Attachment 1

Coastal Resilience Master Plan - DRAFT

The Coastal Resilience Master Plan is made possible through grants from the National Fish and Wildlife Foundation and California State Coastal Conservancy.

June 2025

The City *of* SAN DIEGO

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Climate Resilient San Diego

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Glossary

Adaptation	"Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which minimizes harm or takes advantage of beneficial opportunities" (CCC 2024).
Adaptive Capacity	"The ability of a system to respond to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, and to cope with the consequences" (CCC 2024; Willows and Connell 2003).
Assets	People, resources, ecosystems, infrastructure and the services they provide. Assets are the tangible and intangible things people or communities value" (U.S. Climate Resilience Toolkit 2021).
Berm	A raised bank or terraced embankment used for erosion control and flood protection.
Consequence	The effect of climate change exposure on community structures, functions and populations and on the asset owner or service providers' ability to maintain a standard condition or level of service (sometimes referred to as impacts) (CEMA and CNRA 2012).
Exposure	"The presence of people, infrastructure, natural systems, and economic, cultural, and social resources in areas that are subject to harm" (Bedsworth et al. 2018; IPCC 2012).
Extreme Events	The frequency of extreme events refers to how often these events occur over a certain time period. This frequency is usually described based on historical observations or return periods. For example, a 100-year event has a 1 in 100 (or 1 percent) chance of occurring in any given year.
Groin	A purpose-built structure used to protect a shoreline from coastal erosion by retaining sand.
Hard (Gray) Infrastructure	Engineered structures that typically rely on concrete, steel, and other human-made materials, focusing on control and mitigation of natural processes rather than working with them.
Hazard	"An event or condition that may cause injury, illness, or death to people or damage to assets" (U.S. Climate Resilience Toolkit 2021).

Impact	"Effects on natural and human systems that result from hazards" (U.S. Climate Resilience Toolkit 2021).
Indigenous Knowledge	Traditional tribal knowledge for the protection, management and monitoring of tribal cultural resources.
Nature-Based Solutions	Sustainable planning, design, environmental management, and engineering practices that incorporate or mimic natural features or processes into the built environment to promote climate adaptation and resilience (FEMA 2024a).
Outfalls	Where stormwater and wastewater are discharged into bodies of water.
Resilience	"The capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from a disruption" (U.S. Climate Resilience Toolkit 2021).
Risk	The potential consequences if an asset, resource or community is damaged or lost, considered together with the likelihood of that loss occurring.
Sensitivity	"The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., climatic or non-climatic stressors may cause people to be more sensitive to additional extreme conditions from climate change than they would be in the absence of these stressors)" (CCC 2024).
Vulnerability	"The extent to which a species, habitat, ecosystem, or human system is susceptible to harm from climate change impacts. More specifically, the degree to which a system is exposed to, susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, as well as of non-climatic characteristics of the system, including its sensitivity, and its coping and adaptive capacity" (CCC 2024).
Wave Runup	The height above stillwater elevation reached by a wave along a beach or structure (FEMA 2023). This is typically the highest elevation along the shoreline that the wave reaches.

Executive Summary

The City of San Diego (City) contains over 17 miles of biologically rich coastline, is home to over one million people, and has a dynamic economy concentrated in trade, tourism and military. Climate change increasingly puts the City and its critical built and natural resources at risk of coastal flooding and erosion due to sea level rise and other potentially erosive factors such as extreme precipitation events. In anticipation of this threat, the City has prepared a Coastal Resilience Master Plan (CRMP) to identify specific resilience and conservation needs along the coastline and develop a portfolio of nature-based solutions to promote resilience and protect critical coastal habitats.

The City is committed to building a climate resilient San Diego to protect its community members, infrastructure and natural resources from climate change impacts, including sea level rise. Sea level in San Diego is expected to rise five to fourteen times faster over the course of this century than it did in the previous century, leading to risks of increased flooding and coastal erosion.

San Diego's coastal environment contains many of the City's most appreciated natural resources, including beaches, bays, shoreline, coastal canyons and many rivers, streams and other watercourses. Coastal habitats are also home to many protected and vulnerable plant and animal species who contribute to the region's biodiversity. Additionally, the San Diego coastline provides incredible recreation value for the region and supports both tourism and marine-related industries. Planning for a resilient coastline is vital to ensuring that our coast continues to be a resource for all San Diegans for generations to come.

The CRMP is one component of planning for a resilient coast. Through community and stakeholder engagement, project concepts for six locations along the City's coastline have been developed that will help mitigate risks of sea level rise while supporting coastal habitats, recreation opportunities, coastal access and protecting historic and cultural resources. As these project concepts move forward toward implementation, continued community and stakeholder engagement will help to refine the project concepts, raise awareness of climate change risk and adaptation opportunities and build a shared vision for our coast's future.

Photo by GHD

Photo by GHD

Plan Context and Background

Climate Resilient SD

Through the City's Climate Action Plan, the City is taking steps toward a more sustainable future through programs and policies to reduce the City's greenhouse gas emissions (City of San Diego 2022a). However, even with these efforts, the impacts of climate change are already being felt. San Diego is experiencing more frequent and intense heatwaves, increased wildfire risk, coastal flooding and erosion and more unpredictable and intense rain events.

These hazards impact San Diegans and our economy, infrastructure and the natural environment. The City has taken steps to mitigate these impacts to preserve the natural diversity of our region and to improve residents' quality of life through existing plans, programs and projects. To further address these hazards and improve quality of life, the San Diego City Council adopted the City's first-ever climate adaptation and resilience plan, Climate Resilient SD (City of San Diego 2024a). Climate Resilient SD is the City's comprehensive plan to prepare for, respond to and recover from climate change-related impacts and improve local communities. Climate Resilient SD is a key first step, but there is still much work to be done and there is a role for each of us in building a more resilient future.

Climate Resilient SD addresses the four primary climate change-related hazards for the City: extreme heat, extreme rainfall or drought, wildfires and sea level rise. The plan includes a suite of goals, policies and strategies to minimize risk and increase the resilience of San Diego's people, assets, economy and natural resources to climate change. The five main goals of Climate Resilient SD are:

1. Ensure communities are connected and informed to be best prepared for climate change.
2. Plan for and build a resilient and equitable city.
3. Safeguard, preserve and protect historic and Tribal Cultural Resources from the effects of climate change.
4. Support and prioritize thriving natural environments and enhance adaptability.
5. Maintain and ensure minimal disruption to all critical City services in the face of climate change hazards.

The climate adaptation strategies within the plan focus on increasing the City's capacity to bounce back, and forward, after a climate event. As the City implements these strategies, continued engagement with the community will support a shared vision for a resilient San Diego.

Within Climate Resilient SD, Policy TNE-3, calls for prioritizing the implementation of nature-based climate change solutions wherever feasible. The Coastal Resilience Master Plan (CRMP) is a strategy under this policy that would "identify locations for implementation of nature-based solutions to mitigate coastal flooding and erosion, improve coastal resiliency, protect habitat and increase recreational opportunities for residents and visitors."

Nature-based solutions are prioritized in Climate Resilient SD and in the CRMP, both for the multiple benefits they provide to the community, but also based upon public feedback. In a public survey for Climate Resilient SD, nature-based solutions were identified as the strong preference for coastal resilience approaches and over 89 percent of respondents supported the softer strategies (nature-based solutions) to harder strategies (traditional engineering) (Figure 1).

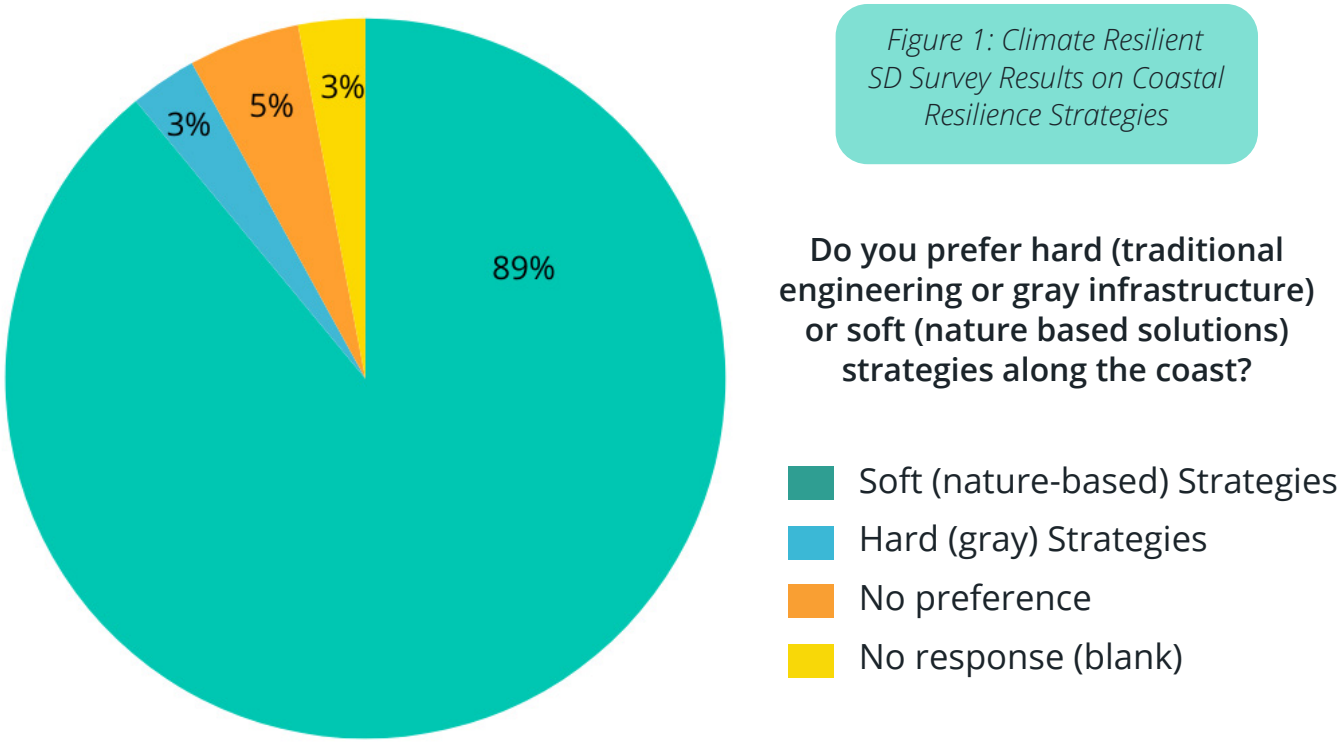


Figure 1: Climate Resilient SD Survey Results on Coastal Resilience Strategies

Supporting Climate Plans and Assessments

The City has completed multiple assessments to evaluate the current conditions of coastal resources and their vulnerability to sea level rise including Coastal Erosion Assessments, State Lands Sea Level Rise Vulnerability Assessment, Sea Level Rise Vulnerability Assessment and the Citywide Climate Change Vulnerability Assessment. These documents assess the current and potential future impacts of coastal flooding and erosion due to sea level rise. These technical documents helped inform the development of nature-based coastal resilience projects for the CRMP, including site selection and prioritization. While these studies focused more on City assets, infrastructure and the environment, Climate Resilient SD recognizes the importance of centering people in implementation of adaptation and resilience strategies.

Coastal Erosion Assessments

The City has completed multiple Coastal Erosion Assessments to better understand current conditions, anticipate future coastal erosion and assess long-term rates of cliff retreat. The City completed an assessment in 1993, 2003 and most recently, a Coastal Erosion Assessment Photograph Analysis Update in September 2018. Each assessment monitors 71 coastal sites along the City's 17-mile shoreline. These sites include bluff-top linear parks, bluff-top streets parallel to the coastal bluff and City streets that end at the bluff edge. The 2018 assessment includes photographs, risk ratings and site notes to help the City identify and prioritize coastal locations for remediation.

Over the 15-year period between assessments (2003–2018), erosion appears to have affected several pedestrian coastal access ways and staircases, bluffs and sea caves. The 2018 assessment rated 71 sites (City of San Diego 2003, 2018). Out of the 71 sites rated, 6 percent ranked with no rating, 55 percent ranked as low priority, 18 percent ranked as moderate priority and 21 percent ranked as high priority, with higher priority rankings reflecting greater pedestrian hazards and signs of potential bluff collapse. The recommendations from the 2018 assessment included establishment of a photo analysis update at least every 10 years, exploration of alternative data collection methods (e.g., citizen science photo submission) and prioritization of a technical analysis from which site level erosion and site management conclusions can be drawn (e.g., LiDAR remote sensing).

State Lands Sea Level Rise Vulnerability Assessment

The City's State Lands Sea Level Rise Vulnerability Assessment, which was completed in July 2019, assessed impacts to the City's granted lands in compliance with California Assembly Bill 691 (City of San Diego 2019a). In the report, the City analyzed the risks that sea level rise, storm surge and coastal erosion pose to City assets and public trust resources, such as parks, coastal habitats and coastal access points, located within granted public trust lands in San Diego. Through this assessment, the City identified the vulnerabilities of City assets and public trust resources and facilities, considered replacement or repair costs and assessed the impact to non-market values, such as ecosystem services, for the years 2030, 2050 and 2100.

Sea Level Rise Vulnerability Assessment

The City completed a Sea Level Rise Vulnerability Assessment in December 2019 (City of San Diego 2019b). This assessment analyzed the vulnerability of critical built, natural and cultural assets to coastal hazards, including sea level rise, storm surge and coastal erosion. Vulnerability was scored using exposure, sensitivity and adaptive capacity as determining factors. The assessment addressed vulnerabilities by City asset type for public safety assets (e.g., lifeguard stations), water and wastewater assets (e.g., pipes, pump stations), transportation and stormwater assets (e.g., bridges, outfalls), historic and tribal cultural resources, open space and environmental assets (e.g., recreation centers, parks, beaches) and other City assets (e.g., libraries).

Citywide Climate Change Vulnerability Assessment

The Citywide Climate Change Vulnerability Assessment, completed in February 2020, included the findings of the previously completed sea level rise vulnerability assessments but expanded the analysis to include consideration for wildfire, changes in precipitation and extreme heat events (City of San Diego 2020). The assessment evaluated critical City assets and resources (e.g., public safety, water, transportation, stormwater, open space and environment) for vulnerability-based exposure of each asset type to each climate change hazard and analyzed the sensitivity and adaptive capacity of each asset type. This assessment found many City assets and resources to be highly vulnerable to sea level rise, including: conservation areas and open space, beaches, lifeguard stations, community parks, recreation centers, drain pump stations and outfalls, bridges and major arterials and historical, tribal cultural and archaeological resources.

Other City Coastal Resilience Initiatives

The City is also leading and participating in additional coastal resilience initiatives including but not limited to the following:

Chollas Creek Watershed Regional Park Master Plan

The Chollas Creek Watershed is a vital natural resource encompassing a network of water channels, parks and surrounding open space. The watershed stretches across the neighborhoods of City Heights, Eastern Area, Encanto, Southeastern San Diego, Barrio Logan, Greater Golden Hill, North Park and Normal Heights. The watershed plays a crucial role in maintaining the region's ecological balance and providing essential habitat for numerous plant and animal species as well as providing opportunities for community-serving recreation. The Chollas Creek Regional Park Master Plan will be a long-term planning document developed by the City of San Diego in partnership with various stakeholders and community members to guide the sustainable future of Chollas Creek Watershed as a regional park (City of San Diego 2024b). The goals of the plan are to protect and enhance the Chollas Creek Watershed's ecology; improve the watershed's sustainability and resilience to the impacts of climate change; increase recreational opportunities; improve walking/rolling and biking within the watershed and adjacent to neighborhoods; and foster a sense of ownership and connection to the creek among community members.

De Anza Natural

De Anza Natural is the De Anza Cove Amendment to the Mission Bay Park Master Plan (City of San Diego 2024c). De Anza Natural aims to expand wetlands for habitat, public enjoyment, climate resilience and water quality benefits; create an iconic recreation destination that maximizes the benefit offered to the region by this waterfront amenity; provide for the highest and best use of the project area to serve the needs of a broad range of local and regional users; and identify a mix of uses that will provide sustainable revenue generating leaseholds for the City. De Anza Natural envisions enhanced recreational activities with new facilities, such as a multi-use waterfront trail and a small non-motorized boat lease area for the cove. The plan also includes space for low-cost visitor accommodations including camping and recreational vehicle facilities accessible to Mission Bay Park visitors, and it proposes an interpretive nature center. These spaces, set amid expanded and restored coastal wetlands, would provide new opportunities for eco-tourism and environmental education. The City is currently seeking approval of the Master Plan Amendment from the California Coastal Commission.

Land Development Code Updates

The Land Development Code contains regulations for the development and use of property, including zoning, subdivisions and other related land use activities. The City Planning Department monitors and continually updates the code to simplify and streamline the permitting processes, assure compliance with state and federal regulations, eliminate unnecessary barriers and align land use and development regulations with the City's climate, equity and housing goals. Recent updates include regulations for development within the Coastal Zone and in areas of future sea level rise (City of San Diego 2024d).

Los Peñasquitos Lagoon Restoration

The goal of the Los Peñasquitos Lagoon Restoration project is to restore historical salt marsh in the lagoon, while also addressing sediment, trash, invasive species and flood attenuation (City of San Diego 2024e). It also includes freshwater management to improve the sustainability of the restored salt marsh and overall health of the lagoon. Phase 1 of the project restores the area southwest of the railroad berm and provides guidance for restoration planned under Phase 2 using an adaptive management approach. Phase 1 scope includes floodplain enhancements, improved storm drain infrastructure and restoration of approximately 146 acres of salt marsh.

The City of San Diego has prepared a draft addendum to the Los Peñasquitos Lagoon Enhancement Plan Final Environmental Impact Report for Phase 1 of the project. After the addendum is finalized, there will be further opportunities for public participation, including during the consideration of the site development permit and resource agency permitting.

Mission Beach Seawall Improvement Feasibility Study Preliminary Engineering Report

The Mission Bay Park 'Ten-Year Plan' identifies a list of priority projects, including navigational and safety dredging, wetlands and water quality improvements, shoreline protection, expansion of preserves and habitat and park facility improvements. To effectively and holistically analyze these projects and their associated environmental impacts, a Programmatic Environmental Impact Report is being developed with the primary goal of streamlining future environmental and permitting review and engaging the public to solicit community input throughout the process. Priority projects included in this effort include restoration of navigable waters and elimination of navigable hazards, wetland expansion, water quality improvements, protection and expansion of eelgrass beds, restoration of shoreline treatments, expansion of endangered or threatened species preserves and upland habitats on North Fiesta Island and San Diego River floodway levee and other deferred capital improvements (City of San Diego 2022b).

Ocean Beach Pier

Since the early 2000s, exposure to large waves and ongoing degradation has required structural repairs to Ocean Beach Pier with increasing frequency. The pier was temporarily closed several times in recent years due to damage suffered in storms and high surf. In 2024, The City of San Diego determined the safest and most cost-effective option for the Ocean Beach Pier is to keep the structure closed to public access while the City moves forward with a long-term solution to replace the 58-year-old pier.

The City is currently working to design the potential replacement of the pier based on public input, community impacts, environmental permitting, sustainability, operational usage, cost, historical significance and other factors (City of San Diego 2024f).

Photo by GHD

SANDAG Regional Beach Sand Replenishment Project

San Diego Association of Governments (SANDAG) developed the Beach Sand Replenishment program as part of their Shoreline Management and Monitoring programs (SANDAG 2023). The San Diego County coastline is subject to coastal erosion, exacerbated by development such as flood control projects and harbors and jetties that can both reduce sand that flows down rivers to beaches and suppress sand movement.

