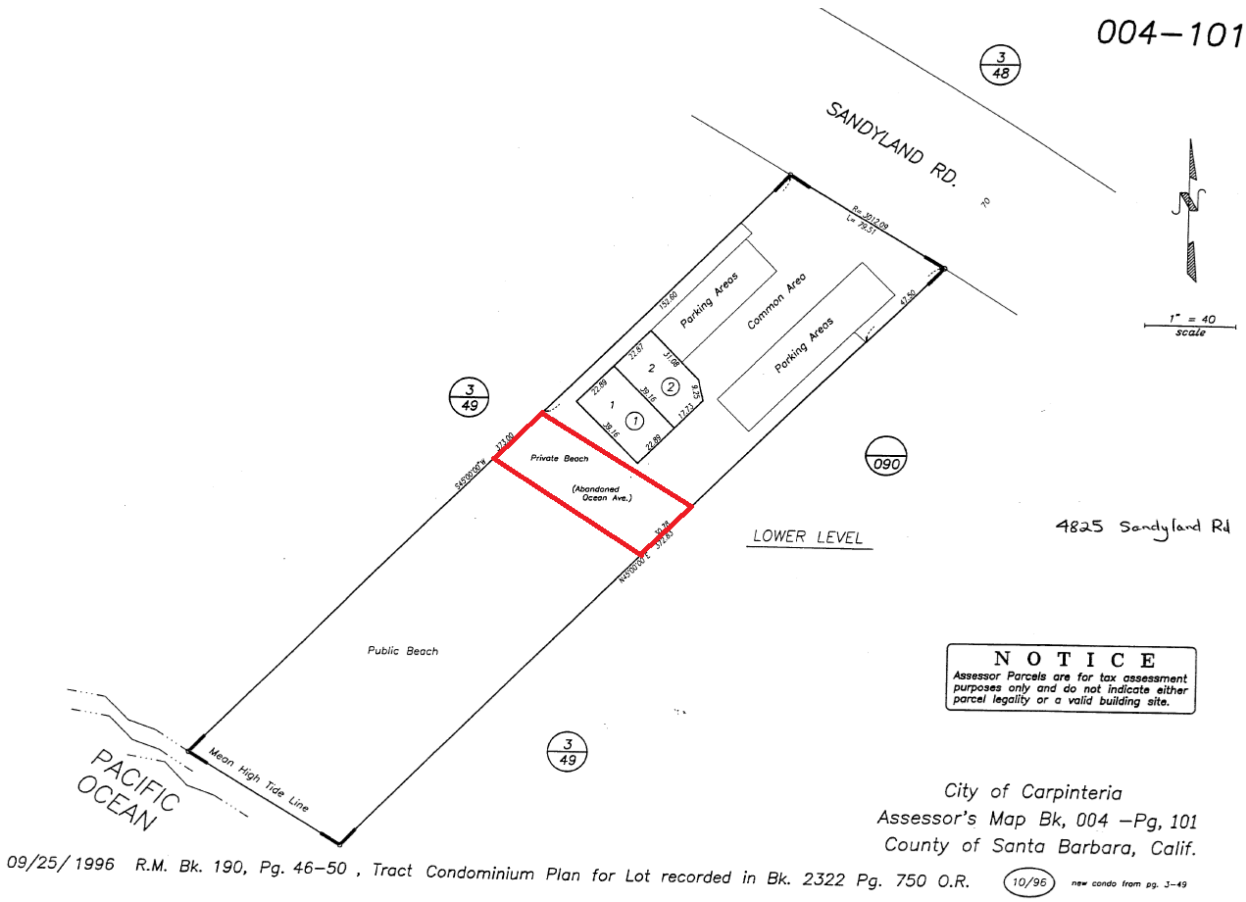

Figure 4.4. APN Map – 4825 Sandyland Rd (private beach highlighted in red)

With regard to the proposed Project, use of the private beach area by the City is allowable, as discussed in Paragraph 7 of the judgment. Specifically, the area is open for the purpose of "erosion control (but not including the right to interfere with pedestrian access to the ocean and shore from the property situated between the Judgment Line and Sandy Land Road, nor to block the view of the ocean and shore from said property with sand except when temporarily required by seasonal or storm conditions for the preservation of the public or private beach, nor to build any structures except as may be hereinafter permitted under Paragraphs 7(b), 7(c) or 8 hereof)." Although the proposed Project is intended for erosion control, the Project may not be intended as temporary. Therefore, potential conflicts could arise should the dune footprint overlap with the private beach. The annual winter berm program currently aims to construct the winter berm just seaward of the private beach, though Judgement No. 79328 explicitly allows the winter berm program within the private beach area, as it is temporary. Private owners along the waterfront are in favor of the winter berm program and will need to be approached regarding the proposed Project. The living shoreline and beach nourishment will likely need to be installed seaward of any private property. Figure 4.5 shows the existing footprint of the "private beach" and the City's winter dike. The living shoreline would likely fall within and seaward of the winter dike footprint.