SANDAG's Beach Sand Replenishment program supports efforts to nourish San Diego beaches with sand placement to restore and maintain coastal beaches, sustain recreation and tourism, enhance public safety, restore coastal sandy habitats and reduce the proliferation of protective shoreline structures (e.g., harbors and jetties). The City of San Diego participated in SANDAG's Regional Beach Sand Project I project in 2001 and is participating in the Preliminary Planning Activities for Regional Beach Sand Project III.

Trails Master Plan

The Citywide Trails Master Plan has been identified as a key implementation item within the Parks Master Plan to establish a framework to guide equitable and sustainable design, enhancement and implementation of existing and new trails throughout San Diego (City of San Diego 2024g). The Trails Master Plan will provide a comprehensive plan for both natural and urban trails and pathways to connect communities with safe and enjoyable walking/rolling and biking connections while respecting and enhancing the overall natural environment. The Trails Master Plan will result in new policies that promote active mobility and equitable access to the City's coastal resources and promote the creation and use of an interconnected trail network that provides easy access for all residents to connect with open spaces and coastal resources.

U.S. Army Corps of Engineers San Diego River and Mission Bay Maintenance Dredging Project

Mission Bay Park was developed from the 1940s through the 1960s in what was a vast tidal marsh. After the creation of Mission Bay into an aquatic park, dredging has occurred in 1973, 1983-84 and 2010 at varying volumes. In 2010, as part of maintenance dredging roughly 450,000 cubic yards of material was placed on Mission Bay. Mission Bay is dredged on an "as-needed" basis with an interval of approximately 20-30 years. The next dredging effort could provide an opportunity to align timing of the dredging with sediment/material needed for some of the proposed project concepts within the Coastal Resilience Master Plan.

Evolving Shoreline

The coasts of San Diego have greatly shifted over time due to both natural and human-led influences. Geologic formations, rivers and ocean forces helped shape this diverse shoreline of San Diego's waterways, bays, beaches, cliffs and estuaries. Human development along the coast and in watersheds, particularly during the post-World War II boom, combined with harbor construction has also played a major role in shaping today's shoreline. Over the last century, coastal development and management, such as beach nourishment, flood control and transportation infrastructure, have greatly influenced the creation of new shorelines, the stabilization of existing shorelines and the modifications of natural systems. These historical lessons, combined with our understanding of existing hazards like El Niño and future impacts such as sea level rise, can help envision a future for San Diego that balances protection and conservation of important resources.

An evocative example of historic processes that can inform planning and decision making is the erosion along San Diego's cliffs and bluffs. Locations such as Sunset Cliffs, La Jolla and Torrey Pines have experienced significant coastal erosion over time. Figure 2 illustrates the evolving shoreline of Sunset Cliffs through a historical perspective.

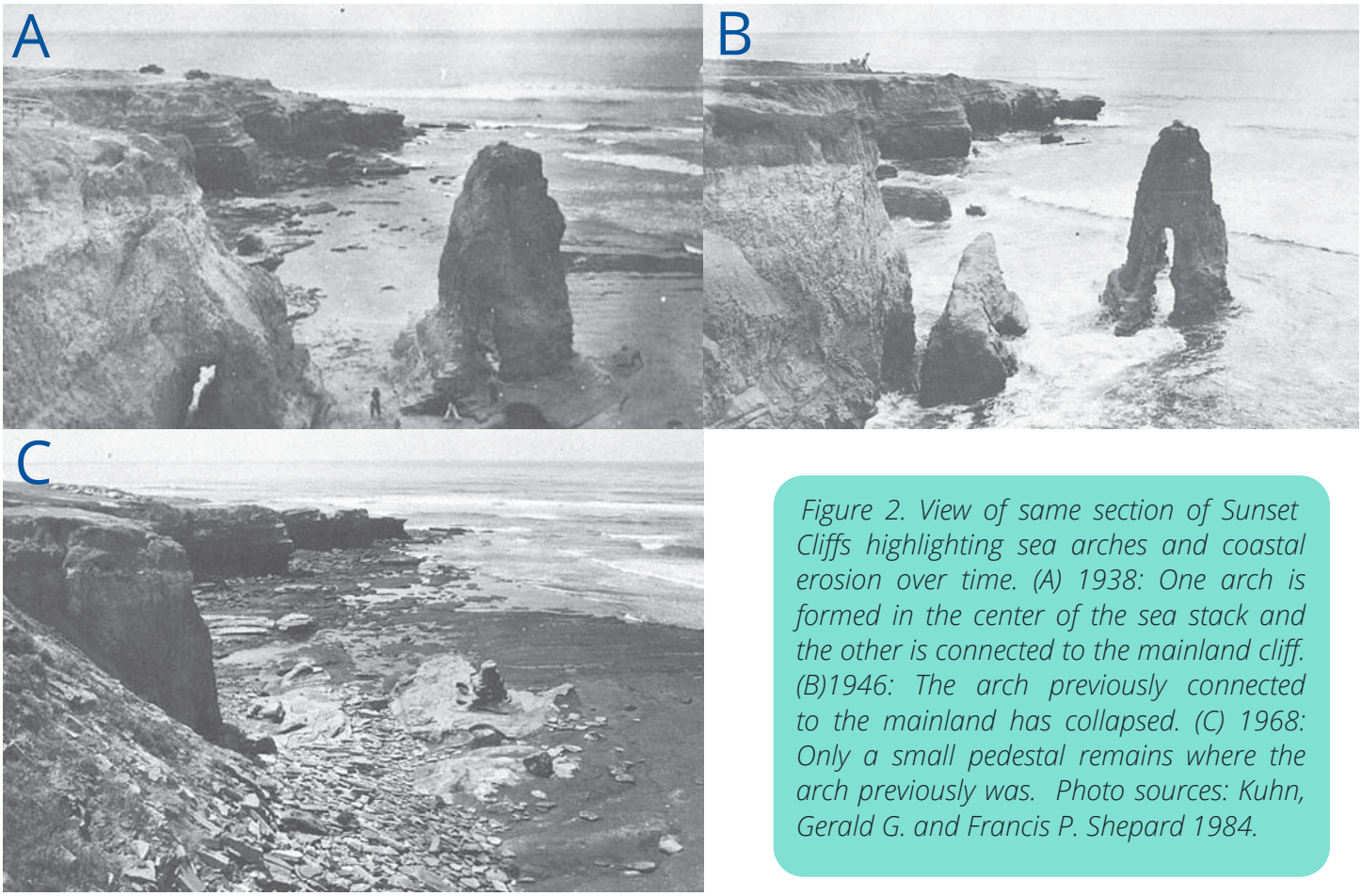


Figure 2. View of same section of Sunset Cliffs highlighting sea arches and coastal erosion over time. (A) 1938: One arch is formed in the center of the sea stack and the other is connected to the mainland cliff. (B)1946: The arch previously connected to the mainland has collapsed. (C) 1968: Only a small pedestal remains where the arch previously was. Photo sources: Kuhn, Gerald G. and Francis P. Shepard 1984.

While cliff erosion is likely to increase with sea level rise and heavier rainfall events, modeling when and where erosion may take place can be difficult. Research from Scripps Institution of Oceanography indicates that cliffs cycle through periods of erosion and stability, meaning historic erosion rates are not always accurate predictors of future erosion (Dickson et al. 2023). Areas that have been stable for some time may start eroding, while areas that have been actively eroding may stabilize. It is hard to predict when and where cliff erosion may slow or accelerate.

Beach erosion is also likely to accelerate with sea level rise. While the City has previously conducted beach nourishment, which involves placing additional sediment onto a beach to combat the effects of erosion, it is unlikely that historic rates of nourishment will be enough to stop future beach erosion. A recent study found significant impacts to the shoreline will occur due to accelerated sea level rise, with 31-67 percent of beaches in Southern California lost by 2100 under a 3-foot sea level rise projection without large-scale human interventions (Vitousek et al. 2017).

While there is uncertainty in precise erosion rates and sea level rise projections, it is certain that the coastline of the future will look different than the coastline of today.

Tribal Cultural Significance

The Kumeyaay are the original inhabitants of the coast within the CRMP area. The word Kumeyaay translates as “the people who are on the cliffs” overlooking the Ocean. Their traditional territory includes desert, mountains, valleys and coastal regions. Kumeyaay habitation and use of the coast is well documented through cultural resources such as remains of villages, temporary habitation sites, quarries, resource exploitation sites and milling areas. The Kumeyaay have a vast knowledge of plants, animals and natural resources that are found along the coast, which allowed them to subsist throughout the years by harvesting sea creatures like kelp, lobster and crab; gathering trade commodities like salt, abalone, ochre and tar; and fishing using traditional tule boats. Areas along the coast remain sacred places to the Kumeyaay Nation, some of which are associated with the creation story of the Kumeyaay people. The Kumeyaay Nation continue their traditional cultural use of the coast, maintaining their connection with their ancestral lands and traditions.

Sea Level Rise Science

Tide gauge data in San Diego suggests sea level here has risen approximately 2.23 millimeters per year, based on monthly mean sea level data from 1906 to 2023, which is equivalent to a change of 0.73 feet in 100 years (NOAA 2024).

For California, sea level rise projections are established by the Ocean Protection Council (OPC). In June 2024, the OPC adopted the State of California Sea Level Rise Guidance: 2024 Science and Policy Update which updated the previous guidance from 2018. The updated guidance includes five scenarios: Low, Intermediate-Low, Intermediate, Intermediate-High and High. These scenarios are:

- **Low: 1 ft by 2100 -** The scenario is on the lower bounding edge of plausibility given current warming and sea level trajectories and current societal and policy momentum.
- **Intermediate-low: 1.6 ft by 2100 -** A reasonable estimate of the lower bound of most likely sea level rise in 2100.
- **Intermediate: 3.3 ft by 2100 -** A reasonable estimate of the upper bound of most likely sea level rise in 2100.
- **Intermediate-high: 4.9 feet by 2100 -** Intermediate-to-high future emissions and high warming; this scenario is heavily reflective of a world where rapid ice sheet loss processes are contributing to sea level rise.
- **High: 6.6 feet by 2100 -** High future emissions and high warming with large potential contributions from rapid ice sheet loss processes; given that deep uncertainties and ambiguity are embedded in this scenario a statement on the likelihood of reaching this scenario is not possible. This scenario should be used with caution and consideration of the underlying assumptions.

Figure 3 shows a comparison of the sea level rise scenarios between 2018 and 2024 OPC projections for the National Oceanic and Atmospheric Administration (NOAA) San Diego tide gauge.

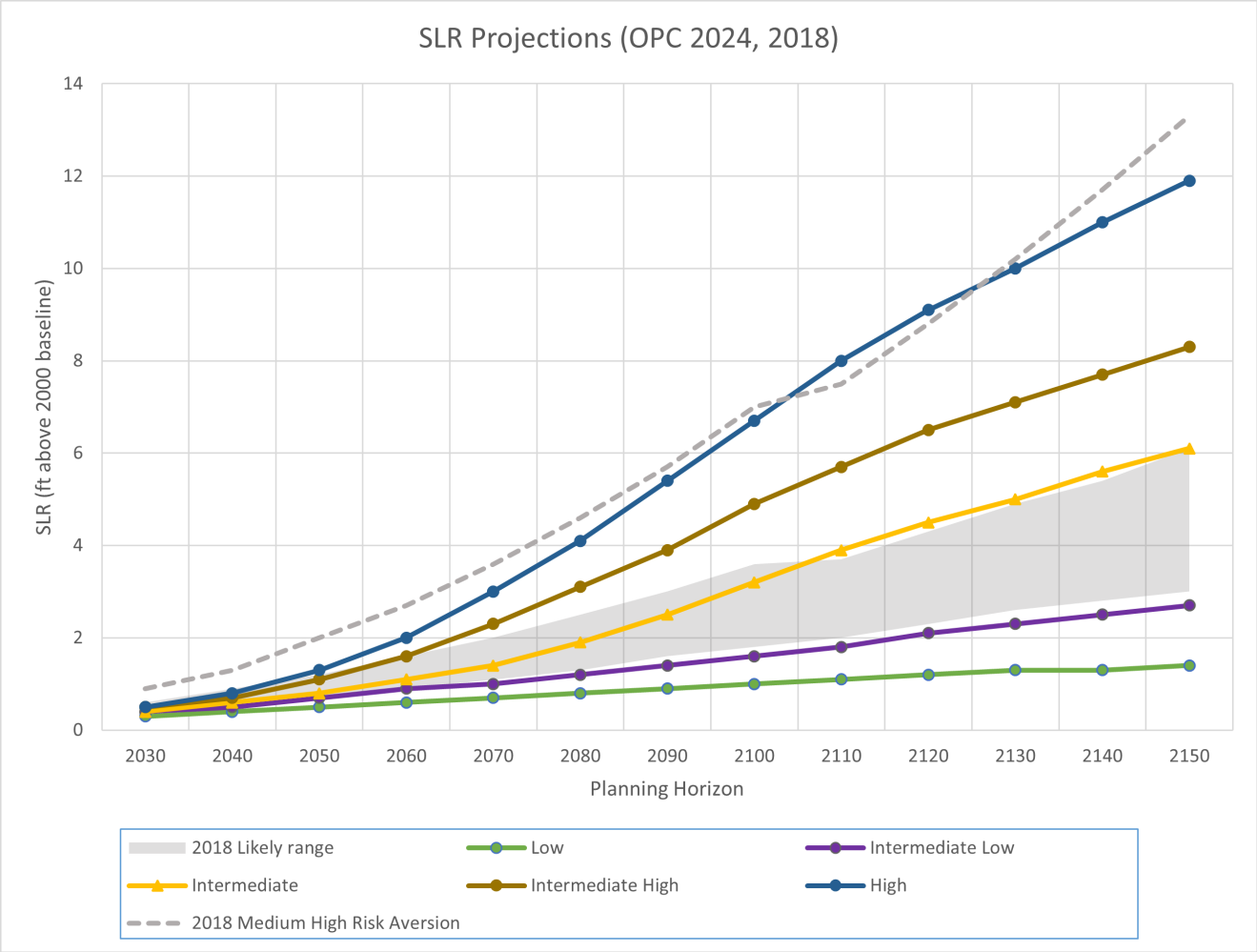


Figure 3. Sea level rise projections for the San Diego tide gauge (modified from OPC 2018, 2024)

These scenarios correspond to average global sea level rise magnitudes and do not have probabilities attached to them like the 2018 OPC scenarios. Instead, the latest scenarios are based on the 'plausibility' of occurring. Plausible ranges of sea level rise means the credible and reasonable range of future sea level rise supported by peer-reviewed publications and the consensus assessment of the Intergovernmental Panel on Climate Change Assessment Report 6 (IPCC AR6).

The scenarios presented in the 2024 guidance have a smaller range of values until 2050 (compared to the 2018 guidance), illustrating more confidence in mid-century projections. In the mid-term (2050–2100), the range of possible sea level rise trajectories expands with the range becoming increasingly larger over the long-term (towards 2100 and beyond). The medium-high risk aversion scenario (from the 2018 guidance) was previously commonly used as a design consideration for infrastructure (gray dashed line in Figure 3), and the H++ scenario was an extreme scenario used for critical infrastructure. However, due to the updates in the science, the 2018 medium-high risk aversion scenario is higher than every scenario in the new projections, and the H++ scenario was removed due to its implausibility.

The frequency of extreme flooding is expected to increase under all projections of sea level rise. In addition, rising seas will magnify the occurrence of severe floods (such as the 500-year flood) along the Pacific Coast of the United States. By elevating storm tide, sea level rise makes it easier for waves to surpass natural barriers, increasing the relative frequency of flooding along the coast. It is also possible that rising sea levels could raise groundwater levels, which could resurface toxic contaminants.

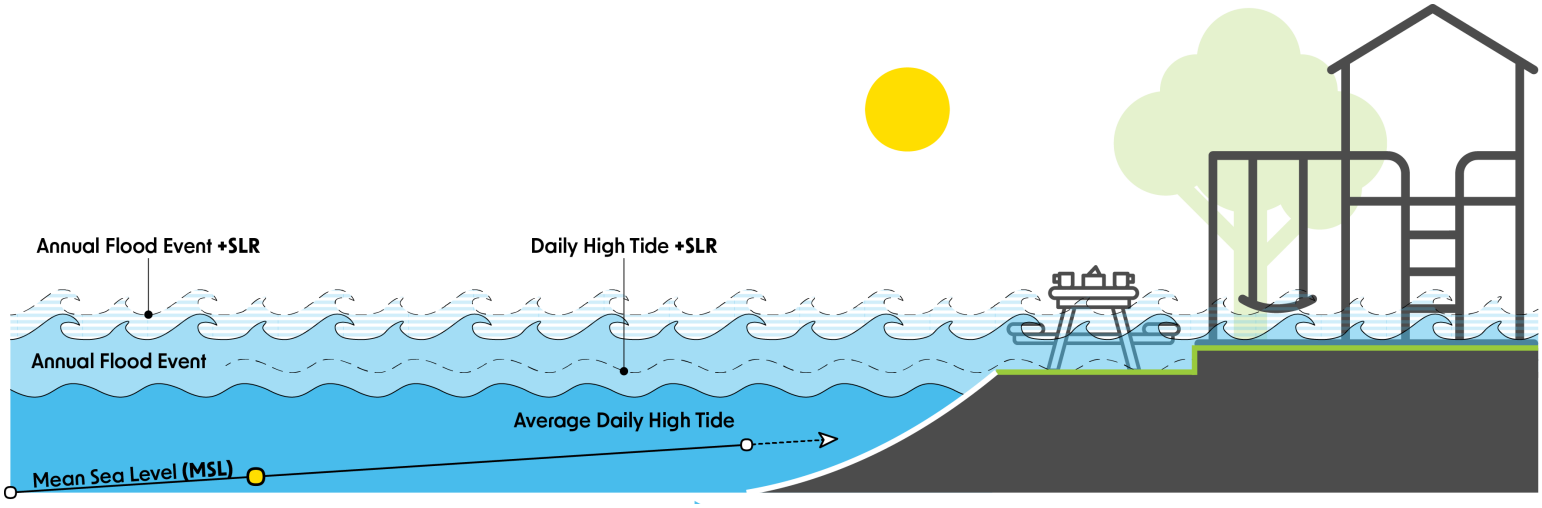


Figure 4. Flood and tidal events with sea level rise

Extreme Rainfall and Droughts

Changes in precipitation patterns, which include extreme rainfall and droughts, is a difficult variable for climate change models to project. More variability in rainfall from year to year is expected along with more intense transitions between droughts and extreme rainfall events. California can experience wide swings in precipitation from drought years to El Niño years. But over the last 80 years, the average rainfall in San Diego has been about 10.13 inches annually (Western Regional Climate Center 2018). Annual average precipitation values from Cal-Adapt and technical sources embedded within it project only small changes in average annual rainfall for Southern California.[1] However, there is expected to be greater variability in precipitation and more intense transitions between dry and wet years. There may be more extreme dry years that are followed by extremely wet years, as recently occurred in 2015 to 2016 and 2016 to 2017. Extreme precipitation events, which historically occurred about every 25 years on average, are also expected to become 2.5 times more frequent in Southern California (Swain et al. 2018). This implies that what we experience as extreme now will be considered the norm in the future. These heavier rainfall events may contribute to coastal erosion events.

1 Cal-Adapt is a web-based tool coordinated by the State of California that provides data and resources for climate change adaptation in California. Cal-Adapt provides the public, researchers, government agencies and industry stakeholders with essential data & tools for climate adaptation planning, building resiliency, and fostering community engagement.

Case Study: Living Shoreline – Engineered Dune, Encinitas, CA

Photo Source: California Coastal Dune Science Network 2021a. Accessed July 16, 2024.