Figure 4.5. Private Beach and Winter Dike Footprints Within Reach 2

Parcel boundaries within Reaches 3 and 4 include those associated with Carpinteria State Beach and Linden Field bordering Linden Avenue. As existing dune habitat is present in these areas, it is possible that the proposed Project could further enhance these areas. Should this be proposed, coordination with CSP will be required to ensure that the proposed concept is agreeable to all parties.

In addition, beach fill projects may evolve in a manner that allows wave run-up and overwash to pool on the beach during extreme high tides. The water slowly seeps into the ground and may move laterally under homes and have an effect on beachfront underground structures (parking garages and basements), if present. Beach fill and dune design should consider this potential secondary effect, especially in Reach 2.

4.2.2 Transportation Infrastructure and Safety

A proposed project must evaluate its potential to impact existing transportation infrastructure in order to best minimize and/or improve existing conditions. Transportation infrastructure within Reach 1 is mainly limited to Avenue Del Mar and Sandyland Cove Road, which provide access to the Sandyland Cove neighborhood. Roadways within the beach neighborhood in Reach 2 include Ash, Holly, Elm, and Linden Avenues running perpendicular to the shoreline. Street parking areas are located at the end of these avenues, providing access to local beaches. Additionally, measures to prevent windblown sand from collecting significantly on roadways and sidewalks should be considered. Sandyland Road additionally runs parallel to the shoreline behind the first row of development within the beach neighborhood. Hiking trails run along the coastline on the open beach in Reach 2, continuing downcoast into Reach 3 and extending inland along Ash Avenue into Salt Marsh Park.

Roadways are largely absent within Reach 3 and Reach 4 except for Palm Avenue, 4th Street, and Sandy Land Road, which provide access to Carpinteria State Beach and Tar Pits Park. Reach 3 contains the major parking area for Carpinteria State Beach. Hiking trails continue along much of the coastline in Reach 3 and Reach 4, including those associated with Carpinteria State Beach. The pedestrian boardwalk located atop the dunes in Reach 3 will require consideration should a dune enhancement program be proposed in this area. Avoidance of impacts to the boardwalk is preferred unless CSP agrees otherwise.

4.2.3 Public Access Ways, Views, and Noise

Public access to coastal areas is provided at the endpoints of Ash, Holly, Elm, and Linden Avenues within the beach neighborhood in Reach 2 and at Carpinteria State Beach in Reaches 3 and 4. Conceptual design of the Project must consider a method to maintain beach access in these areas. A characteristic of coastal access within the beach neighborhood is the ease in which pedestrians can access beach areas directly from the roadways and the ample coastal viewshed provided to waterfront residences and businesses. Additionally, visitors and homeowners of beachfront property currently have front-door access directly to the beach. A concept dune system must consider methods to facilitate beach access for these populations, such as dune access pathways.

The City's winter berm program impacts public access ways and viewshed in favor of coastal erosion protection. The majority of beachfront properties lose direct access to the beach unless pedestrians climb over the berm. Viewsheds are greatly impacted in these areas, as the berm reaches heights several feet above the beach surface. Additionally, cobble material is often exposed during this period, which can be a difficult material for beach recreational activity. However, this program is seasonal, whereas the dune system would be in place year-round. Dune systems in this area would need to account for any impacts to coastal access and viewsheds at this location and ensure that recreational impacts from use of materials such as cobble are mitigated appropriately.

4.2.4 Utilities

Should utilities exist within a proposed project footprint, they must be managed appropriately to avoid significant impact and maintain function. Stormwater utilities infrastructure is largely set back from the coastline across all study reaches. The nearest sewer pipes and water mains are located along Avenue Del Mar in Reach 1 and Sandyland Road in Reach 2. Drop inlets, hydrants, and manholes are distributed throughout the beach neighborhood in Reach 2, though none are present west of Sandyland Road. Stormwater infrastructure along the coastline in Reaches 3 and 4 is limited to outfalls present at the Carpinteria Creek mouth. A sewer pipe also extends offshore of the creek mouth.

Oil wells were historically distributed near the coastline in Reaches 2, 3, and 4. Oil wells within the City are currently inactive and no longer present as they have been appropriately plugged and abandoned. The California Department of Conservation Division of Oil, Gas, and Geothermal Resources (DOGGR) holds data regarding historic and current wells. The data is viewable at: https://maps.conservation.ca.gov/doggr/wellfinder/#openModal/-119.50568/34.39427/14. Oil wells are not anticipated to pose a constraint to the Project because they are abandoned.

4.2.5 Coastal Structures

Coastal armoring is located at three sites within the Project area. Within Reach 1, rock revetment spans the full length of the shoreline, fronted by a narrow beach, and backed by the residential community. Within Reach 2, a short length of decorative retaining wall is present in front of the Carpinteria Shores development bordering Linden Avenue. Revetment armor is also present for a short length in Reach 4, fronting an RV campground area. Coastal armoring provides a hardened line that must be considered in Project conceptual design. Although armoring may present a barrier to certain Project designs, there is an opportunity to fold it into design to provide a last line of defense for protection of landside assets.