Engineered dunes were constructed at Cardiff State Beach to protect Highway 101 through a multi-benefit coastal resiliency project. The highway was prone to frequent flooding and erosion and lacked sufficient pedestrian accessways to and along the beach. In response, sand dunes were constructed with dredged sand from the adjacent lagoon and placed on top of a buried rock revetment. Native vegetation was planted on top of the dunes and sand fences were installed to control wind-blown sand from reaching the highway and pedestrian footpath adjacent to the dunes. The vegetated sand dunes now protect the highway from high tide and large wave events, provide rare coastal strand habitat and improve access to the beach. Specifically, the project has protected the highway from flooding and erosion during two significant El Niño winters and has exceeded the biological performance metrics. The dunes are adaptively managed and maintained through beneficial reuse of dredged sand from the San Elijo Lagoon inlet mouth each spring. This project cost approximately $3.5 million to design and implement in 2019 and roughly 8 months to construct.

Purpose of the Coastal Resilience Master Plan

The CRMP implements Climate Resilient SD, the City's climate adaptation and resilience plan, to inform the development of nature-based coastal resilience projects that allow the City to adapt to the impacts of sea level rise and enhance and protect the biological diversity of the City's coastline. Many of the City's critical assets, including open space, habitat and conservation areas and community resources are identified as highly vulnerable to sea level rise and erosion. Additionally, the coastline provides habitat for populations of endangered, threatened and key sensitive species protected by the City's Multiple Species Conservation Program Subarea Plan including the Light-footed clapper rail, Western snowy plover and California least tern.

Further, the prioritization of nature-based solutions for coastal resilience through this project provides additional resilience, environmental and socio-economic benefits such as enhanced or protected habitat, coastal access, green jobs and environmental education opportunities. The projects identified in the CRMP will mitigate risk from climate change and provide co-benefits, such as habitat protection, water quality improvements, flood storage and recreation opportunities. The projects also consider ways to enhance access to the beach for all community members, such as increased public transportation to the beach, parking and pedestrian and bicycle infrastructure.

The purpose of the CRMP is to prepare the City to adapt to sea level rise through implementation of nature-based solutions where feasible. The main objectives are as follows:

A. Prioritize the implementation of nature-based climate change solutions wherever feasible, consistent with Climate Resilient SD Policy TNE-3

B. Address the effects of sea level rise and coastal flooding while leveraging additional co-benefits of nature-based solutions

C. Protect and enhance critical coastal habitat and associated wildlife from the impacts of climate change

D. Protect and enhance recreational opportunities

E. Protect historical, archaeological and tribal cultural resources and incorporate Indigenous Knowledge into resilience efforts and adaptation strategies

F. Increase coastal access for all community members, with prioritization of Communities of Concern

Resilient Climate Protections

Prioritize nature-based climate change solutions wherever feasible, consistent with Climate Resilient SD Plan Policy TNE-3

Address Sea Level Rise & Coastal Flooding

Address the effects of sea level rise and coastal flooding while leveraging additional co-benefits of nature-based solutions

Protect & Enhance Habitat/Wildlife

Protect and enhance critical coastal habitat and associated wildlife from the impacts of climate change

Enhance Recreation Opportunities

Protect and enhance recreational opportunities

Protect Historic & Cultural Resources

Protect historical, archaeological and tribal cultural resources and incorporate Indigenous Knowledge into resilience efforts and adaptation strategies

Increase Coastal Access

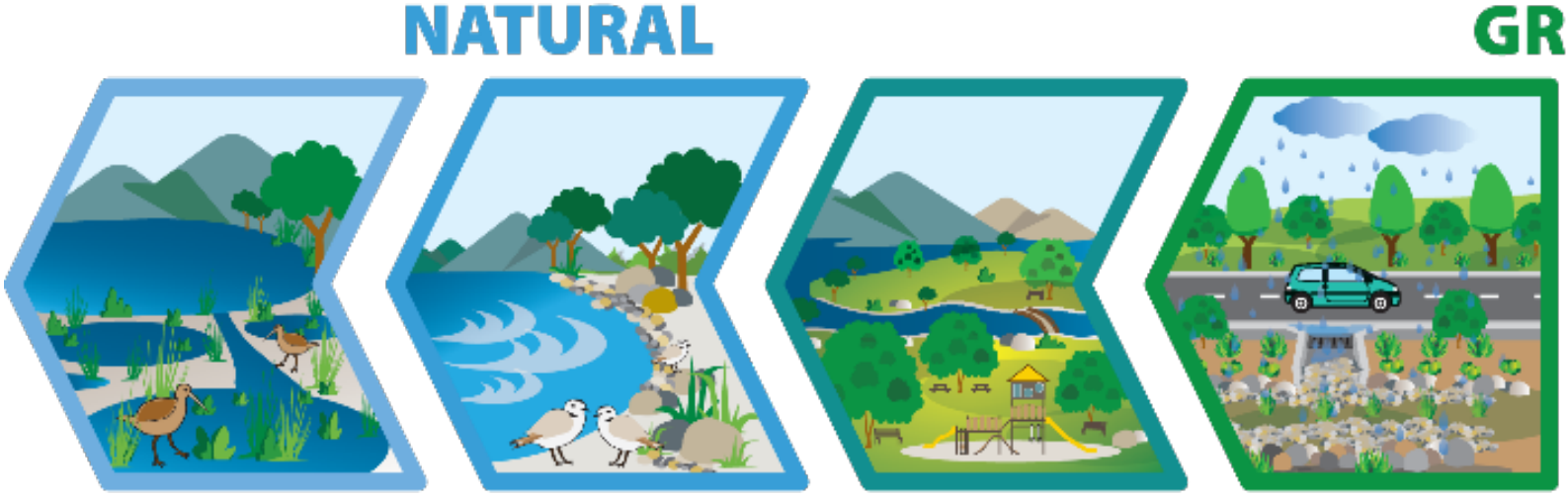
Increase coastal access for all community members, with prioritization of Communities of Concern

What the Plan Looks to Accomplish

The CRMP builds upon previously adopted planning and policy priorities and begins to understand what kind of coastal resilience solutions are possible along San Diego's coast to protect against sea level rise driven flooding and erosion, while supporting a thriving coastline into the future that reflects community values and vision. The CRMP identifies specific resilience and conservation needs along the coast and develops a portfolio of nature-based solutions to promote resilience against the risk of climate change, protect critical coastal habitats and support coastal access in accordance with Climate Resilient SD. The coast is a valuable resource for all San Diegans and for those who visit the region. The CRMP aims to not only benefit the immediate coastal communities, but also to ensure coastal accessibility and habitat protection and viability. The coast is and should continue to be an accessible resource for all, where anyone can enjoy the natural and recreational benefits of a resilient, restored and protected coastline.

The CRMP looks beyond traditional coastal engineering techniques and includes nature-based solution pilot projects for prioritized sites along the City's coastline. The CRMP is the first phase of this effort and includes high level concept designs. Future phases of work will include refinements to the designs, engineering, technical studies, permitting and construction.

The CRMP does not address the entirety of the City's coastline and is not a comprehensive list of coastal resilience projects for the entire City of San Diego's coastline. As noted in Other City Coastal Resilience



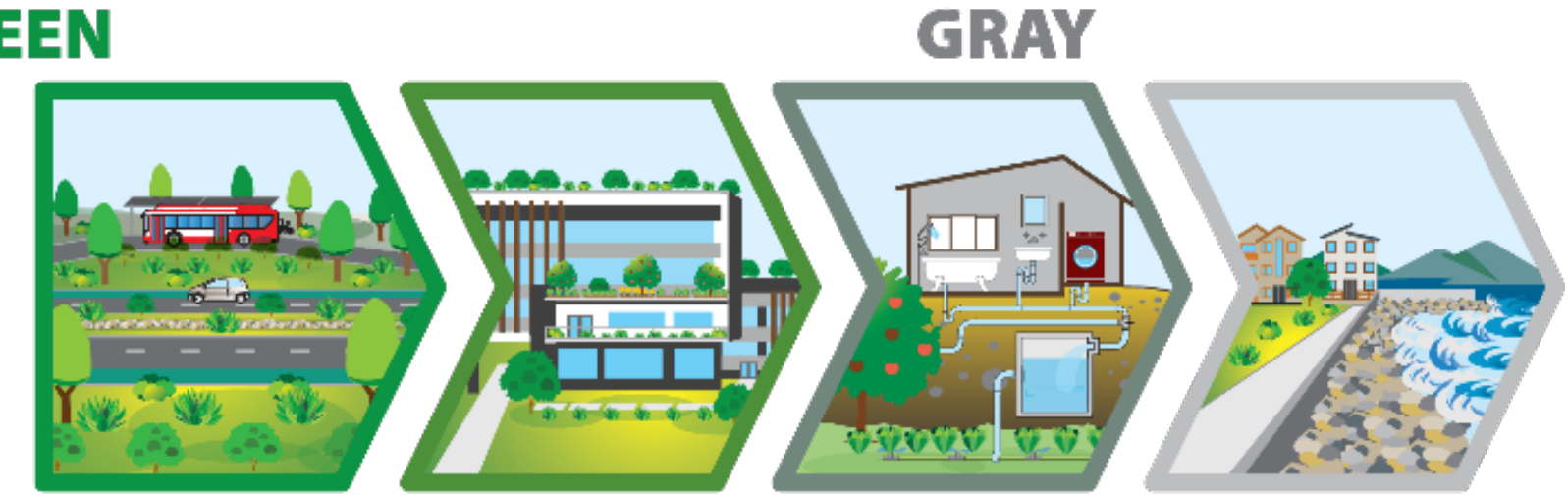
Initiatives, there are many other projects underway that address sea level rise and plan for a resilient coastline. The CRMP addresses select, prioritized sites that are well suited for nature-based solutions. It is anticipated that as projects move forward to implementation and as the City completes regular updates of both its vulnerability assessments and Climate Resilient SD, the CRMP will be updated to include additional sites. Site selection will consider updated science as well as community needs and priorities.

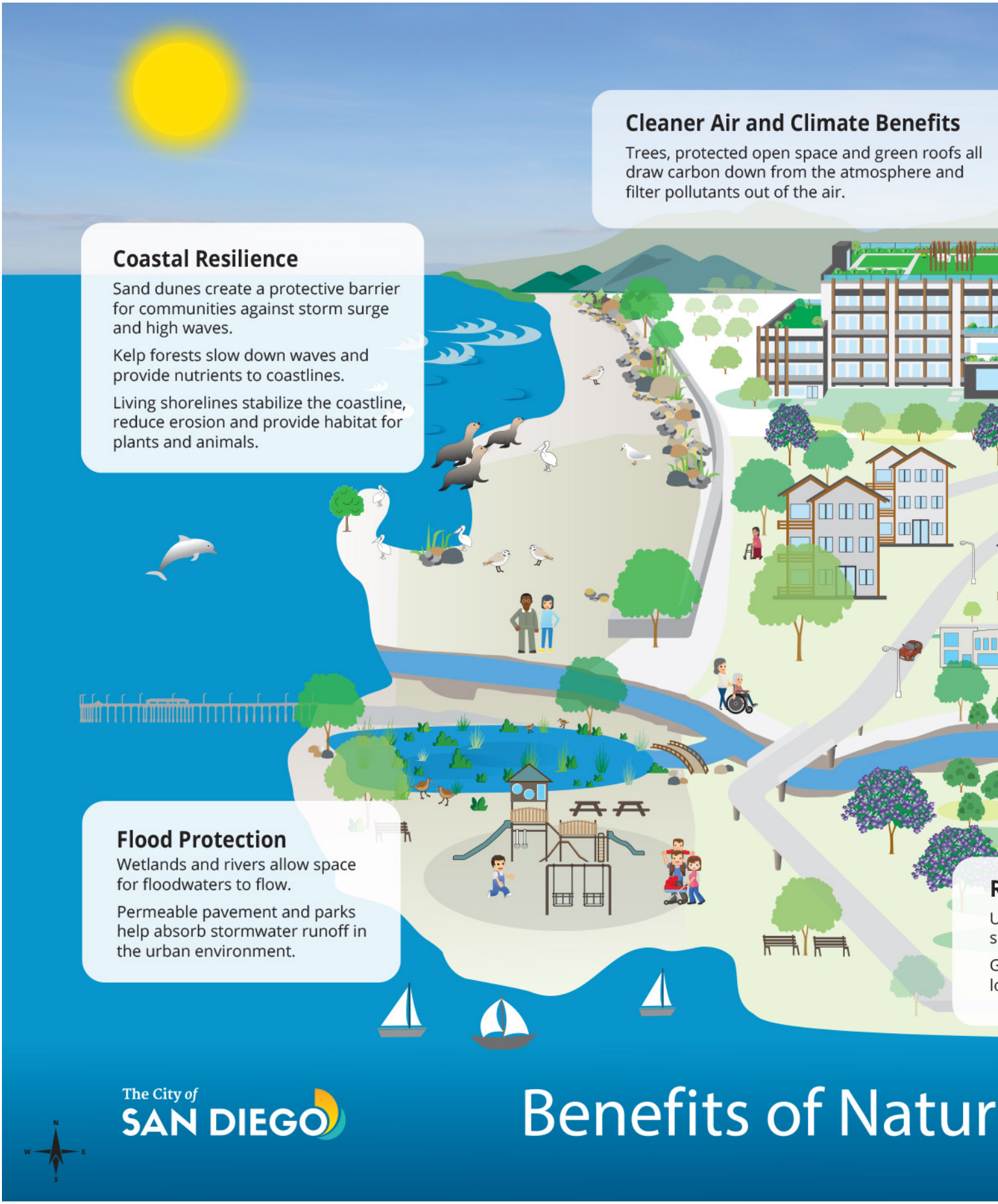
Nature-Based Solutions

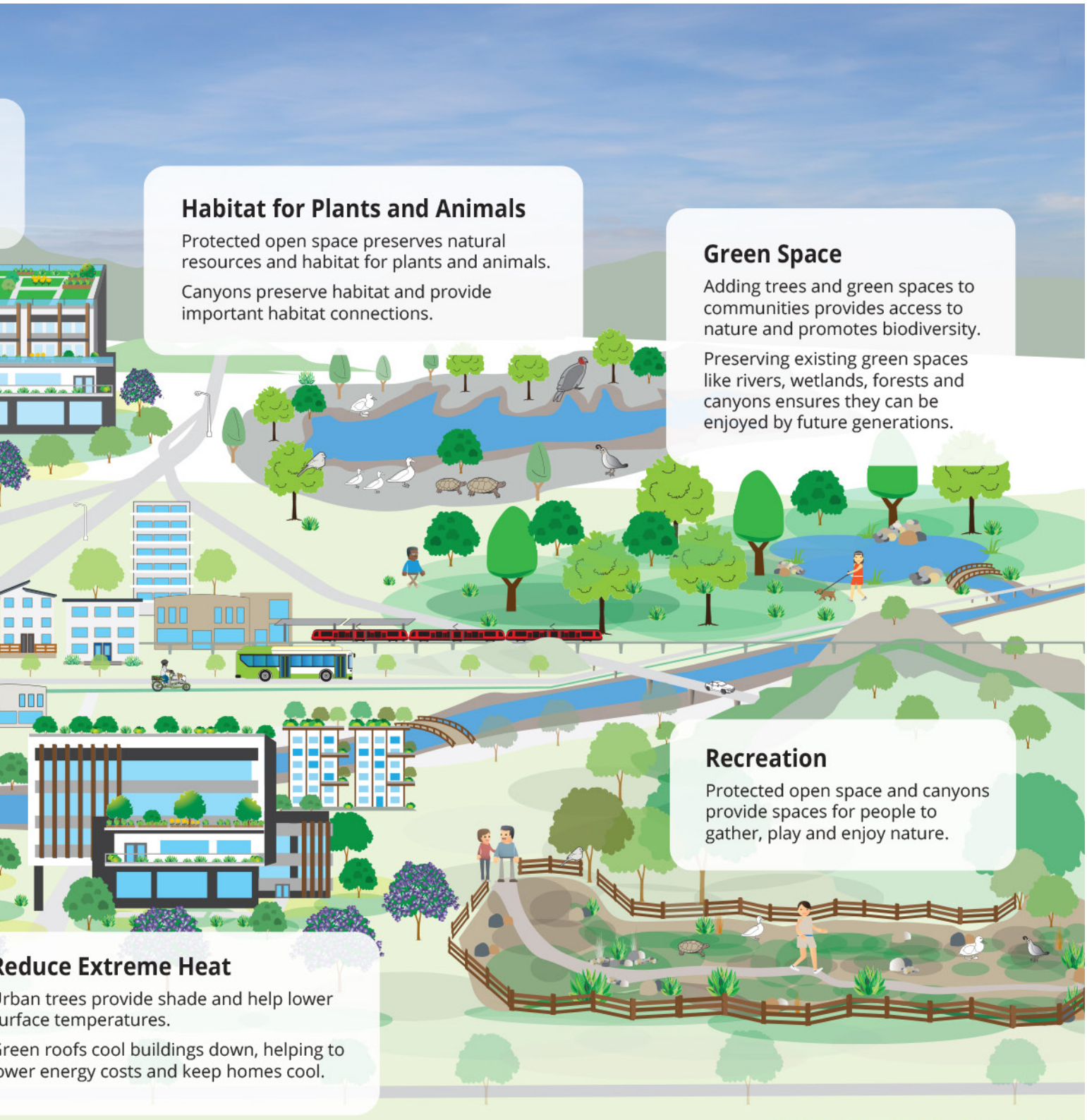
Nature-based solutions are sustainable planning, design, environmental management and engineering practices that incorporate or mimic natural features or processes into the built environment to promote climate adaptation and resilience. In coastal settings, nature-based solutions incorporate ecological principles into shore protection strategies to support multiple benefits, including hazard adaptation and mitigation, natural resource resilience and enhancement and recreation and scenic resource preservation. While there are varying definitions of nature-based solutions, a generally recognized definition of coastal nature-based solutions and nature-based adaptation strategies is: "A coastal adaptation and/or erosion control method that is comprised of natural or mostly natural elements, which contributes to the persistence and enhancement of coastal processes and ecological benefits while also offering protection services to inshore areas" (CCC 2021).

Multi-Benefit Overview

Nature-based solutions provide multiple benefits for coastal resilience planning. These solutions use natural features and processes to reduce flood risk, improve water quality, protect coastal property, restore and protect wetlands, provide ecological benefits, stabilize shorelines, reduce urban heat and add recreational space, among other benefits (FEMA 2024a).




Cleaner Air and Climate Benefits
Trees, protected open space and green roofs all draw carbon down from the atmosphere and filter pollutants out of the air.
Coastal Resilience
Sand dunes create a protective barrier for communities against storm surge and high waves.
Kelp forests slow down waves and provide nutrients to coastlines.
Living shorelines stabilize the coastline, reduce erosion and provide habitat for plants and animals.
Flood Protection
Wetlands and rivers allow space for floodwaters to flow.
Permeable pavement and parks help absorb stormwater runoff in the urban environment.
The City of SAN DIEGO
Benefits of Natur



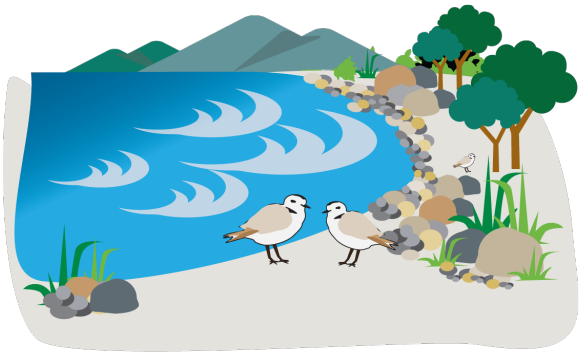
e-Based Solutions

SD City Planning

Types of Nature-Based Solutions for Coastal Resilience

A description of the nature-based solutions to consider in planning for coastal resilience:

- **Living shorelines** stabilize and protect the shoreline using a combination of plants, sand, rock and other natural materials. They can help reduce wave energy, slow erosion and minimize flooding.



Living shorelines

- **Engineered and passive dunes** can be designed to combine the aesthetic and habitat benefits of a dynamic beach and dune system with the robust storm protection provided by a structural core. A spectrum of passive (e.g., sand fencing, wooden slates) to full engineered approaches is possible with dunes.

Engineered Dunes

- **Waterfront/stormwater parks** are open space parks or recreational spaces in coastal areas that are designed to flood during extreme events, minimizing flooding elsewhere. During "normal" non-extreme event periods, they operate as community serving recreational facilities.

Stormwater parks

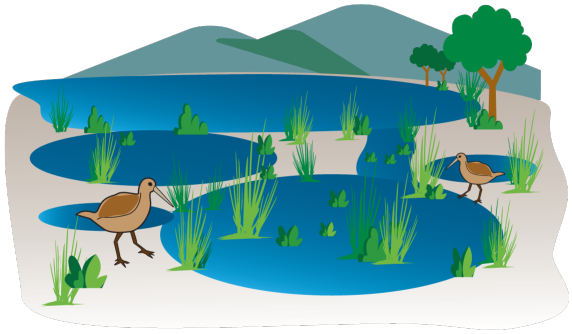
- **Landward realignment** refers to the modification of the alignment and shape of features, and mimics natural processes of balancing space and gradual transitions between elevations, slopes and habitat and use types.

Landward Realignment

- **Living levees/ecotone slopes** incorporates a levee that, instead of dropping down sharply, slopes gently downwards towards the waterbody in the same way that the land naturally would. This allows for natural, gradual transitions—from open water to tidal mudflat, to tidal marsh, to "ecotone" or transitional upland habitat—to be re-established in these areas.

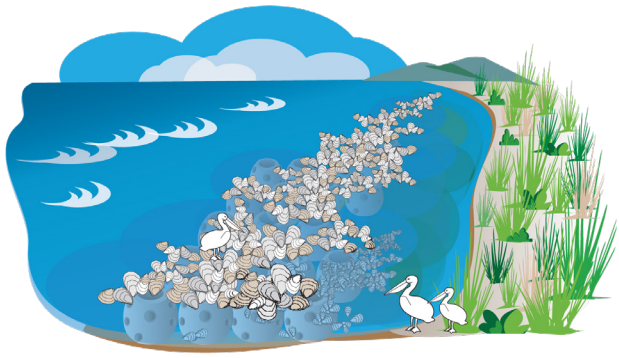
Living Levees and Ecotone Slopes

- **Wetland creation/restoration** encompasses enhancing wetland ecosystems characterized by permanent or seasonal inundation, which help mitigate flooding, provide habitat, improve water quality and absorb wave energy.



Wetlands and floodplains

- **Reefs** provide natural barriers to the shoreline, protecting it from erosion, strong waves and storm surge. Designing nature-based reef features can be performed on more exposed shorelines as well as in protected environments, such as bays with oyster reefs.



Oyster Reefs

Approaching Adaptation to Coastal Hazards

When developing nature-based solutions, it is important to consider the various options for coastal adaptation. In a coastal setting, there are generally three main categories to approach adaptation to coastal hazards such as flooding and erosion: protect, accommodate and relocate. In some instances, a combination of these options, a hybrid approach, is necessary initially or over time (i.e., a phased adaptation approach) to balance social, environmental and economic needs for coastal resiliency.

Protect: Strategies that seek to defend development and other resources through engineered efforts and generally prioritize existing alignment and certain uses.

Accommodate: Strategies that support retrofitting of existing structures (e.g., increase elevation) with a focus on repair and maintenance as impacts are realized. The level of use or service may need to be adjusted as status of assets change.

Relocate: Strategies that realign or relocate assets out of hazard areas and limit new development in vulnerable areas.

Hybrid: Strategies that blend protective and realignment elements using natural materials with structural designs while incorporating social and environmental considerations.

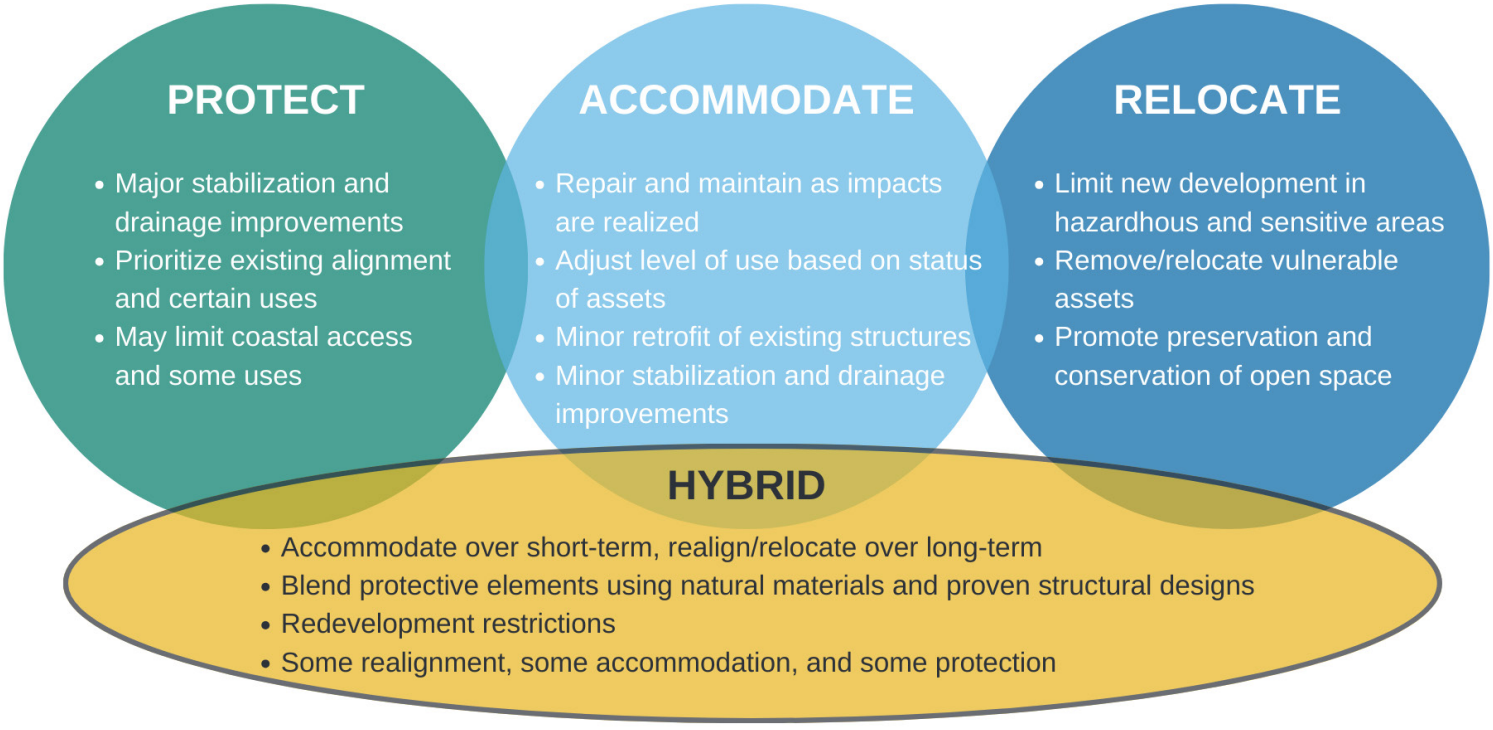


Figure 5. An overview of general coastal adaptation strategies, informed by California Coastal Commission Sea Level Rise Guidance 2018.

Nature-based solutions can encompass natural infrastructure and green infrastructure and provide a broad approach of fully soft or hybrid soft and engineered approach to projects. Conversely, gray infrastructure relies primarily on hard, engineered infrastructure focused on armoring or fixing shorelines and landscapes to gain protective or resilience benefits.

It is important to note that there are tradeoffs associated with every category and adaptation strategy. For example, strategies with more physical protection may protect the built environment and preserve certain uses but may compromise environmental aspects. Conversely, strategies that prioritize environmental features may not provide the same level of protection for built infrastructure but can offer environmental benefits and can reflect community values.

Different locations, assets and resource protection goals will require different types of strategies. The effectiveness of the different strategies detailed above will vary. In many situations, a hybrid approach that combines strategies from all three categories will be essential, and the selected strategies may need to evolve over time. When softer more natural solutions alone may not be preferred, a combination of both hard and natural infrastructure may be necessary to achieve resilience goals. Many of the nature-based solutions presented in this utilize a hybrid approach where natural infrastructure elements are incorporated and prioritized where feasible and practical in conjunction with some, mostly existing, hard armoring. Across all solutions presented, the goal is to design a suite of strategies that can work with the coastal setting to provide multiple benefits for the community, coastal protection and local environment.

Case Study: Landward Realignment, Surfer's Point, Ventura, CA

Landward realignment and habitat restoration are being integrated into increasing resilience at Surfer's Point. Phase I of the project added a new bike path and replaced the prior bike path and parking lot with a cobble beach backed by dunes. Infrastructure was relocated inland to support restoration and widening of the beach. Since Phase I's completion, access to the beach has continued and wildlife has rebounded. Funding for Phase II was approved this June, which will work on some of the cobble berm and dune areas that have been eroded by storms and complete relocation of public amenities and parking.

Photo Source: California Coastal Dune Science Network 2021b. Accessed July 16, 2024.

Community Engagement and Feedback

Community engagement is a key component of developing the Coastal Resilience Master Plan as it ensures that community voices, priorities, concerns and local knowledge of the project sites are heard and incorporated into the planning effort. By actively involving community members, stakeholders and community organizations, the planning process benefits from diverse perspectives and local knowledge, leading to more robust resilience strategies and a shared vision of our coastline.

Overview of Engagement Activities

Stakeholder Advisory Committee

The City invited 22 stakeholder agencies to participate in an informal Stakeholder Advisory Committee (Committee) comprised of local, state and federal agencies, research institutions, coastal-focused environmental groups and transportation agencies. The Committee was formed to support the development of the CRMP and provide technical input on feasibility, benefits and prioritization of proposed nature-based solutions, as well as coordination efforts. For Phase 1 of the CRMP, three Committee meetings were held. The Committee will continue to be engaged in future phases of the CRMP to provide technical input on feasibility, design and implementation of nature-based solutions.

Community Engagement

Pop-Ups

The City conducted eight pop-up events in winter and spring of 2024. At each pop-up event, the City engaged with community members by presenting an overview of the CRMP project goals and draft design concept(s) for each site. Community members were invited to share feedback on the draft concepts and ask questions about the project. Informational flyers that that included an overview the project, proposed project sites and a link to the Coastal Resilience Master Plan webpage were shared with community members. The webpage is regularly updated with information on the plan and upcoming community engagement opportunities.

Online Survey

In April 2024, the City launched an online survey seeking feedback from the public on each of the draft project designs for each of the sites within the CRMP. The online survey provided an overview of the sea level rise challenges facing each site and the key features of the proposed project design. The survey sought feedback from the community to inform project design, improve recreation opportunities and support coastal access. The online survey was live through the end of June 2024 and received 790 responses.

Community Workshops

In June 2024, the project team held two community workshops. The community workshops provided an opportunity for the project team and community stakeholders to dive deeper into the proposed features for each of the six sites, explore the range of nature-based solutions that are available for each site and provide meaningful insights into the recreation and access opportunities and challenges of each site. At each workshop, the project team presented an overview of the CRMP project process and sought feedback from the community on the draft project designs for each of the sites. Feedback received from the community helped to inform project design.

Community feedback received from all engagement activities helped to inform the project concepts to ensure that as the City designs for a more resilient coastline that is prepared for the challenges of sea level rise, we are centering community value and priorities. Continued community engagement as these project concepts are further refined, finalized and implemented will be essential for project success.

For an overview of all the community and stakeholder engagement efforts that has been conducted and potential future engagement opportunities, please see Appendix B: Public Engagement Plan.

Key Themes from Public Engagement Events

The following are summarized key themes gathered from the survey, pop-ups and workshops that have been held for the project to date.

Maintenance

Through both the pop-up events and community workshops, ongoing maintenance was a frequently raised issue. Many of the sites are subject to incorrect trash disposal resulting in waste along the beaches and pathways. Community members cited the need for more maintenance of facilities such as bathrooms, general repairs and increased cleaning of our beaches and coastline.

Safety

Another common theme was the desire for greater safety. Workshop participants from Sunset Cliffs expressed a need for greater safety along Sunset Cliffs Boulevard, including slowing the speed of motorized vehicles, designating safe crossings, providing protected and separated space for pedestrians and a desire for patrolling of the area. Greater enforcement at Ocean Beach – Dog Beach was also recommended to ensure the dunes did not become gathering locations for people or dumping areas.

Parking

Access to parking was a top priority for all sites. Most community members stated improving parking areas near the beach as an important aspect of the CRMP. Improving the parking area at Tourmaline Beach was noted as one priority for that site. Feedback from the pop-up event at La Jolla Shores indicated a preference to maintain the existing parking lot in its current configuration. For Sunset Cliffs, a range of suggestions regarding how to address parking were received, including relocating parking off the cliffs and replacing it with on-street diagonal parking, the use of timed and limited parking and adding parking at the north end of Sunset Cliffs.

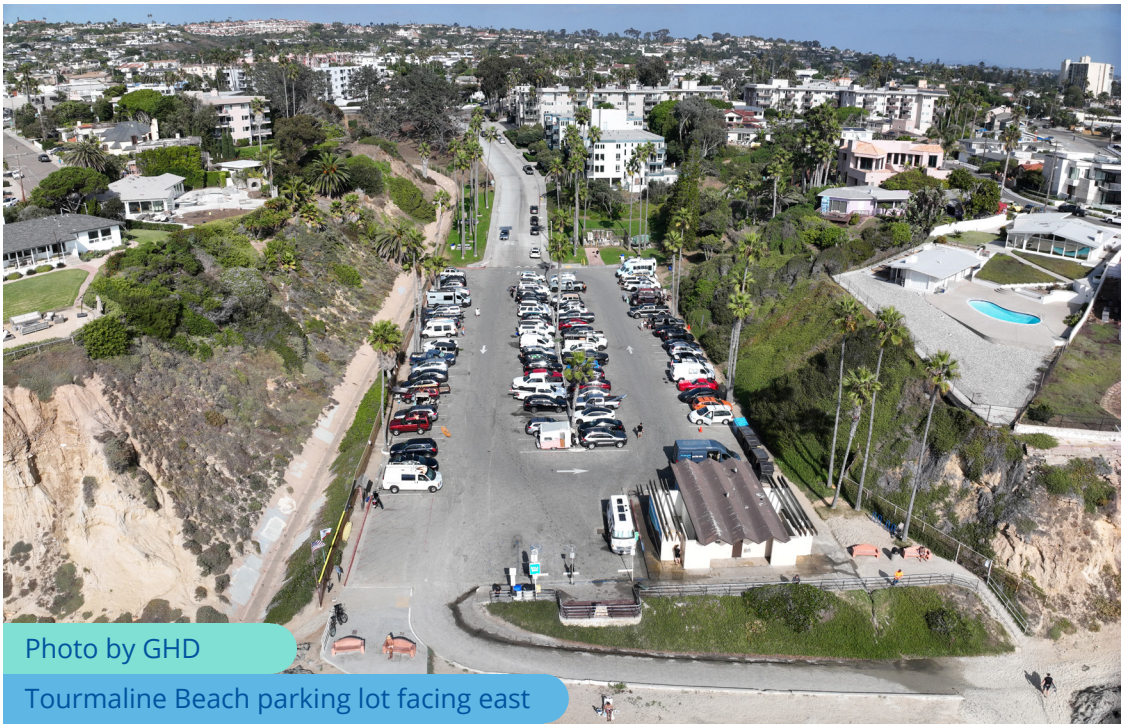


Photo by GHD

Tourmaline Beach parking lot facing east

Access

Enhancing access to the coast is a top priority of the CRMP. From the survey, arriving by car was selected as the primary mode of access to each site. In general, feedback suggests beachgoers support increased access and an expansion of multiple modes of access (including pedestrian, bicycle and transit access). There is support for pedestrian and bicycle paths and to make the sites more pedestrian friendly. Emergency and Americans with Disabilities (ADA) access were also brought up as important considerations in the design of the proposed berms and dunes. Several comments included the need to preserve access to views and the desire for viewing platforms and seating areas. For Sunset Cliffs, many comments were received regarding potential reconfiguration of the street and traffic flow, with some stating it will improve access in the area and help control erosion, and others stating it will divert traffic into the neighborhood and cause greater congestion and parking impacts for residents and those visiting the Sunset Cliffs Linear Park.

Recreation/ Activities

All sites host a range of activities, from recreational to natural activities. Common activities include walking, sunset-watching, surfing, sitting and exercising, among others. In the survey, walking was selected as the primary activity for all sites. At Sunset Cliffs Natural Park, stakeholders expressed a desire for passive recreation activities, such as nature walks and sight-seeing. At Mission Beach and Ocean Beach, the need to preserve the volleyball courts was noted. For La Jolla Shores, the park, scuba diving staging area, playground and “The Map” were highlighted as special areas that need to be respected. For many sites, there is a concern about how much the beach will erode and how those activities may be curtailed by the impacts of sea level rise.

Education, Arts & Culture

Engagement events highlighted the significant role of culture in each site. At the workshops and pop-ups, some shared different ways to raise awareness of the history and culture of the sites through art, interpretive signage and educational installations. At La Jolla Shores, a discussion about expanding the seawall revealed an opportunity to paint the back of the seawall with art that tells a story about the diverse and rich marine habitat in the area. Comments for Sunset Cliffs Natural Park included adding educational signage about the geology and habitat of the area.

Native Plants

Mixed comments were received regarding the use of native plants, especially for proposed dunes and perched beaches. Some indicated that ice plant, while an invasive species, helps prevent erosion and should be considered for the cliffs and dunes to control erosion and retain sand. Others indicated the City should use only native plants and drought-tolerant and water-saving plants.

Stormwater Drainage

A major theme of the outreach is the need to consider stormwater drainage in all adaptation strategies. Some stakeholders indicated that storm events are the primary cause of big flood events. Notes from the workshops and pop-ups assert that storm drainage contributes to significant erosion at Sunset Cliffs and Tourmaline, and to flooding at Ocean Beach, La Jolla Shores and Mission Beach. Stakeholders suggest stormwater improvements and management to enhance the project design, including diverting drainage away from the cliff edge at Sunset Cliffs and exploring "capping" the storm drain channel at Tourmaline.

Adaptation Strategies

The adaptation strategies presented focused on nature-based solutions. Several comments received included questions and concerns about how the proposed solutions would work. For example, comments added to workshop boards ask how dunes would work, if they will wash away, what plant material would work, how views would be impacted and how tall would they need to be? Access, including ADA and emergency access, were also noted as concerns. This feedback reflects the need for continued engagement and education around nature-based solutions, how they function, their benefits and operational considerations. For La Jolla Shores and Mission Beach, stakeholders asked if improvements to the existing seawall (expansion, adding height) would be a superior solution to the use of berms and dunes and were interested in the addition of flood gates.

Continued Outreach

There is a general interest and desire for the City to continue to engage with the various community organizations and groups.

For more detail on the community feedback received from the pop-up events, online survey and workshop, please refer to Appendix C, Community and Stakeholder Engagement Summaries.

Case Study: Living Shoreline – Passive Dune, Beach Restoration Pilot Project, Santa Monica, CA

This pilot project restored about 3 acres of dune habitat. Actions to improve this location included seeding native vegetation, installing sand fencing and interpretative signs and integration of a beach pathway. This habitat's plants capture windblown sand over time to create small dunes that prevent waves and extreme tides from flooding the beach and infrastructure. With the success of this pilot, the city of Santa Monica is implementing a larger project of about 5 acres.Since Phase I's completion, access to the beach has continued and wildlife has rebounded. Funding for Phase II was approved this June, which will work on some of the cobble berm and dune areas that have been eroded by storms and complete relocation of public amenities and parking.