5. Feasibility

Variable factors affect the feasibility and success of a potential living shoreline project. They include a range of considerations listed and discussed below. New and different issues may arise during this process based on public input and project evolution. Overall, the feasibility is significantly determined on whether sufficient sand is available, affordable, and permittable to be placed at Carpinteria Beach, and whether it can be retained. To assess that, this section provides a reminder of what this feature needs to accomplish, followed by discussions of sand availability and affordability, permitability, and funding.

5.1 Example Project

First, however, a short description of a hypothetical living shoreline project is provided to serve as a "strawman" for the basis of evaluation. The actual design of the living shoreline project has not been initiated, but this example is likely to represent the proposal in a rough sense sufficiently to determine the feasibility of such actions at this site.

An example project is shown in Figure 5.1. The project will likely consist of:

- A living shoreline along Reach 2 from the end of the revetment at Reach 1 all the way to the northwestern terminus of the existing living shoreline at Reach 3 (1,670 feet long, up to 7 feet above the beach, and 40-feet base width estimated to be 20,000 cy in volume with 75% sand and 25% cobble for a toe and core);
- An improvement to the living shoreline along Reach 3 with non-natives removal and sand addition of 10,000 cy;
- A new living shoreline along a portion of Reach 4 (same dimensions as Reach 2 but only 700 feet long composed of 8,000 cy of material that is 75% sand and 25% cobble for a toe and core); and
- A beach nourishment along Reaches 1 and 2 at a minimum to provide for sufficient beach width to establish and sustain the living shoreline at Reaches 2, 3 and 4 (estimated to be 720,000 cy).

Although sand retention measures are recommended, they are likely the least firm components of a project due to their controversial nature and the uncertainty of their need. It may be possible to install pilot sand retention features that are removable if they cause an impact or that can be replaced with permanent features if they are successful. Beach renourishment frequency would be based on results of monitoring, but a rough estimate is decadal at a volume of 50% of the initial placement volume for 360,000 cy each event. It is possible that sand retention could reduce or possibly eliminate the need for renourishment except after major coastal storm wave events.

Figure 5.1. Example Living Shoreline Footprint Mainly Within Reach 2

5.2 Design Criteria

Some of the criteria for the design and function of a living shoreline in Carpinteria are listed below.

Design

- Develop design that will not compromise quality of nearshore reefs and rocky intertidal habitats.
- Determine appropriate vegetative cover and composition.
- Determine beach and dune dimensions needed for success.
- Assume episodic damage and repair/maintenance will be required for the beach and dunes and determine the target frequency of repair/maintenance of both (first suggestion is every 10 years).
- Assume wind or wave runup/overtopping transport of sand or cobble inland and periodic maintenance after storms to clear private property, and transportation and access routes.

Public and Private Access

- Maintain access by well-marked pathways from public access points at all four street ends (Ash, Holly, Elm, and Linden Avenues), as well as from multiple private pathways designated for beachfront residences.

Establish and Enhance Dune Habitat Areas for Biological Resources

- Determine appropriate mix of vegetation type, vegetation cover, and growth rates to sustain the living shoreline.
- Minimize damage or removal of native vegetation to maintain beneficial ecological functions and promote establishment of dunes.
- Establish dunes on native sand if feasible; if imported sand must be used it should match the native grain size and be free of excessive fines (i.e., < 3% silt and clay combined)
- Temporarily stabilize sand while plants are establishing

5.3 Feasibility of a Living Shoreline in Carpinteria

The considerations for the feasibility of a living shoreline consist of whether the project:

- Can be constructed;
- Is resilient;
- Is affordable;
- Is permittable; and
- Can be accepted by the public.

Each consideration is addressed below.

5.3.1 Constructability

A living shoreline at Reaches 2, 3, and 4 is able to be physically constructed due the area available seaward of the homes and the private beach line. Although narrow, a living shoreline could be built without widening the beach. However, its resilience would be minimal, and it would likely be damaged frequently and require extensive maintenance, especially as sea level rises. Widening the beach through nourishment will render the Project more resilient and long-lasting and, therefore, less vulnerable to damage and the need for repair.

The availability of sand sources is a key issue to building a nourishment and dune project. Sand exists within the area, but the volume needed to build this Project in one phase according to the preliminary design is questionable. Sand sources are addressed below in general. More detailed searches for sand should occur during Project design.

Several potential sediment sources have been identified for placement at the Ash Avenue area specifically, including flood control debris basins, sediment from rivers, creeks, sloughs, and marshes, sediment from landslides, and other sources such as upland construction or offshore sources (Figure 5.2, BEACON 2009). Potential available material volumes are listed in Table 5.1. Although dated, this basic information still applies and can be researched in more detail as needed in the design process. Due to the sand quantity needed for the entire Project, it is likely that sand from the Santa Barbara harbor and from offshore using a dredge may be required. Renourishment may be possible using smaller upland sources, depending on the level of maintenance needed.

Table 5.1. Potential Sediment Sources and Estimated Volumes from BEACON (2001)

Potential Sand Sources	Transport Method	Capacity (cy)
Flood Control Debris Basins	Truck	125,000*
Carpinteria Marsh	Dredge/Truck/Conveyor	10,000 – 40,000**
Caltrans Landslide Material	Truck/Rail	10,000 – 100,000***
Offshore Sand Deposit	Dredge	Millions
Santa Barbara Harbor, West Beach	Dredge and/or Truck	250,000

**Debris basin capacity multiplied by 20% (the percent of material believed to be of beach quality).*
***Historic dredge volume, projected every 3 to 4 years, varying according to weather conditions.*
****Average yearly volume.*

Construction access for equipment is available at each reach envisioned for a living shoreline. Construction can be done using conventional construction equipment such as trucks, scrapers, earthmovers, bulldozers, front end loaders, and possible other items.

The timing of construction would likely be in the off-season beach use period, such as from Fall through Spring, avoiding spring break weeks.

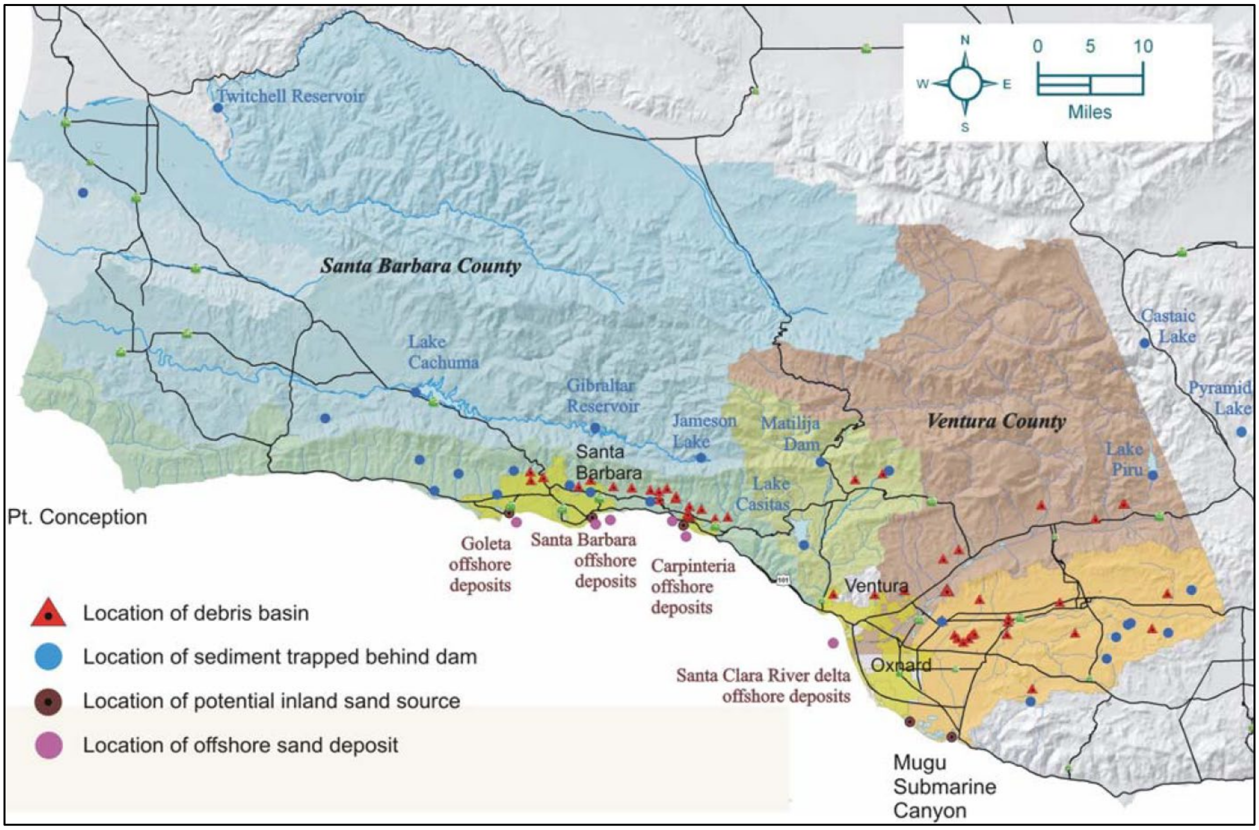

Figure 5.2. Regional Sediment Sources (BEACON 2009)

5.3.2 Resilience

Resilience is being defined as the time period over which the dune and beach system can naturally erode and repair itself while limiting coastal flooding of built areas. Project resilience will be greatest in the near-term at existing sea level, and then would likely decrease over time as sea level rises. Assuming the Project can be built in year 2025, existing conditions should dictate its design. If project construction occurs later, future predicted conditions will become more influential in the design. A project built in 2025 should be resilient to the year 2050 and protect infrastructure from flooding if the beach fronting the dune is sufficiently wide (e.g., 250-feet-wide). This 250-foot beach width stipulation is arbitrary but was applied by Dr. Craig Everts as a rule of thumb in southern California for sufficient protection from the 100-year storm wave event (SANDAG 1993).