Photo Source: California Coastal Dune Science Network 2021c. Accessed July 16, 2024.

Project Concepts

The CRMP developed concept-level designs for six locations along the coast. Sites were initially selected for feasibility of implementing a nature-based solution that supports three primary factors:

- Increases resiliency to sea level rise;
- Provides habitat enhancement and preservation opportunities; and
- Supports and/or enhances coastal access, with a focus on disadvantaged communities.

Sites were investigated through a multi-criteria analysis to identify the location and site boundaries most viable for a nature-based concept, narrowing down to six locations which were identified as the most appropriate and feasible. For more detail on the site selection and prioritization process, please refer to Appendix A, Coastal Resilience Master Plan Phase 1: Prioritizing Nature-Based Solution Pilots and Site Profiles.

Project concepts were iteratively vetted with City departments, the Stakeholder Advisory Committee and community members. The concept designs included in the plan aim to balance the goals of the plan and reflect what is possible from a nature-based solutions approach. The development of the concept level design is a key first step in moving these projects forward to implementation. Additional community and stakeholder engagement, technical studies, environmental analysis, engineering and permitting will all be necessary before these designs are implemented.

Detailed site profiles for each of the six project sites are available in Appendix A.

Project Concept Descriptions

For each project site, a brief overview of the project site and proposed concept(s) at each site is provided. Each Project Concept description includes a graphic showing concept-level design of the project concept, with cross section graphics and a list of key features. Each Project Concept Description includes items for further consideration that should be explored with City departments, relevant stakeholders and community members as the project concept designs move forward. Additional technical studies may be needed to further inform the project design.

Project sites are labeled A through F and concepts at each site are numbered (e.g., A-1, A-2). The pilot project, Ocean Beach – Dog-Beach, is featured first, followed by the other five sites, listed from north to south (Figure 7).

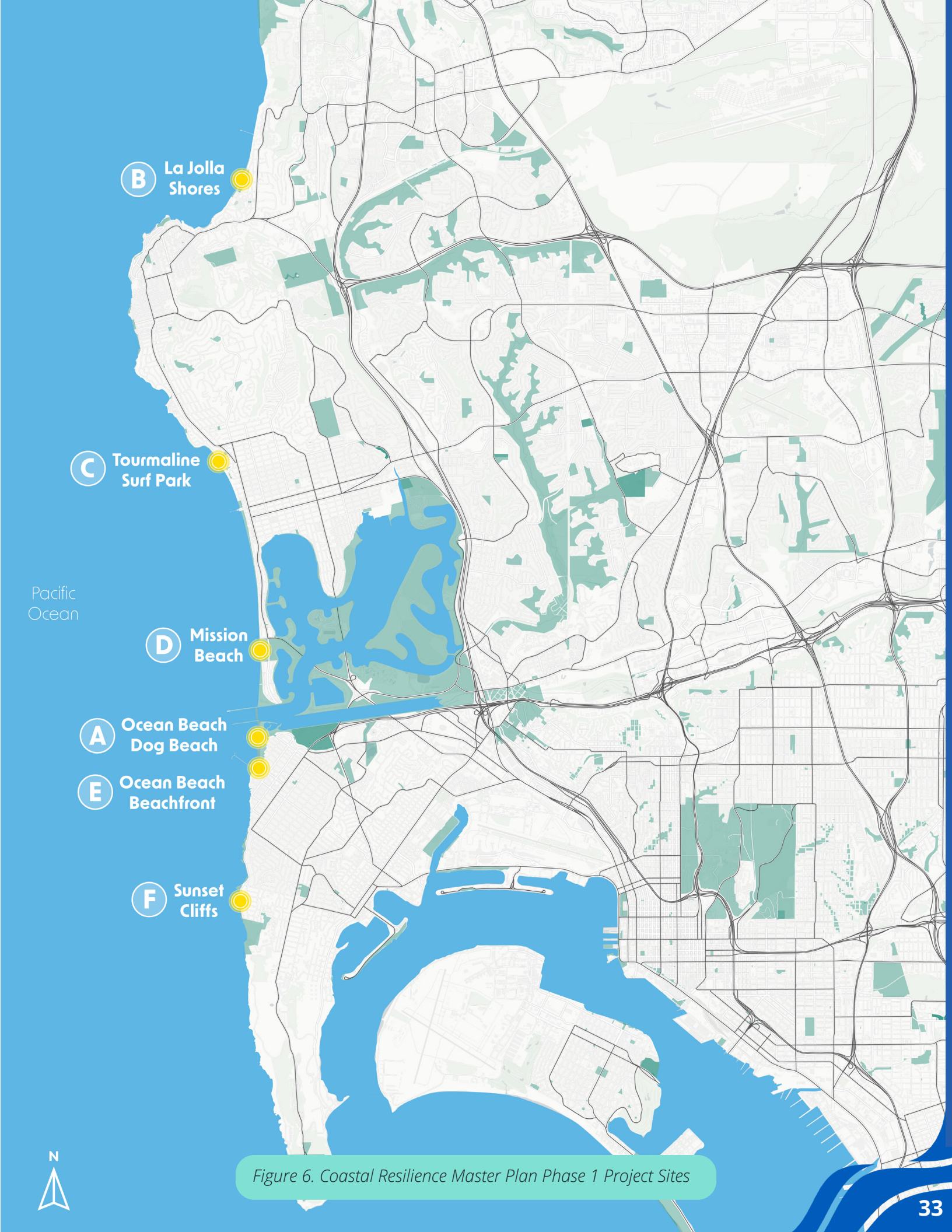


Figure 6. Coastal Resilience Master Plan Phase 1 Project Sites

Ocean Beach – Dog Beach

Photo by GHD

Ocean Beach – Dog Beach

The Ocean Beach – Dog Beach project site is approximately 13 acres comprising open space beach and shoreline, a developed parking lot and a small portion of native dune and scrub habitat in the eastern portion of the site. The project site includes a portion of the San Diego River Bikeway and adjacent areas; however, it is located outside of the San Diego River Levee footprint. If the project footprint changes and it is determined that the project may impact the levee, continued coordination with the City's Stormwater Department and the U.S. Army Corps of Engineers would be required.

The concept for Ocean Beach – Dog Beach includes proposed dune habitat restoration along the eastern edge of the project site, a new multi-use path for cyclists and pedestrians fronted by elevated sand dunes along the beach. The multi-use path and sand dunes would be located along the landward edge of the beach, adjacent to the existing parking lot (refer to Concept A-1 figures). The sand dunes, which are inspired by the City's existing winter berm program, would provide flood protection to the coastal park infrastructure and community of Ocean Beach by adding elevation to the back of the beach and by providing a reservoir of sand to the beach that can be utilized during erosive conditions. The proposed sand dunes would make this annual feature a permanent fixture at the project site and would be designed to provide protection from existing and projected flooding impacts associated with sea level rise.

The proposed multi-use path and sand dunes would include pedestrian and emergency access points along the project site and maintain existing parking onsite. The orientation/angle of the accessways would be designed to limit flood water from entering walking paths and accessways during extreme events (e.g., combined high wave energy and high tide). For instance, accessways might be angled away from the dominant wave direction to minimize direct water entry. Small berms and elevation increases might be included in vehicle and pedestrian accessways to divert water away from the paths, providing additional protection against flooding. Sand fencing would be used particularly during the initial phase of dune vegetation establishment, delineating where people should be walking to help protect plants and animals in the dunes. As the project progresses, sand fencing along the back of the dune may remain to support sediment accretion and reduce nuisance sand. Sand fencing along access pathways may be removed and replaced with symbolic fencing (e.g., post and cable) to prevent trampling and support vegetation growth.

An optional component of the concept would be to relocate the existing restroom facility further inland to reduce vulnerability and continued exposure to coastal flooding and sea level rise. Another optional component of the concept would be to provide an express shuttle that runs from an appropriate transportation center (e.g., Old Town Transit Center) to the Ocean Beach – Dog Beach project site (refer to Concept A-2 figures).

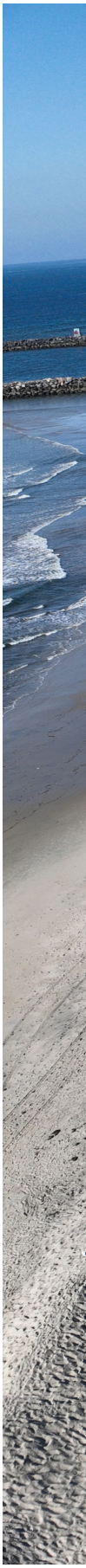


Photo by GHD

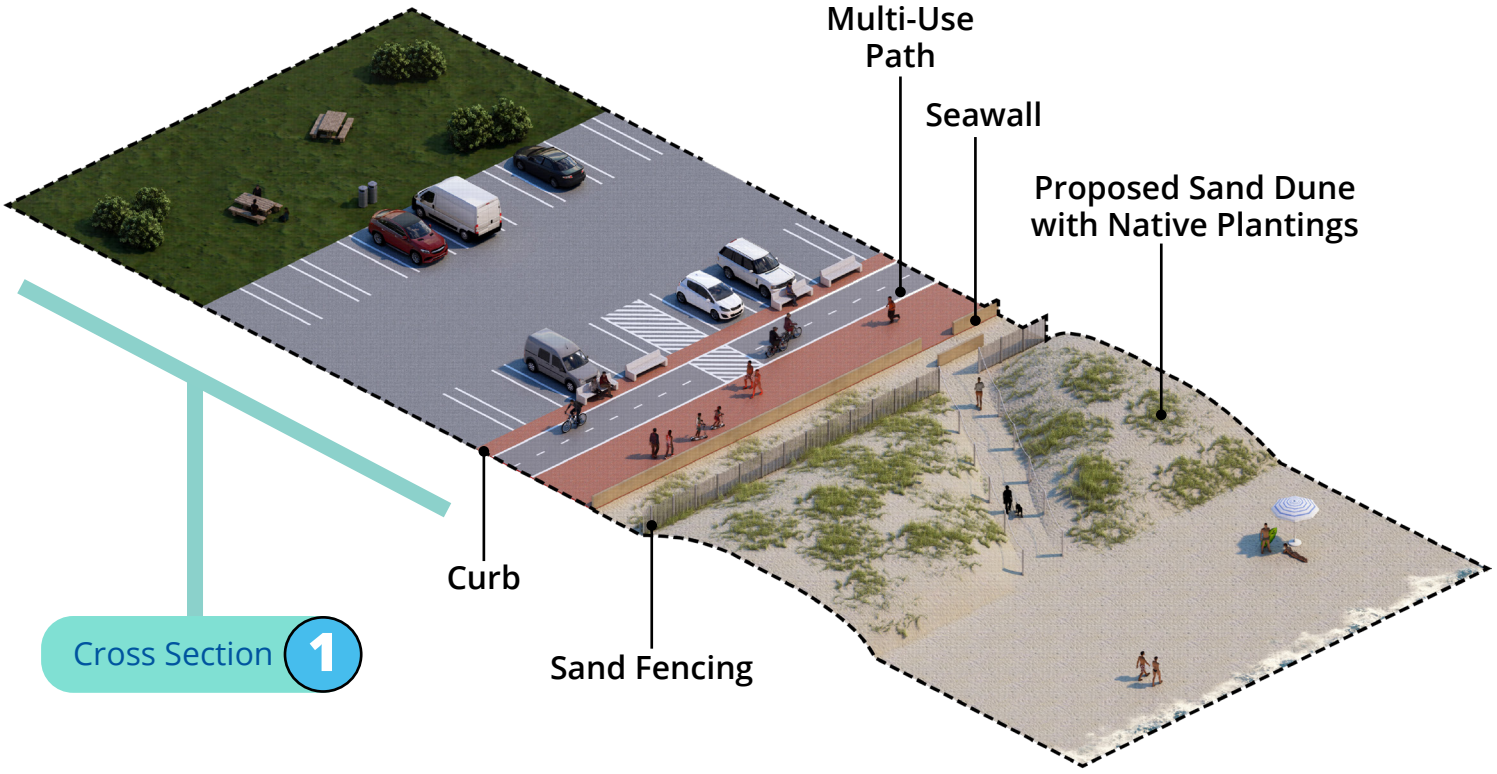
Ocean Beach - Dog Beach facing north towards the mouth of the San Diego River

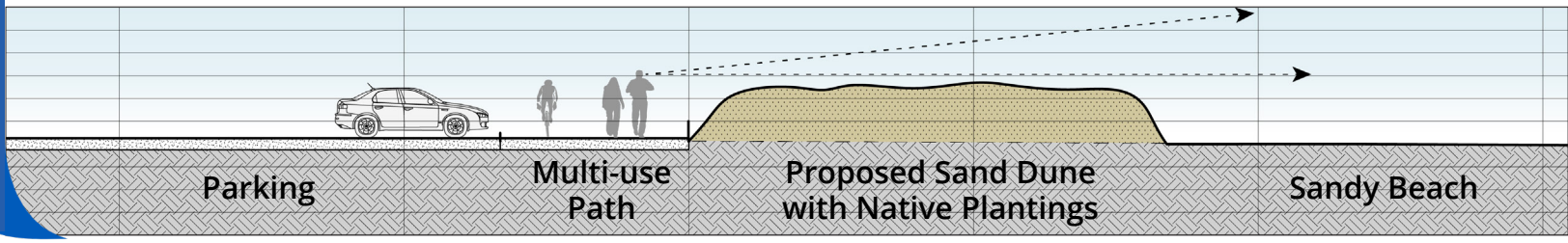
Project Concept A-1: Dunes

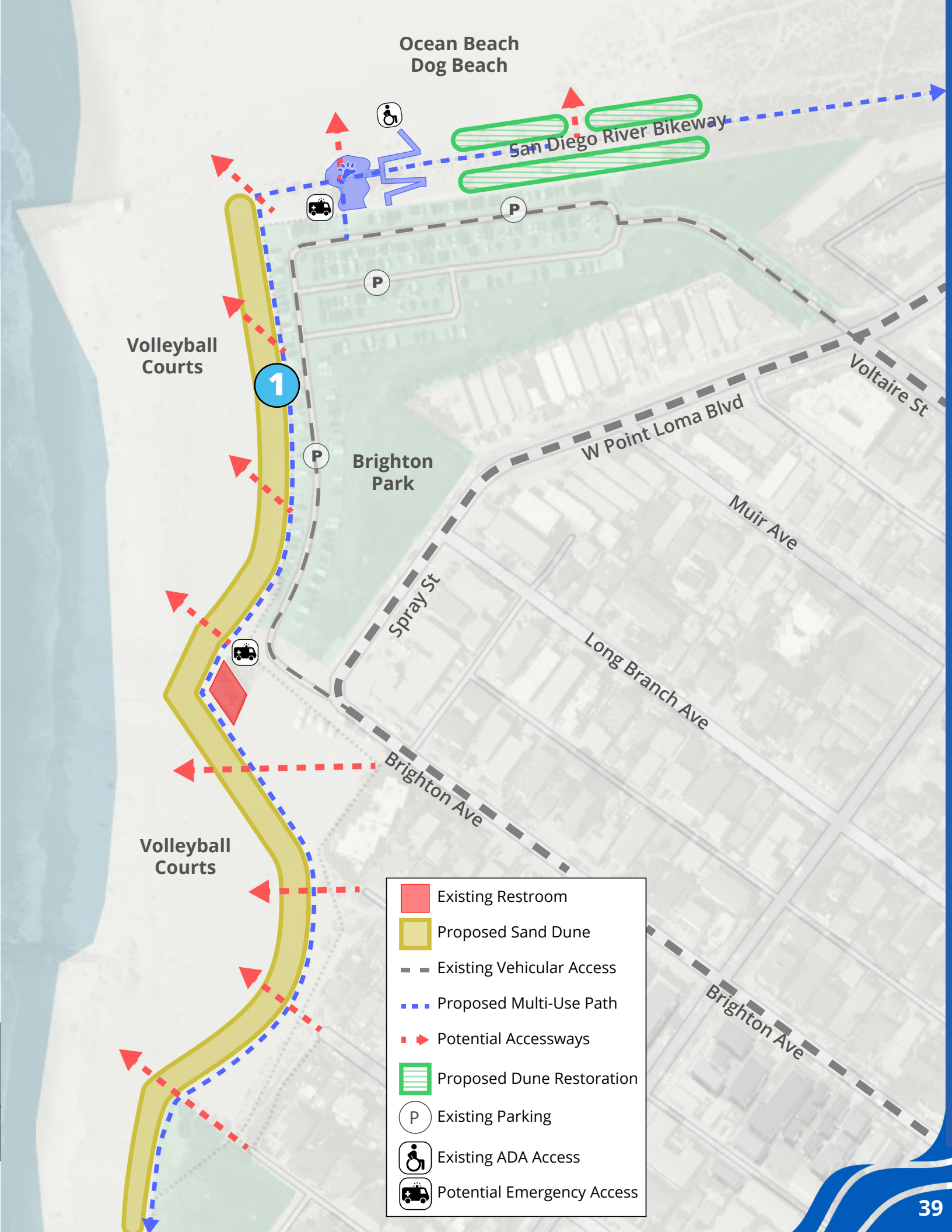
Objectives Implemented

Key Features

- Vegetated dune along beachfront
- Multi-use path to connect San Diego River Trail, Dog Beach and Ocean Beach Pier
- Dune restoration near Smiley Lagoon
- Beach accessways through the dune at key points
- No change to parking





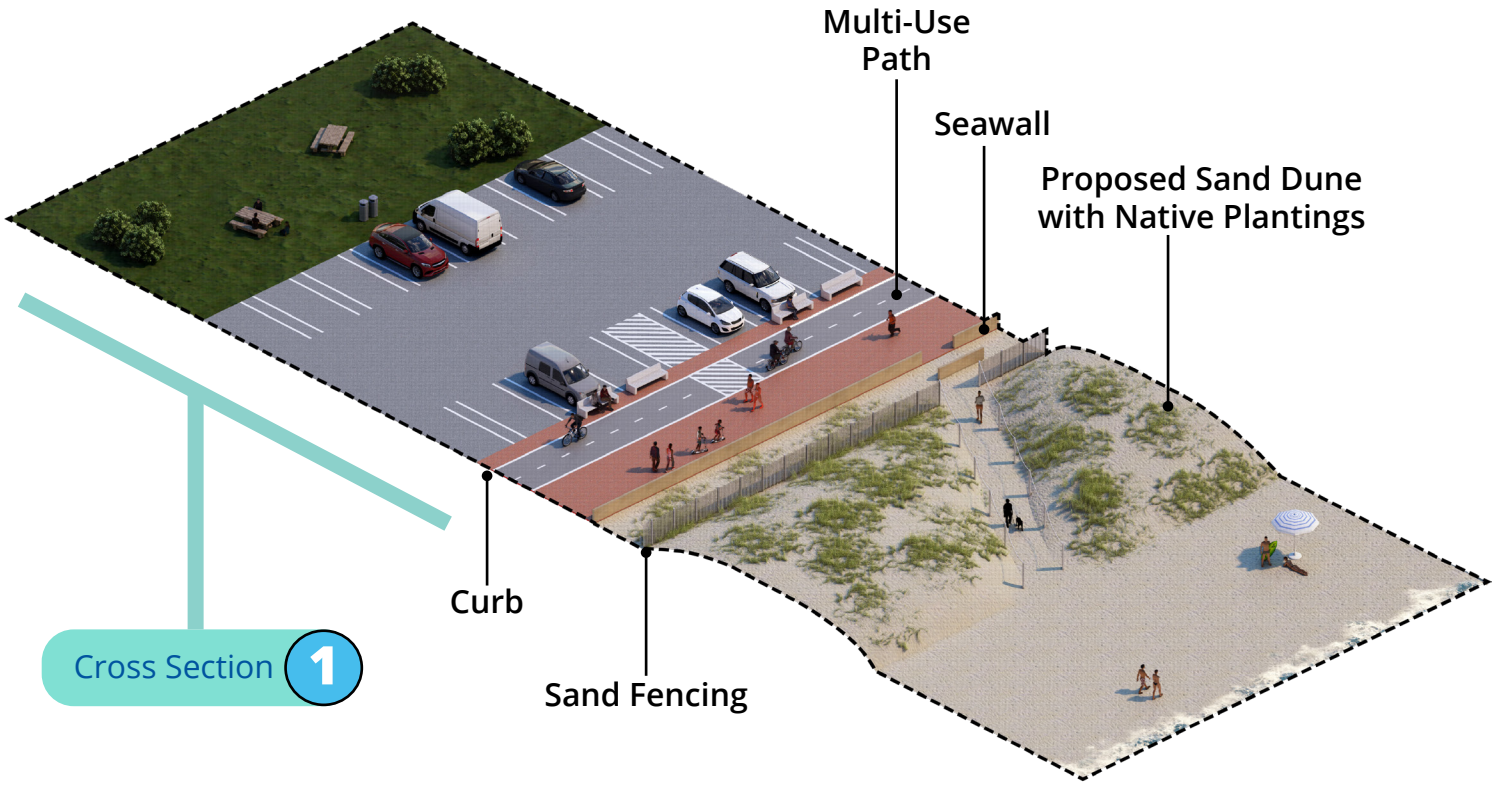

Ocean Beach
Dog Beach
San Diego River Bikeway
P
P
P
Volleyball
Courts
1
Brighton
Park
W Point Loma Blvd
Voltaire St
Muir Ave
Spray St
Long Branch Ave
Brighton Ave
Brighton Ave
Volleyball
Courts
Existing Restroom
Proposed Sand Dune
Existing Vehicular Access
Proposed Multi-Use Path
Potential Accessways
Proposed Dune Restoration
Existing Parking
Existing ADA Access
Potential Emergency Access