Assuming longshore transport of sand continues at the current rate, the beach will also gradually rise and retreat at the same rate as sea level gradually rises. That phenomenon is called the Bruun rule, developed by Per Bruun in 1962 (Bruun 1962). As the beach retreats, dunes will also retreat at the same rate. If sufficient beach width can be maintained along Reaches 2, 3, and 4, the dunes will not need to retreat. Beach nourishment and sand retention will be key to maintaining beach width as sea level rises. Further, the frequency and/or volume of nourishment will have to increase as sea levels rise. Therefore, the rate of renourishment, assumed to be decadal at this writing, may need to become more frequent or more voluminous over time.

At some point in the SLR curve, the cost of maintaining the beach and dunes may become too great or flooding in the City may occur via other pathways (e.g., from the salt marsh or due to rising groundwater). Before that point, the City will need to make decisions on other approaches to handling the coastal flooding problem. In other words, the living shoreline's useful lifespan is not unlimited. However, different initial designs will present a trade-off between Project resilience and initial costs. For example, the combination of an engineered cobble-core dune with a nourished beach and sand retention structures will be among the most expensive projects to build but will provide more resilience (and less maintenance) than nourishment alone.

Sand retention with structures can increase project resilience by holding an artificially wide beach and should be considered. A common form of sand retention structure is a groin, a shore-perpendicular structure designed to trap sediment that would normally move downcoast. Structures can be built from a variety of materials, including rock material or sheetpile walls. Sand is placed upcoast of the retention structure to create the sand deposit that would form naturally. Once filled, the sand on the upcoast side of a groin forms a "fillet", widening beaches and mitigating potential impacts from erosion and wave hazards. An example of this process can be seen in Ventura, CA at Ventura Beach where a field of seven groins retain sand upcoast, maintaining a wide beach capable of supporting coastal strand and dune habitat (Figure 5.3).

Figure 5.3. Groin at Ventura Beach Showing Upcoast Sand Retention & Back Beach Dune System (California Coastal Records Project)

Nearshore reef construction or headlands can also be used as a means to retain sediment on-site or in addition to a groin structure. The concept behind reef or headland construction is to dissipate wave energy offshore of the project area, thereby reducing erosive forces at the Project site, promoting beach widening, and potentially delivering recreational benefits such as improved surf conditions. As with a groin, nearshore reefs can be constructed from materials that are compatible with surrounding ecosystems, though larger size rocky material is generally needed to withstand offshore wave energy impacts. Reef structures can also be modified over time to further increase sand retention functions. They typically require a very large footprint and, therefore, are costly.

Sand retention structures have been difficult to permit in recent past, with the primary disapproval coming from the CCC who often deems such projects in conflict with the Coastal Act of 1972. Key issues that tend to arise surround the impediment of sediment for the benefit of one area to the detriment of another. While a groin will promote beach growth upstream, the downstream end can suffer from erosion if not addressed in the design and construction to mitigate the impact. Project design can minimize these impacts by over-nourishing (i.e., pre-filling) the project site following groin construction to promote sand transport downcoast or installing a low elevation and short length groin, which allows sediment to pass once a certain beach width is obtained upcoast. Recent research has identified groins as an effective SLR adaptation measure (Griggs et. al. 2020), which stated:

> *While groins have been generally discouraged in recent decades in California, and there are important engineering and environmental considerations involved prior to any groin construction, the potential benefits are quite large for the intensively used beaches and growing population of southern California, particularly in light of predicted sea-level rise and public beach loss. Stabilizing and widening the beaches would add valuable recreational area, support beach ecology, provide a buffer for back beach infrastructure or development, and slow the impacts of a rising sea level. All things considered, in many areas groins or groin fields may well meet the objectives of the California Coastal Act, which governs coastal land-use decisions.*

5.4 Affordability

This Project may be a combined living shoreline and beach nourishment effort. Projects along the coast are expensive and can be challenging for relative agencies to afford. Carpinteria will need assistance in funding this Project. A gross estimate of the Project cost ranges from $15,000,000 to $20,000,000 due to the large volume of sand needed and the distance to large marine sand sources. Decadal renourishment may cost nearly 50% to 75% of this initial cost due to the same factors, and sand retention can further add to that cost. Cost-sharing with the State, federal government, and other agencies will significantly help the City to afford this capital outlay.