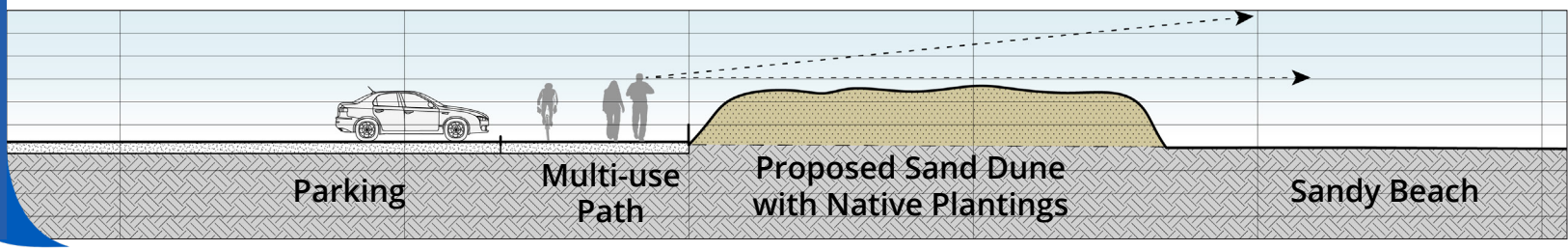
Project Concept A-2: Resilient Relocation

Objectives Implemented

Key Features

- Vegetated dune along beachfront
- Multi-use path to connect San Diego River Trail, Dog Beach and Ocean Beach Pier
- Dune restoration near Smiley Lagoon
- Beach accessways through the dune at key points
- Bathroom relocation to a centralized, more protected inland location
- Potential public transit stop






Ocean Beach
Dog Beach
San Diego River Bikeway
Volleyball
Courts
1
Brighton
Park
W Point Loma Blvd
Voltaire St
Muir Ave
Spray St
Long Branch Ave
Brighton Ave
Volleyball
Courts
Brighton Ave
Relocated Restroom
Proposed Sand Dune
Existing Vehicular Access
Proposed Multi-Use Path
Potential Accessways
Proposed Dune Restoration
Existing Parking
Existing ADA Access
Potential Emergency Access
Potential Shuttle Stops

For Further Consideration

- Explore opportunies to tie-into San Diego River Park Trail improvements, including trail upgrades, as identified in the San Diego River Trail, Trail Enhancement Plan.
- Identify opportunities to relocate impacted volleyball courts to maintain overall number of courts if possible (10 permanent, 4 seasonal).
- Explore addition of express shuttle stop that would run from nearby transportation center (e.g., Old Town Transit Center) to the project site to improve access to the coast and reduce vehicle dependence and congestion.
- Evaluate stormwater conditions and potential infrastructure improvements.
- Evaluate inclusion of electric vehicle charging and/or solar carports at parking lot.

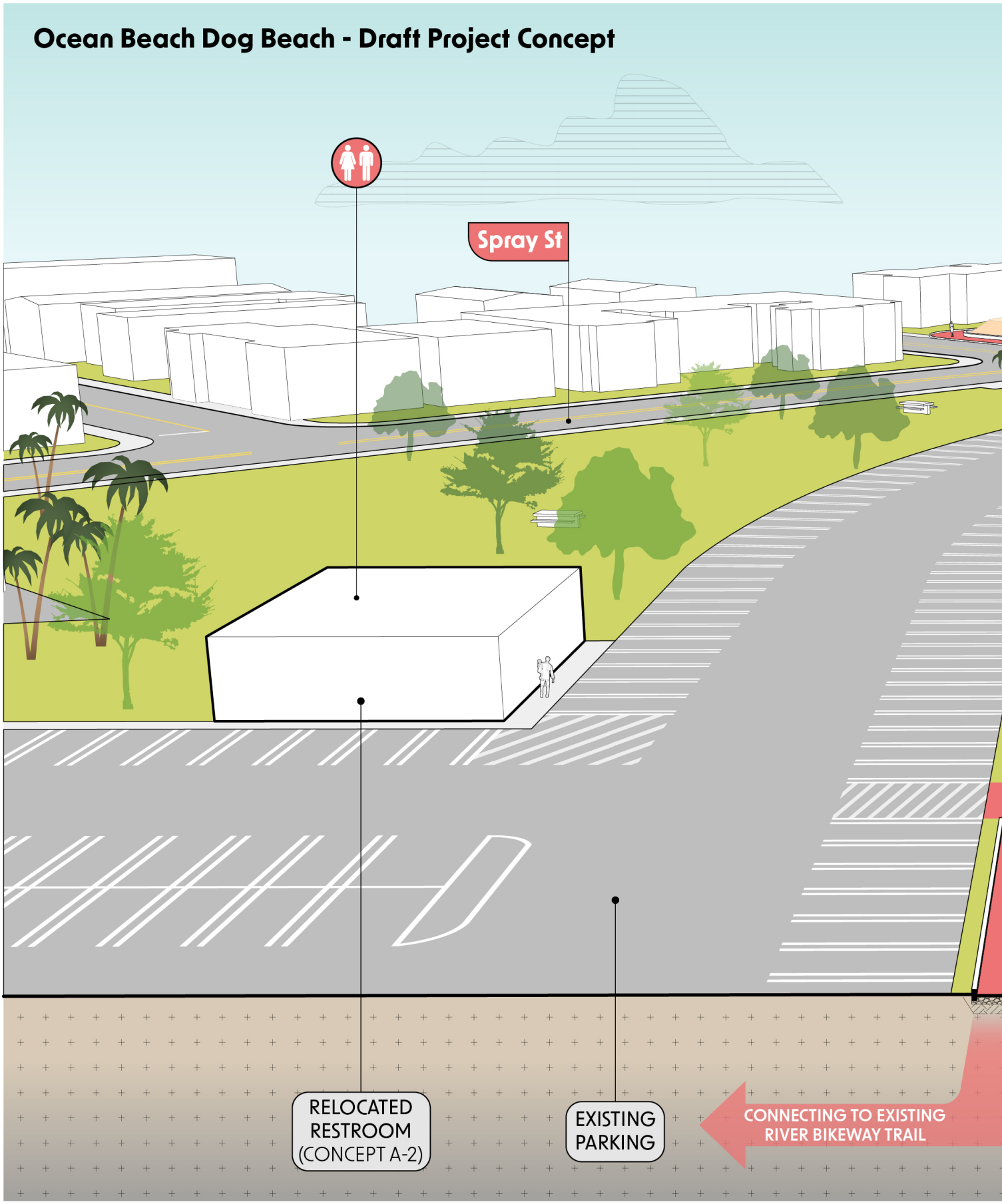
Photo by GHD

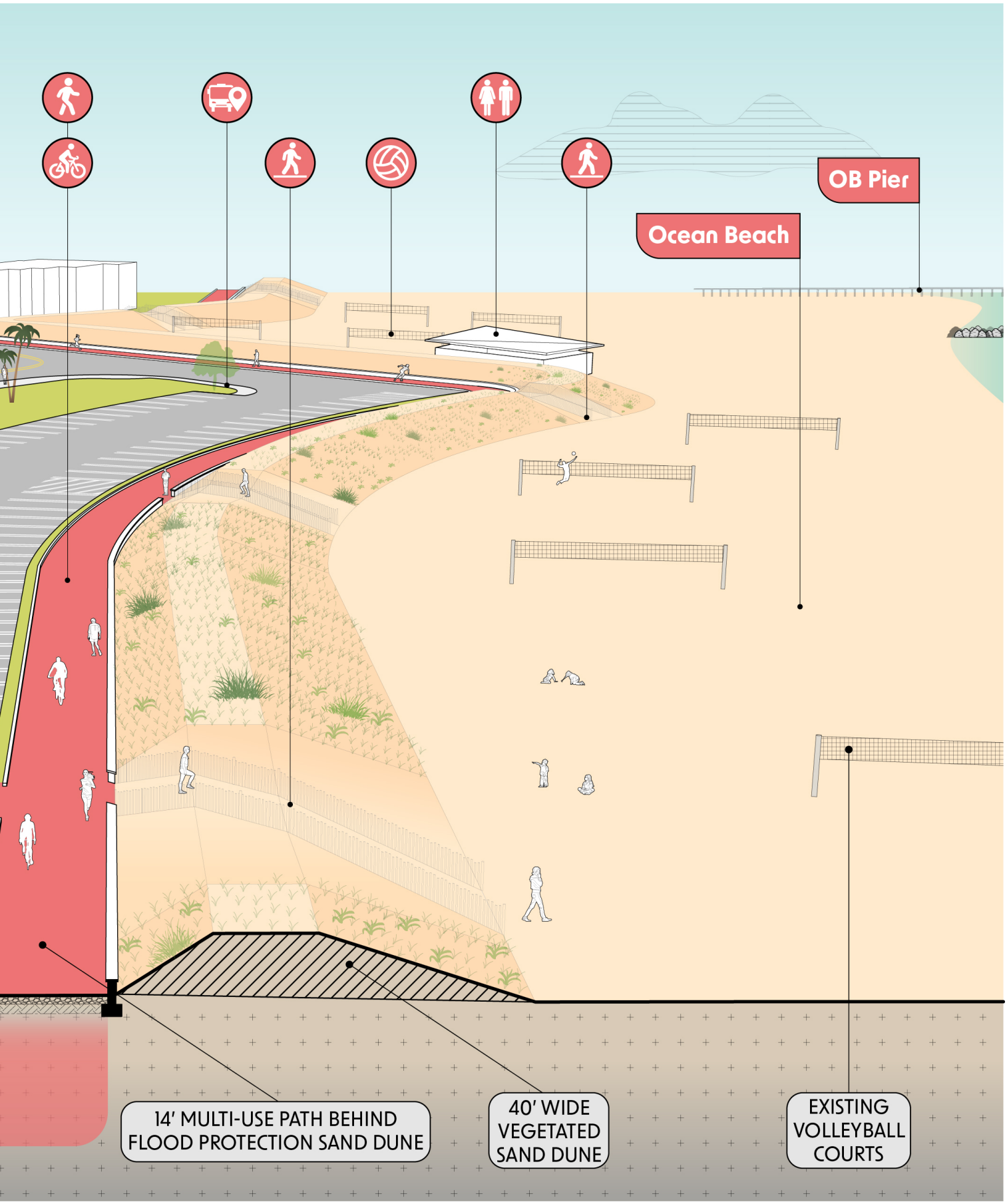
The volleyball courts at Ocean Beach

San Diego River Trail: Trail Enhancement Plan

In 2016, the San Diego River Park Foundation completed a Trail Enhancement Plan for the San Diego River Trail. The Trail Enhancement Plan establishes a framework for implementation of a comprehensive river park system, guided by five principles: restore and maintain a healthy river system, unify fragmented lands and habits, create a connected continuum with a sequence of unique places and experiences, reveal the river valley history, and reorient development toward the river to create value and opportunities for people to embrace the river. The plan covers the entire estuary segment of the San Diego River Trail and overlaps with a portion of the Ocean Beach – Dog Beach project sites. Recommendations from this plan could be included in the Ocean Beach – Dog Beach project design as the project concepts moves forward, including but not limited to trail improvements, signage and wayfinding, and inclusion of additional rest points and shade structures.

San Diego River Park Foundation


Ocean Beach Dog Beach - Draft Project Concept
Spray St
RELOCATED RESTROOM (CONCEPT A-2)
EXISTING PARKING
CONNECTING TO EXISTING RIVER BIKEWAY TRAIL
Path/Walk
Restrooms
Biking



Access Path Shuttle Stop Volleyball

La Jolla Shores

La Jolla Shores

The La Jolla Shores project site is approximately 21 acres and extends from the intersection of Paseo Del Ocaso and El Paseo Grande at the northern boundary to Avenida De La Playa at the southern end. The site includes open space beach, shoreline, parkland and the La Jolla Shores parking lot, which provides approximately 360 vehicle parking spaces. The La Jolla Shores project site consists of two grassy park areas (La Jolla Shores Park to the north and Kellogg Park to the south) separated by a paved parking lot located immediately east of a boardwalk (La Vereda pedestrian path) and sandy beach area to the west.

The Amphitheatre Design concept (Concept B-1) to maintain the existing alignment for La Jolla Shores would construct two different flood protection strategies across the site. Along the seaward (western) borders of La Jolla Shores Park and Kellogg Park, an elevated linear earthen dike would be constructed between the grassy area and the La Vereda pedestrian path. The earthen dike could be contoured and planted with native plants to integrate more natural elements and provide ecological benefits. Along the seaward border of the parking lot (between the parking lot and the La Vereda pedestrian path), a terraced seatwall would be constructed to provide a viewing and seating area while also providing flood protection benefits. The seatwall could be constructed with concrete or fill that is graded and encapsulated by concrete retaining walls, pavers and other stonework. Using fill in combination with pavers could create a more welcoming environment. This approach allows for terraced seating areas that are planted, offering picnicking opportunities in an amphitheater style.

The Reconfigured Park concept (Concept B-2) would realign the parking lot and grassy recreational areas essentially swapping the seaward edge of the parking lot for a more inland alignment where the parking lot would be reoriented more linearly along Camino del Oro. A grassy recreational area would be added along the entire western edge of the site (formerly parking lot) creating a large linear and continuous grassy park. The project design would keep existing footprints of the grassy recreational areas and parking lot intact (the total area of recreational space would remain the same and the total number of parking spaces would remain the same). The design of the grassy recreation areas could incorporate the elevated earthen dike with an amphitheater design as described above, or it could incorporate a gradual slope across the entire area.

The picnic areas at La Jolla Shores Park

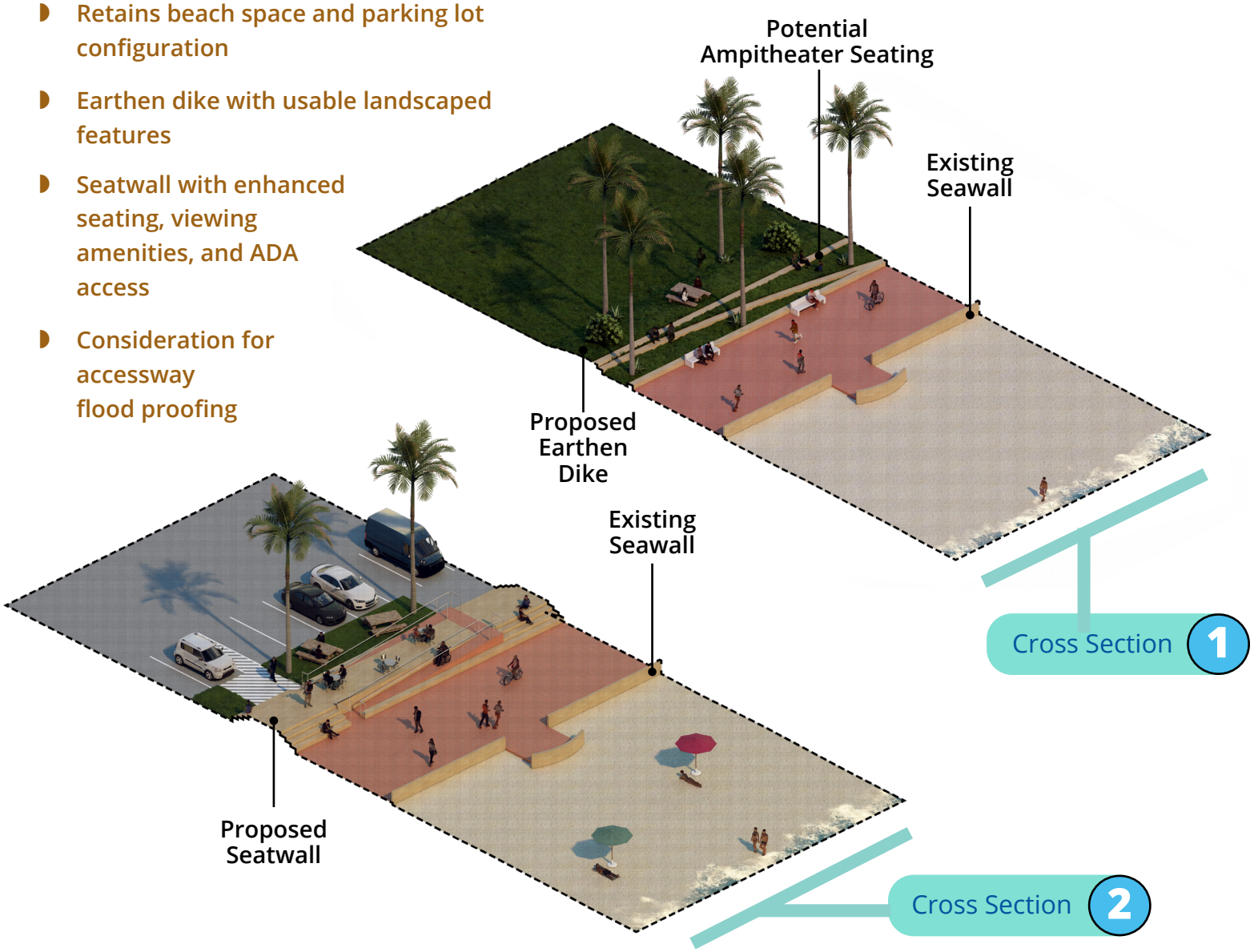
La Jolla Shores beach facing south

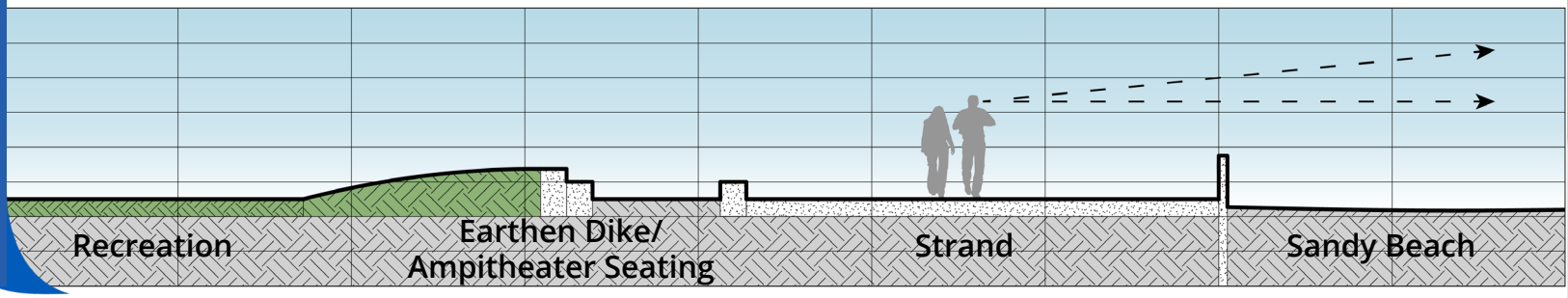
Project Concept B-1: Amphitheater Design