A strategy might be to seek funding through the USACE if the Feasibility Study appears to justify a project. The other large historic source of funding has been the State Department of Boating and Waterways (DBAW), which was succumbed by the State Parks Department (Parks). DBAW funded many large beach nourishment projects as appropriations with the Boater's Gas Tax under the Shoreline Erosion Program. That program is now run by State Park's and has not funded the same level of work along the coast. Lobbying the State to reinitiate funding for beach nourishment could be a productive use of local political assets. The City should consider teaming with BEACON, the State, and the Feds, if possible, to fund the ultimate project. Otherwise, the City needs to apply for the host of other funds being advertised by various agencies. Examples of opportunities are below.

Funds necessary to implement a living shoreline project are variable depending on specific design and construction requirements. Past project costs in southern California have ranged from $100,000 to $200,000 per acre of shoreline for implementation (California State Coastal Conservancy 2018). Additional maintenance costs are also required, typically in the range of $10,000 per year without the inclusion of labor for dune maintenance (California Natural Resources Agency 2018). However, the most recent project at Cardiff in Encinitas cost nearly $700,000 per acre ($2,700,000 over 4 acres), and that project had the benefit of a 300,000-cy beach nourishment project immediately seaward of it at no cost.

Therefore, the Carpinteria living shoreline may cost more than would be expected, depending on design and materials, and even more if significant beach nourishment is required as is assumed in this study. There may be tradeoffs between naturally functioning wide systems such as Surfers Point (with low or no maintenance) and narrower beach and dune systems such as Carpinteria City Beach that may not be self-repairing in some years (i.e., more maintenance)

While initial implementation and ongoing maintenance costs may be significant, use of living shorelines as a coastal protection strategy has risen in popularity in recent years due to the potential for multiple benefits to surrounding coastal communities and ecosystems. State agencies such as the California State Coastal Conservancy, CCC, and California Natural Resources Agency have provided funding for past living shorelines projects. Agencies such as Caltrans have also supported living shorelines projects as a means to protect transportation infrastructure from coastal hazards over time. Federal funding opportunities are also available through agencies such as the NOAA and the National Fish and Wildlife Foundation (NFWF). An example of grant opportunities at the State and federal level are provided below.

California State Coastal Conservancy: Climate Ready Program

- Seeks to support multi-benefit projects that utilize natural systems to help communities adapt to climate change.
- Recent focus on natural shoreline infrastructure strategies.
- Relevant focus areas and priorities:
    - SLR adaptation planning.
    - Use of nature-based solutions that provide co-benefits to people, wildlife, and the economy.
    - Support of on-the-ground demonstration projects that implement innovative approaches or enhance understanding of effective coastal management strategies.

California State Coastal Conservancy and Ocean Protection Council: Proposition 1

- Proposition 1 allocated $100 million to the SCC for multi-benefit ecosystem and watershed protection and restoration projects, such as those that assist communities to adapt to the impacts of climate change and SLR.
- Award amounts have varied from $49,000 to $2 million.
- Funding may be provided for planning, construction, or implementation of projects in the following relevant focus areas:
    - Habitat Enhancement
    - Restoration
    - Urban Greening
    - Water Sustainability

California State Coastal Conservancy and Ocean Protection Council: Proposition 68

- Proposition allocated $204.8 million to the SCC. Proposals are solicited for a wide variety of projects. Recent solicitations have prioritized in the following areas:
    - Local and Regional planning and coordination
    - Nature-based solutions to build coastal resiliency
    - Socio-economic Impact of Sea Level Rise

- Project types that may be funded have included:
  - Community capacity building, technical assistance, and planning
  - Project site assessment and preliminary design
  - Project final design and permitting
  - Construction, monitoring, and adaptive management
- Project awards typically range between $100,000 and $2,000,000.

California Department of Boating and Waterways: Public Beach Restoration and Shoreline Erosion Control Program Grants

- Public beach restoration is focused exclusively on "the planning and construction of engineered placement of sand on the beach or in the nearshore environment."
- Shoreline Erosion Control Program is developed to "assist in the planning and construction of all types of beach erosion control and shoreline stabilization measures, including hard structures like seawalls."
- Threshold requirements to apply for grants include, but are not limited to:
  - Applicants must include 15% local funding match, either monetarily or in-kind contribution;
  - Projects must be fully funded;
  - Grants must be fully encumbered and utilized within three years of award;
  - Applications must be limited to one phase (planning or implementation);
  - The project area must be publicly owned; and
  - Routine shoreline monitoring and maintenance projects are not eligible.

National Fish and Wildlife Foundation: National Coastal Resilience Fund

- Seeks to restore, increase, and strengthen natural infrastructure to protect coastal communities while enhancing habitat for fish and wildlife.
- Invests in projects that restore or expand natural features including dune and beach systems.
- Relevant focus areas and priorities:
  - Implementation of design-ready restoration projects that enhance resilience and reduce threat risk.
  - Project site assessment, design, and permitting in at-risk communities to position them for future implementation.
  - Projects that demonstrate the effectiveness of innovative approaches to enhance coastal resilience with natural infrastructure

National Oceanographic and Atmospheric Administration: Coastal Resilience Grants Program

- Funds aim to help coastal communities and ecosystems prepare for and recover from extreme weather events, protect property, improve public safety, reduce damage to infrastructure, and benefit ecosystems and the economy.
- The stated objective is to increase the resilience of U.S. coastal communities and ecosystems through environmental and socioeconomic benefits. Supported local actions explicitly include nature and nature-based infrastructure, including dunes.
- All projects are required to match federal funding with a 1:2 ratio.