Objectives Implemented

Key Features:

- Retains beach space and parking lot configuration
- Earthen dike with usable landscaped features
- Seatwall with enhanced seating, viewing amenities, and ADA access
- Consideration for accessway flood proofing





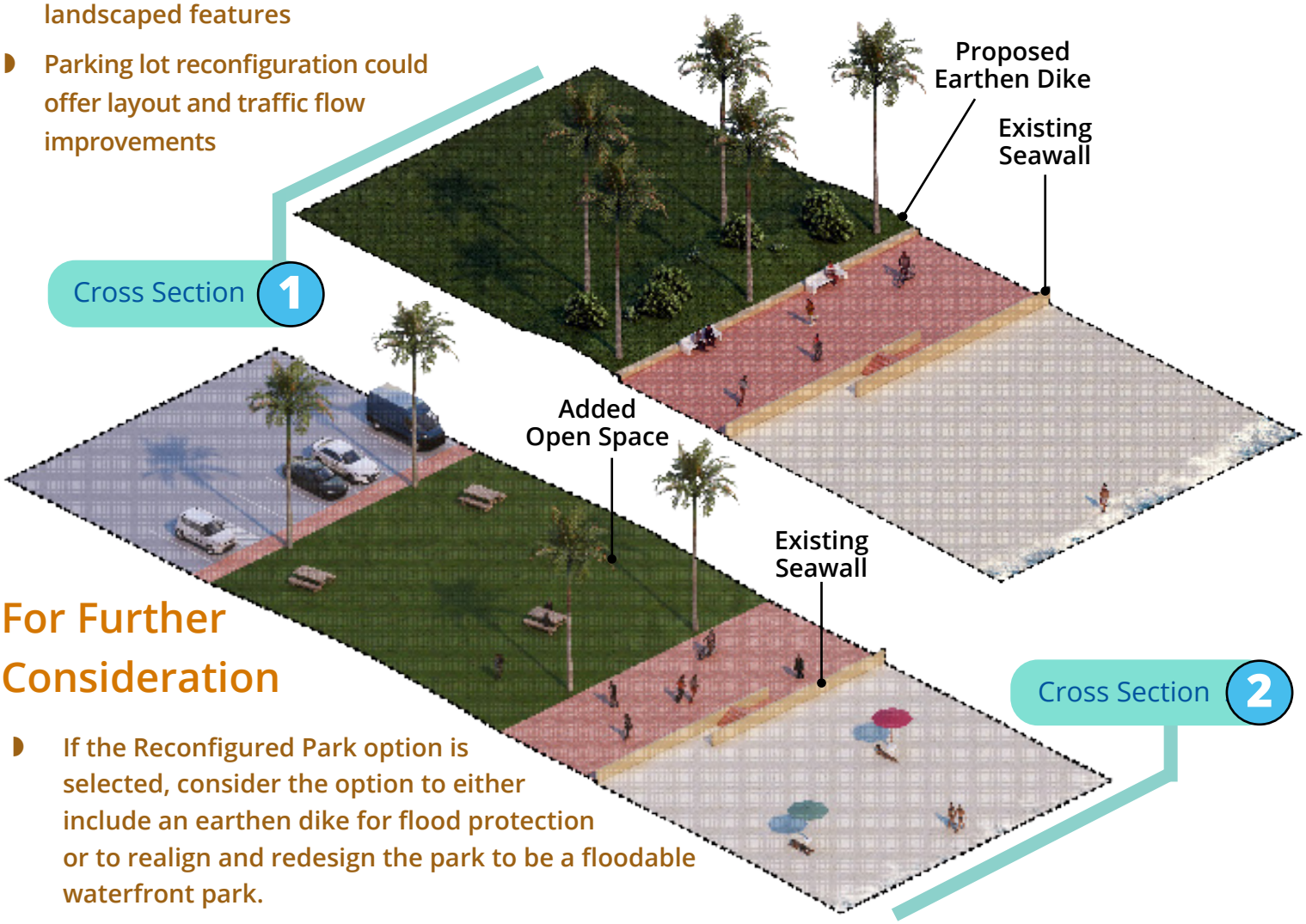

Existing Lifeguard Facilities
Existing Restrooms
Proposed Elevated Earthen Dike
Proposed Seat Wall
Proposed Floodwall
Existing Vehicular Access
Proposed Pedestrian Access
Potential Accessways
P
Existing Parking
Existing Playground
Existing Community Area
Existing ADA Access
Emergency Access
Manual Beach Wheelchair at Lifeguard Station
Beach Access Mat
Sandy Beach
1
La Vereda
La Jolla Shores Park
El Paseo Grande
Camino Del Oro
Paseo Del Ocaso
2
P
La Vereda
Camino Del Oro
El Paseo Grande
Paseo Del Ocaso
Calle Frescota
Sandy Beach
La Vereda
Kellogg Park
Camino Del Oro
El Paseo Grande
Paseo Del Ocaso

Project Concept B-2: Reconfigured Park

Objectives Implemented

Key Features

- Retains beach space
- Continuous grassy recreational area along the entire length of the park
- Earthen dike with usable landscaped features
- Parking lot reconfiguration could offer layout and traffic flow improvements
- Consideration for accessway flood proofing
- Consideration for opportunities to expand recreational areas and play structures at the southern end of the park



For Further Consideration

- If the Reconfigured Park option is selected, consider the option to either include an earthen dike for flood protection or to realign and redesign the park to be a floodable waterfront park.
- Consider opportunities to raise awareness of history and culture of the site, such as through art, interpretive signage and educational installations.
- Option to add a new or relocated restroom facility to replace the one that would be removed from the parking lot to create a reconfigured park.
- Evaluate stormwater conditions and consider potential infrastructure improvements.


Existing Lifeguard Facilities
Proposed Elevated Earthen Dike
Proposed/Added Open Space
Existing Restroom
Storage Facility To Be Removed
Existing Vehicular Access
Proposed Pedestrian Access
Potential Accessways
Existing Parking
Potential Parking Relocation
Existing Playground
Existing Community Area
Existing ADA Access
Emergency Access
Manual Beach Wheelchair at Lifeguard Station
Beach Access Mat
Sandy Beach
1
La Vereda
La Jolla Shores Park
El Paseo Grande
Camino Del Oro
2
Paseo Del Ocaso
Calle Frescota
Sandy Beach
Kellogg Park
P

Pacific Beach – Tourmaline Surf Park

Photo by GHD

Pacific Beach – Tourmaline Surf Park

The approximately 4-acre Pacific Beach – Tourmaline Surf Park project site is located along and at the end of Tourmaline Street. The stretch of beach at this project site is naturally narrow due to the coastal bluff-backed setting and contains open space beach and shoreline to the west, a developed parking lot and landscape areas to the east and stormwater infrastructure along the northern perimeter of the project site boundary.

The concept for Pacific Beach – Tourmaline Surf Park would convert the existing shoreline protection feature into a hybrid nature-based solution. The existing rip rap would be buried to provide a core layer and topped with a mix of cobble and sand. The proposed sand and cobble dune would be vegetated with native plantings, which would provide ecological benefits through rare plant species and habitat for various avian species. The proposed sand dune would provide protection for the existing access ramp, restroom and parking lot from existing and projected flooding impacts associated with sea level rise, as well as provide a reservoir of sand and cobble to the beach that can be utilized during erosive conditions. A wide section along the top of the dune would remain unvegetated to allow for sitting and viewing space, similar to the existing sandy area near the top of the access ramp. Existing seating areas are limited to a couple of benches and logs at the west end of the parking lot. Some visitors also sit on the existing revetment.

Additional seating and enhanced viewing areas would be integrated into the top of the vegetated dune, increasing the usability and aesthetics of the site. Formalized pedestrian access would be integrated into the northern end of the dune, which would improve safety for visitors and limit foot traffic effects (e.g., minor erosion and trampling) on the vegetated dune (refer to Concept C-1 figures).

An optional component includes covering or undergrounding the existing drainage culvert along the north edge of the project site. Additional optional stormwater improvements include an underground vault beneath the parking lot to capture runoff and provide water quality treatment.

Photo by GHD

The parking lot, restrooms and access ramp at Tourmaline Surf Park

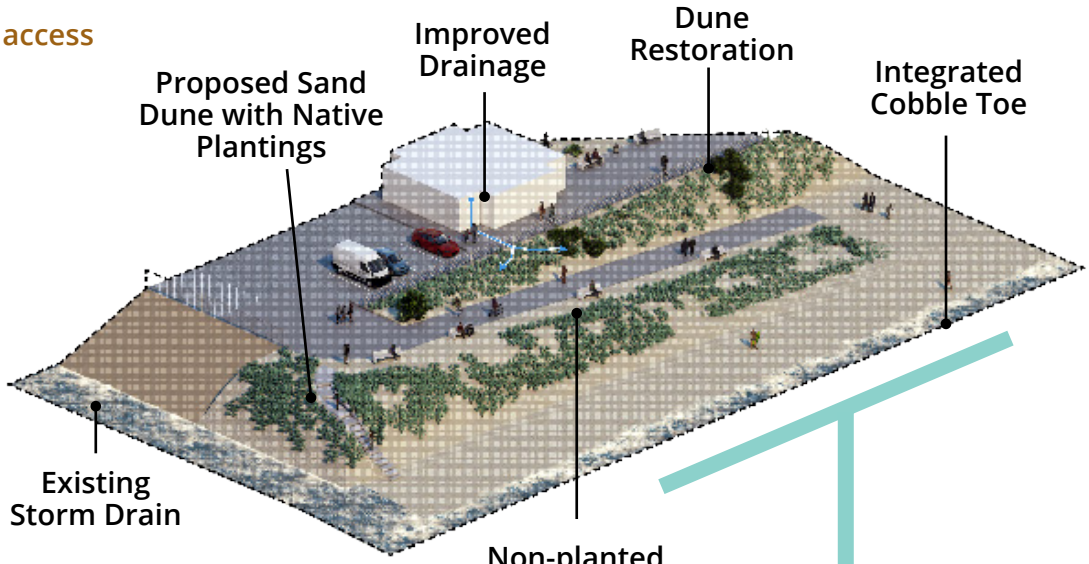
Tourmaline Surf Park facing north

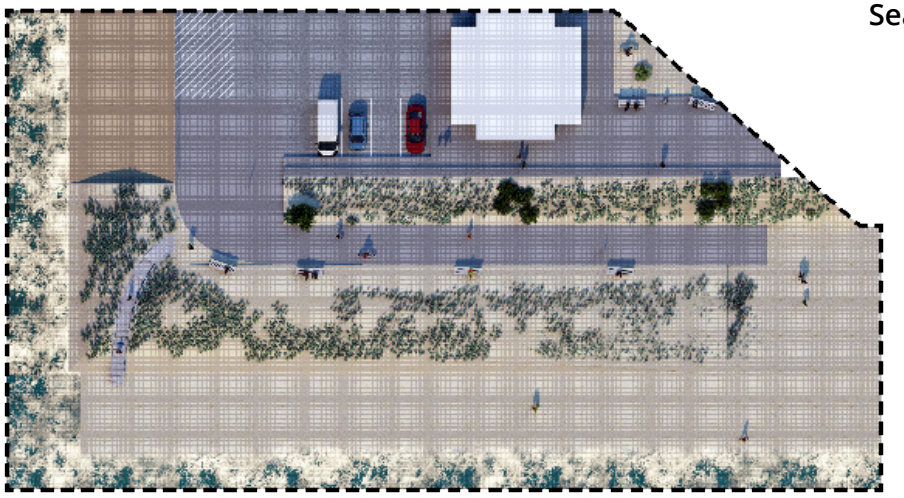
Project Concept C-1: Resilient Surf Park

Objectives Implemented

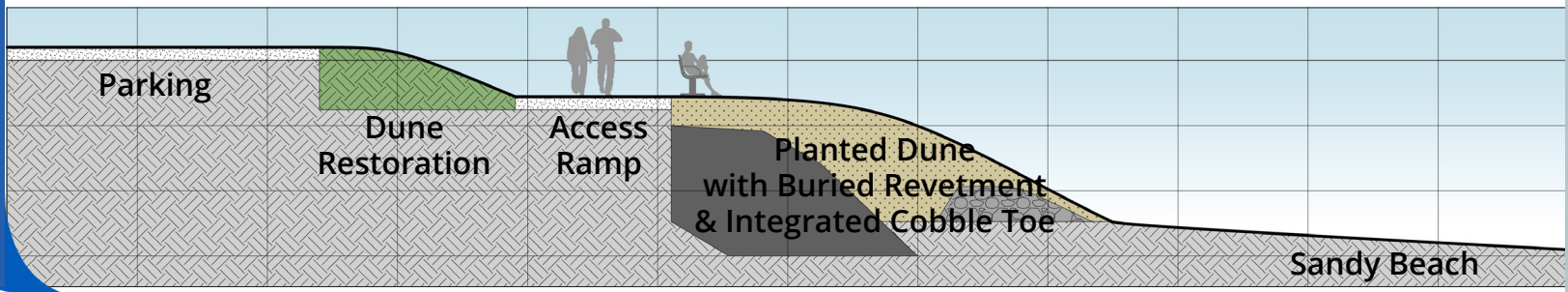
Key Features

- Vegetated dune leveraging existing material
- Enhance existing seating, access and aesthetics
- Retain public and vehicular access via ramp
- Improve access on north end of ramp





Cross Section 1




Existing Restroom
Proposed Sand Dune
Existing Vehicular Access
Proposed Pedestrian Access
Potential Accessways
P
Existing Parking
Optional Pedestrian Pathway
Existing Storm Drain
Emergency Access
La Jolla Blvd
Tourmaline St
P
1
Tourmaline
Surf Park

For Further Consideration

- Consider additional optional design features including undergrounding of the storm drain culvert and development of an underground vault for water quality benefits. Initial review by the Stormwater Department confirmed the potential for both of these design features at this project site; however, additional assessments would be needed as this project concept moves forward to confirm asset condition, maintenance requirements and model climate change conditions for the channel to determine if additional capacity may be needed.
- While not evaluated under this planing effort, a more extensive project design could evaluate relocation of the bathroom to a more inland location. This would provide the opportunity to shift the parking lot landward, creating more space along the seaward edge of the project site for the beach to migrate landward and maintain as sea levels rise. Consideration for maintaining coastal access for City lifeguards and existing stormwater infrastructure should accompany any design changes.
- Consider realignment of parking lot for better flow of traffic and enhanced visitor safety.
- Consider opportunities for addition of ADA compliant pedestrian walkways for enhanced access and safety to the beach.

Case Study: Stormwater Infrastructure Integration with Coastal Accessway, Fletcher Cove Beach Park, Solana Beach, CA

Fletcher Cove was created in the 1920s and has seen access, recreation, and stormwater infrastructure improvements over the last century. Similar to Tourmaline Beach, the northern end of Fletcher Cove includes a stormwater drainage system that helps move water from the elevated inland bluff down to the beach area. By undergrounding the pipes and placing them alongside the beach access ramp, the drainage system at Fletcher Cove is effectively hidden in plain sight. Given this similar configuration, Fletcher Cove in Solana Beach serves as an analogous site to Tourmaline Beach, offering comparable coastal features and highlighting opportunities to potentially increase public access at Tourmaline by undergrounding the stormwater drainage infrastructure. This conceptual option for Tourmaline includes undergrounding the existing culvert, which would allow for pedestrian access and the implementation of other amenities on the newly available space.

California Coastal Records Project

Mission Beach

Photo by GHD

Mission Beach

The approximately 8-acre Mission Beach project site consists of an approximately 0.3-mile stretch of Mission Beach bounded by Ventura Place to the north and San Fernando Place to the south, encompassing the beach area fronting Belmont Park and Mission Beach Park. The project site consists primarily of the sandy beach area west of Ocean Front Walk.

The Sand Dune concept for Mission Beach (Concept D-1) would construct an elevated sand dune seaward (west) of the seawall and Ocean Front Walk. The proposed sand dunes would be vegetated with native plantings, which would provide ecological benefits. The sand dunes, which are inspired by the City's existing winter berm program, would provide flood protection to the community of Mission Beach by adding elevation to the landward side of the beach and by providing a reservoir of sand to the beach that can be utilized during erosive conditions. The proposed sand dunes would be a permanent fixture at the project site and would be designed to provide protection from existing and projected flooding impacts associated with sea level rise. Sand fencing would be installed behind the dunes to help delineate where people should be walking, protect to plants and animals populating the dunes and retain sand in the dune system.

The Perched Beach concept for Mission Beach (Concept D-2) considers swapping out grass recreational space at Mission Beach Park, the southern area of the project site, for a perched sand beach. A perched beach is an elevated beach area that would provide increased usable beach space during higher water levels and offers a reservoir of sand for the adjacent beach area. This would be achieved by realigning the seawall and Ocean Front Walk inland. This concept could be implemented in conjunction with a dune feature stretching north along the project site.