5.5 Permitability

The Project can be permitted given sufficient time and resources. This Project will require permits or determinations from several resource agencies. The anticipated permits for a living shoreline and beach nourishment project are summarized in Table 5.2. Projects would also have to meet requirements of both the California Environmental Quality Act and National Environmental Policy Act.

It is important to get buy-in early on from resource agencies. This can take the form of targeted meetings with individuals who are anticipated to play an important role later in the process. The approach in such meetings would begin with a sound vision from the City and anticipating common concerns of each agency. Additionally, a partnership with the County Flood Control District and/or BEACON would enhance the ability to secure the necessary permits, as such agencies have established protocols in the region.

Table 5.2. Living Shoreline and Nourishment Permitting and Actions – Resource Agency Checklist

Resource Agency	**Permit**
Federal	
U.S. Army Corps of Engineers (USACE)	• Permit under Section 404 of the Clean Water Act, 33 USC Section 1344 • Section 10 of the River and Harbors Act of 1899, 33 USC Section 403
State	
Central Coast Regional Water Quality Control Board (RWQCB)	• Water Quality Certification under Section 401 of the Clean Water Act
California Coastal Commission (CCC)	• Coastal Development Permit (CDP)
California State Lands Commission (SLC)	• Lease of State Lands
California State Parks (CSP)	• Memorandum of Agreement (MOA) ○ Should the project footprint occur within CSP jurisdiction, a MOA may be required to permit construction and maintenance activities. • Right of Entry Permit ○ May be required for access to CSP land for construction and maintenance activities.
Regional/Local	
City of Carpinteria	• Encroachment and Grading Permits • LCP Coastal Development Permit • Noise Variance or Exemption Letter
County of Santa Barbara	• Encroachment and Grading Permits for work in Reach 1 • Noise Variance or Exemption Letter

5.6 Acceptance by the Public

The acceptability of a project by the public is difficult to assess. Public sentiment may be mixed with feelings of wanting to be protected from flooding and feelings that the status quo of building a winter dike is sufficient. Sentiments may vary but be less supportive until local ocean water levels show definitive increases. Thus far, SLR has remained more of an abstract concept rather than a tangible reality for many residents due to its less than obvious presence at this time. Severe coastal flooding has not occurred since the 1988 storm, and even more prominent since the 1982/82 El Niño event. If a significant El Niño winter threatens property, local feelings may be more supportive.

The local stakeholders have shown support for the Project thus far. It will be important for the City to be able to continue to garner public support at every step to maintain a sufficient level of public support to implement the Project. The issues that may raise public questions may be related to views, access, costs, and other potential concerns. Keeping these issues at the forefront of planning and analyses during the Project design and reporting will help secure a supportive position of the public that can be used to apply political pressure on funding agencies.

6. Conclusions and Next Steps

6.1 Conclusions

The Carpinteria Dune and Shoreline Management Plan is a significant step for the City to adapt to ongoing coastal erosion and projected SLR vulnerability. Coastal flooding problems exist along the beach neighborhood and also occurs farther inland adjacent to Carpinteria Marsh at Ash Avenue and 3rd Street. Both conditions warrant attention for solutions. Carpinteria concluded in their SLRVAAP and General Plan that a living shoreline may be worth considering for solving coastal flooding problems for current sea level and one to two feet of SLR.

The City has initiated this study of a living shoreline for its appropriateness to protect the coast. Living shorelines are generally "green" features composed of sand, potentially cobble/rocks, and vegetation that can self-repair after storms and with SLR. This study evaluates the entire City coastline subdivided by individual reaches and considers problems, constraints, possible solutions, and feasibility of an approach to protection.

Certain advantages or opportunities exist to support the Project. A natural dune system that acts as a living shoreline presently exists along portions of the State Beach site and has to date naturally eroded and re-built itself while protecting inland areas from flooding. A winter dike is constructed along the beach neighborhood each year to successfully protect the area from coastal flooding, indicating functional success and neighborhood acceptance. Other living shorelines have been constructed in the region and serve to inform the design of any new living shoreline in Carpinteria. Also, sand sources appear to be available to construct the Project, beach nourishment has occurred in the past at the City Beach as a precedent, and recently there has been regained interest in sand retention strategies by Coastal Commission staff as a SLR adaptation measure.

Natural and anthropogenic constraints were evaluated with regard to the Project. Constraints considered are listed below.

Natural Constraints

- Biological and Environmental Resources – The mouths of Carpinteria Salt Marsh and Carpinteria Creek present constraints as they cannot be impacted from their existing condition. Fish passage conditions need to be maintained at both sites and wetland habitats preserved. An offshore reef exists west of Reach 1 that is sensitive to shoaling and/or turbidity, and nearshore/intertidal hardbottom habitat exists in Reaches 3 and 4, with one area in Reach 4 serving as a regional monitoring site for the California Department of Fish and Wildlife (CDFW).
- Topography – Reach 1 (Sandyland) has a beach that is too narrow to sustain a living shoreline, and nourishment would only temporarily widen that beach, thus precluding a living shoreline option. Reach 2 (beach neighborhood) is suited for a living shoreline; however, it would need significant beach nourishment to be sustainable. Reach 3 (State Park) is well-suited for dunes but Carpinteria Creek mouth cannot be impacted by the Project. Reach 4 is not well-suited for dunes along the bluffs; however, a short sub-reach fronting the State campground would be a logical site for a living shoreline.
- Sand Supply – Natural sand supply to the Project area may not be sufficient to provide conditions suitable for a resilient living shoreline project along the City beach. This is due to sand supply

reductions imposed by Santa Barbara Harbor and by the upstream flood control infrastructure. Accomplishing this Project would require intervention by man to nourish the beach and install a living shoreline.

Anthropogenic Constraints

- Land Ownership
  - Reach 2 – Within the beach neighborhood, privately owned parcels extend approximately 30 feet into the Carpinteria City Beach, encompassing a back beach area under the category of Private Beach. As a dune system would be preferably constructed along the back beach, the dune could be proposed at the landward edge of the Public Beach, in the approximate location of the current winter berm project, in order to avoid conflict with ownership boundaries. It is imperative that dune system construction join or follow a beach nourishment project in order to ensure a sufficiently wide beach is present.
  - Reaches 3 and 4 – The City holds jurisdiction over these reaches; however, the State Beach land ownership may overlap with the ideal location for a proposed dune project. Coordination with the State would be required to ensure all parties are agreeable to and invested in the Project and its goals.
- Public Access Ways, Viewshed, and Noise
  - Reach 2 –The living shoreline crest elevation needs to account for views and be set to not block views to the extent feasible. In some circumstances, that may not be possible. The design also needs to include several public access ways through the dune system, as has been done at virtually all living shoreline projects in southern California. Additionally, dune crest elevations would require a balance between wave runup and overtopping, SLR protection, and views. The dune crest elevation may need vary along the beach neighborhood in order to attain this balance. In the western boundary of the beach neighborhood, where residences are at their lowest elevations, the dune crest may need to be lowered and width increased to maintain a sufficient level of protection while reducing viewshed impacts.
- Utilities – Utility lines do not appear to be a problem or constraint to the Project at this time, but utility maps should be included on plans for the living shoreline to inform design by maintaining distance from construction.
- Coastal Structures - Coastal armoring exists in nominal quantities in Reach 4, with a short reach of decorative wall in Reach 2, which must be considered in Project conceptual design. Neither presents a constraint to the project.

Feasibility

The living shoreline project at Reaches 2, 3, and 4 is feasible, but with certain caveats. It is constructible but will require significant resources and material (sand and maybe cobble) supplies. Construction access exists and conditions are suitable for conventional equipment, but it will disturb residents and should be done in the non-peak beach use season. The resilience of the Project depends on its protection from damaging ocean conditions and the ability to self-repair or be maintained after damage, and to adapt to SLR. The best way to accomplish these conditions is to nourish the beach and retain the sand to the greatest extent. Thus, beach nourishment and potentially sand retention should be considered as Project components. This Project will be expensive, upwards of $20 million, and will, therefore, need a team effort for funding from all levels of government and whatever funds may exist. The City should partner with locals (BEACON), the State, and Federal government to fund the Project. Permits can be secured from the agencies with jurisdiction over the Project, but the effort will be significant if sand retention is included. Partnering with other agencies should help to bolster support as a coalition. Garnering public support is also critical and can make or break a project. Public acceptance is a key Project component.

6.2 Next Steps

The next steps of the Project are to: (1) develop preliminary dune and shoreline concepts to be modeled and summarized in the Carpinteria Dune Coastal Hazards Modeling Report; and (2) identify a preferred concept to carry to preliminary (30%) design and assessment in the Conceptual Living Shoreline Design Memorandum. Along with this Constraints and Feasibility Report, the subsequent -dune design and analyses tasks of this project will support the development of the Final Dune and Shoreline Management Plan.

Public outreach and stakeholder support is also critical to continue through Project conception. Regular meetings with both stakeholders and the public are necessary to see the concept through to completion.

Finally, preparation of a funding strategy would be useful in identifying sources to fund all future work. That future work would include:

1. A search for ocean-derived sand deposit(s) for mining to build and maintain the Project;
2. Environmental review to meet State and Federal guidelines;
3. Permitting;
4. Pre-construction monitoring of the shoreline;
5. Final engineering for construction;
6. Construction;
7. Post-construction monitoring; and
8. Repair and maintenance.

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