Photo by GHD

Mission Beach and Belmont Park facing south

Photo by GHD

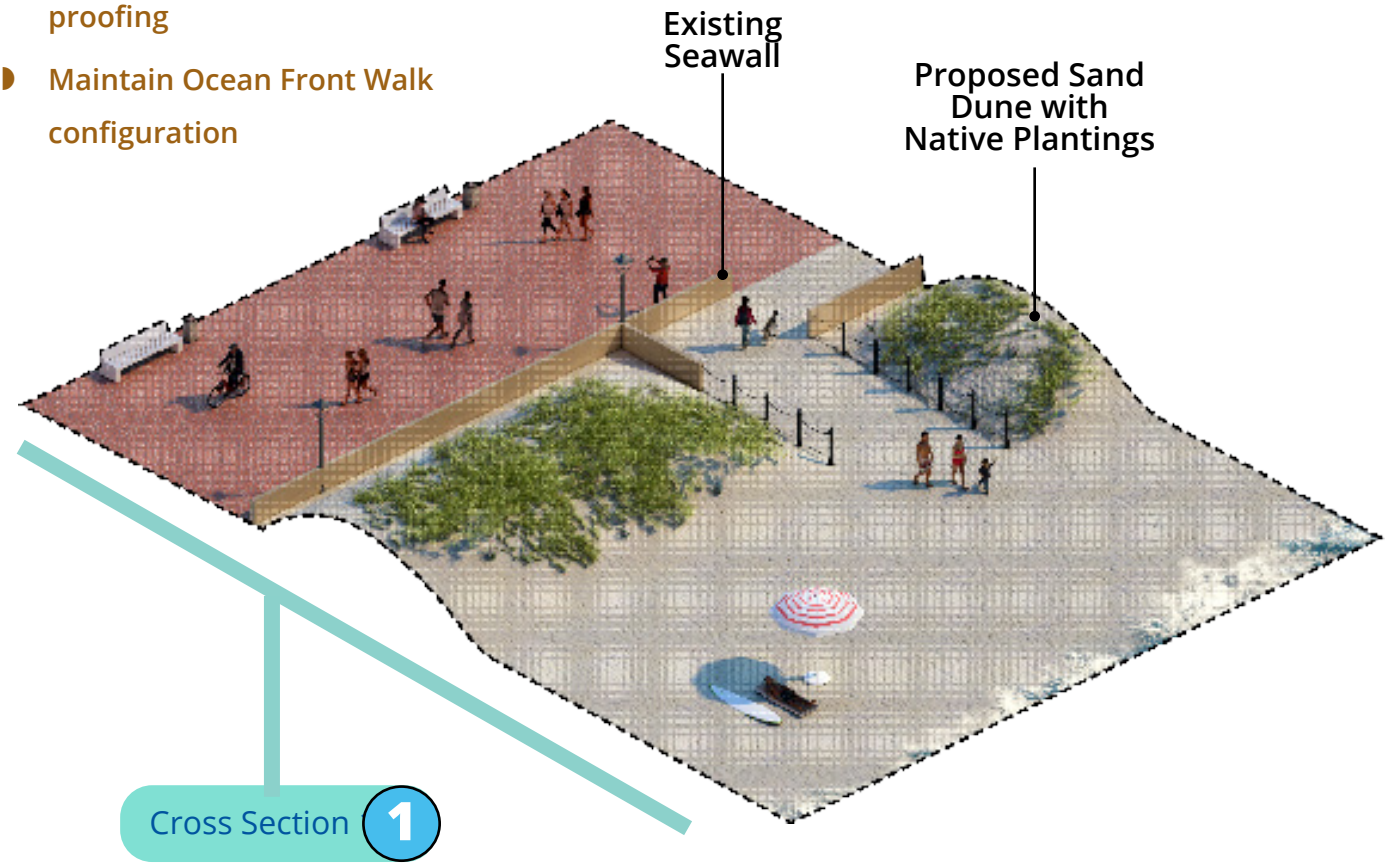
Mission Beach facing north

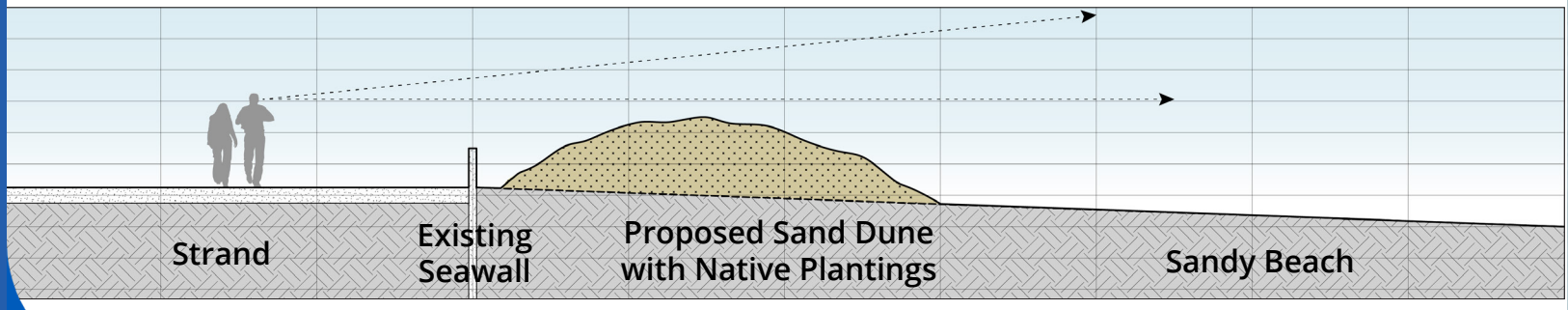
Project Concept D-1: Dune Design

Objectives Implemented

Key Features:

- Vegetated dune with native planting
- Maintain accessways with consideration for accessway flood proofing
- Maintain Ocean Front Walk configuration





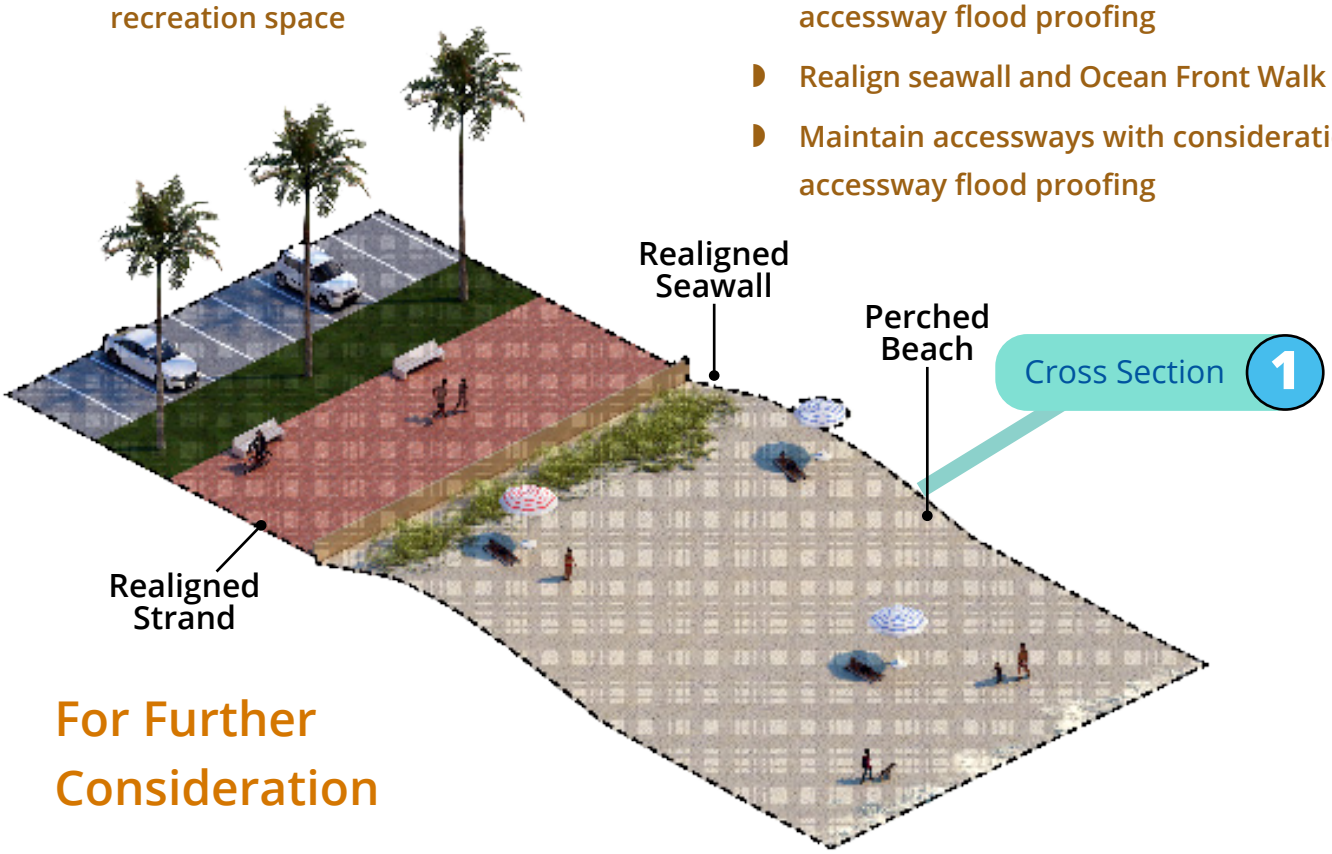

Mission Beach Boardwalk
P
Belmont Park
Ocean Front Walk
Mission Blvd
1
P
P
Mission Beach Park
San Fernando Pl
Motorized Beach Wheelchair
Manual Beach Wheelchair at Lifeguard Station
Beach Access Mat
Existing Restroom
Existing Lifeguard Tower
Proposed Sand Dune
Existing Vehicular Access
Proposed Pedestrian Path
Proposed Ped. Accessways
P
Existing Parking
Proposed ADA Access
Emergency Access

Project Concept D-2: Perched Beach

Objectives Implemented

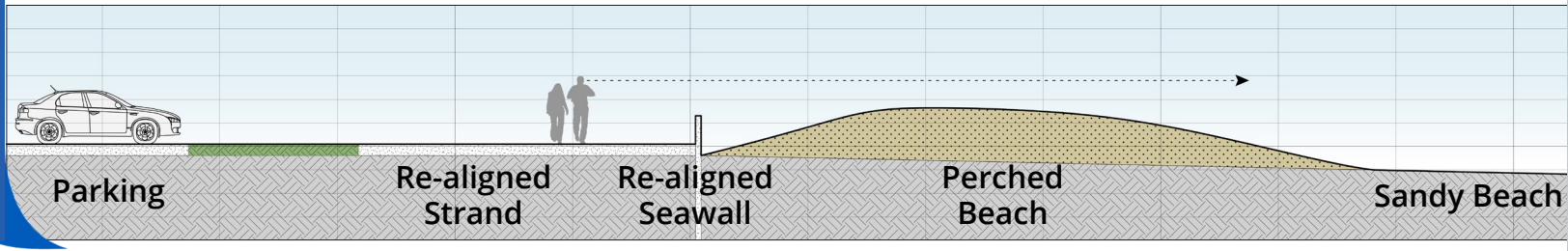
Key Features

- Vegetated dune with native planting
- Perched beach for additional beach recreation space
- Maintain accessways with consideration for accessway flood proofing
- Realign seawall and Ocean Front Walk inland
- Maintain accessways with consideration for accessway flood proofing



For Further Consideration

- The Mission Beach seawall is a historical resource with eligibility for listing on the National Register. If the Perched Beach option is chosen, additional review will be required for compliance with all applicable regulations.
- Ensure continued opportunities for volleyball at or near the project site.
- Evaluate inclusion of electric vehicle charging and/or solar carports at Mission Beach Parking Lot.




Mission Beach Boardwalk
Belmont Park
Ocean Front Walk
Mission Blvd
Mission Beach Park
San Fernando Pl
P
1
Motorized Beach Wheelchair
Manual Beach Wheelchair at Lifeguard Station
Beach Access Mat
Existing Restroom
Existing Lifeguard Tower
Proposed Sand Dune
Existing Vehicular Access
Proposed Pedestrian Path
Proposed Ped. Accessways
Existing Parking
Proposed ADA Access
Emergency Access

Ocean Beach – Beachfront (Pier)

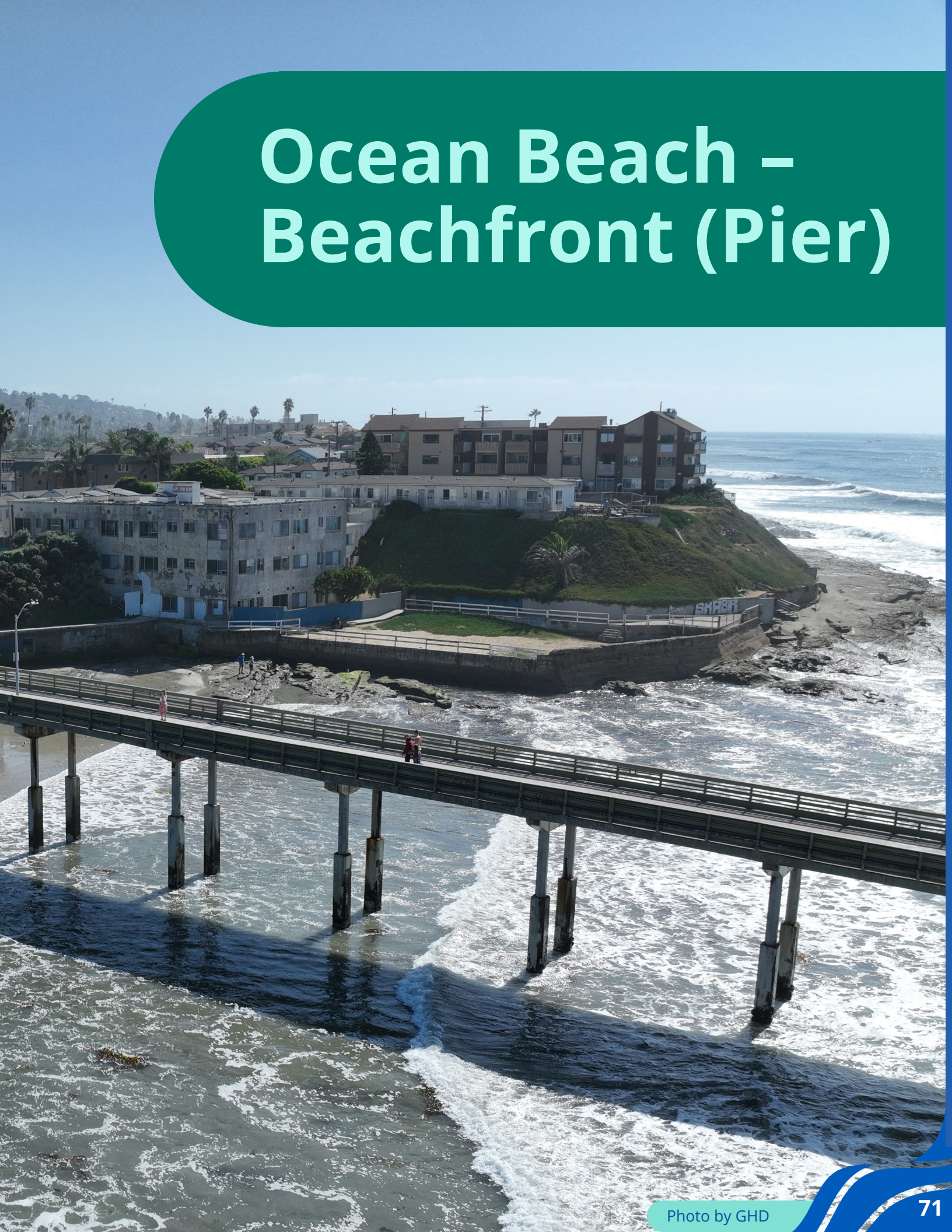


Photo by GHD

Ocean Beach – Beachfront (Pier)

The Ocean Beach – Beachfront (Pier) project site is immediately adjacent to and south of the Ocean Beach – Dog Beach site. The approximately 12-acre project site consists of open space beach and shoreline, as well as a developed parking lot, with a small portion of commercial development along the southeastern edge. The site extends from the groin at the south end of the Ocean Beach – Dog Beach project site to the Ocean Beach Pier.

Similar to Ocean Beach – Dog Beach, the concept for Ocean Beach – Beachfront would construct a multi-use path for cyclists and pedestrians fronted by an elevated vegetated sand dune. The dunes and path would be located along the landward edge of the beach and would connect to the proposed improvements at the Dog Beach project site. As such, the multi-use path would connect the existing western terminus of the San Diego River Trail to the Ocean Beach Pier (refer to Concept E-1 figures).

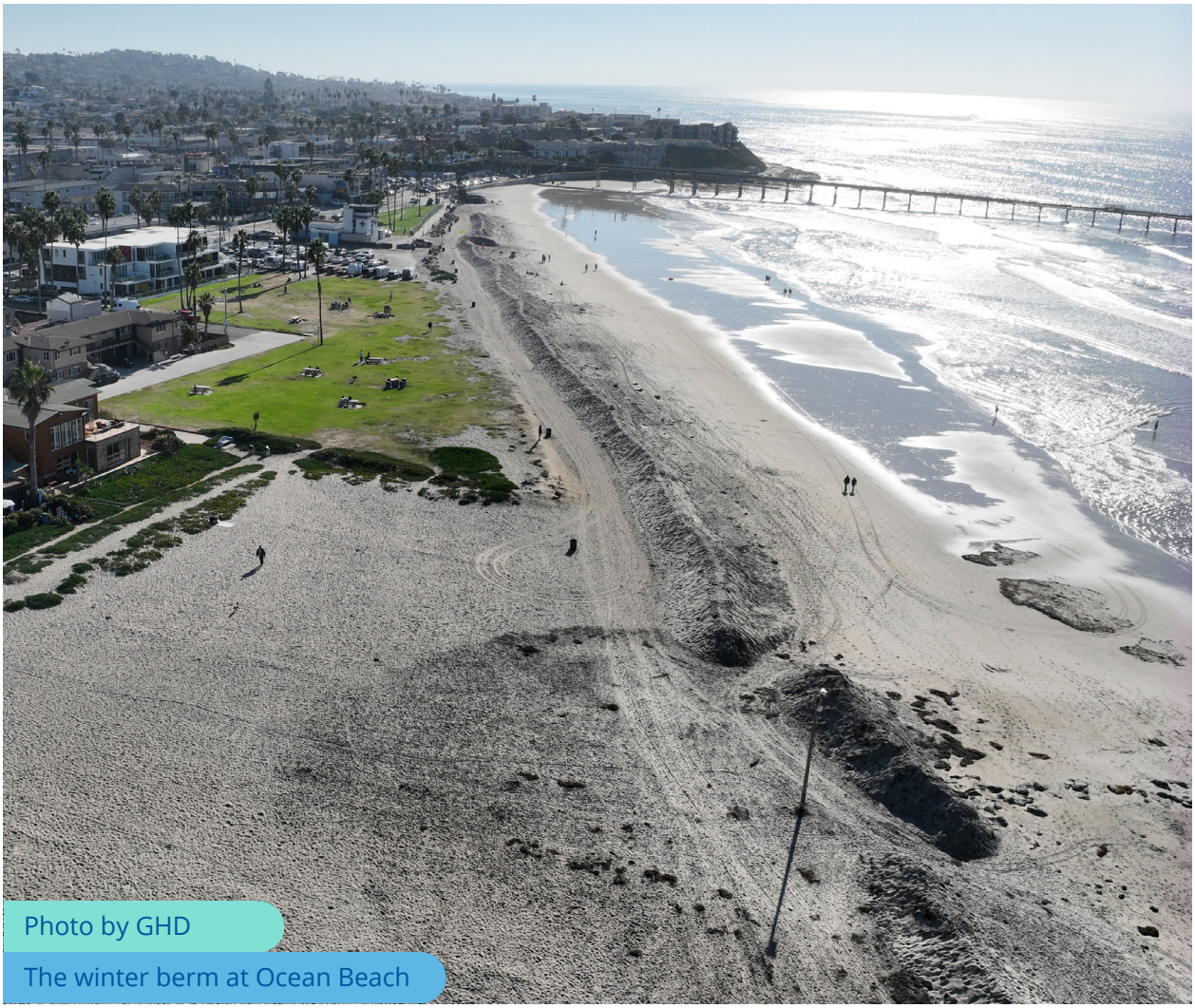


Photo by GHD

The winter berm at Ocean Beach

Sand fencing would be used particularly during the initial phase of dune vegetation establishment, delineating where people should be walking to help protect plants and animals in the dunes. As the project progresses, sand fencing along the back of the dune may remain to support sediment accretion and reduce nuisance sand. Sand fencing along access pathways may be removed and replaced with symbolic fencing (e.g., post and cable) to prevent trampling and support vegetation growth. As with Ocean Beach – Dog Beach, sand fencing would be used during establishment of the dune vegetation to help delineate where people should be walking, protect plants and animals populating the dunes and retain sand in the dune system. The proposed multi-use path and sand dunes would include pedestrian and emergency access points along the project site and maintain all existing parking. As this project moves forward, there is the opportunity to align the project design with other improvements, including an upgrade to the existing lifeguard station and local park and amenity enhancements at Veterans Park and Saratoga Park. As this concept is developed there are opportunities to combine aspects of these other ongoing efforts and to leverage external funding sources.

Photo by GHD

Ocean Beach Pier

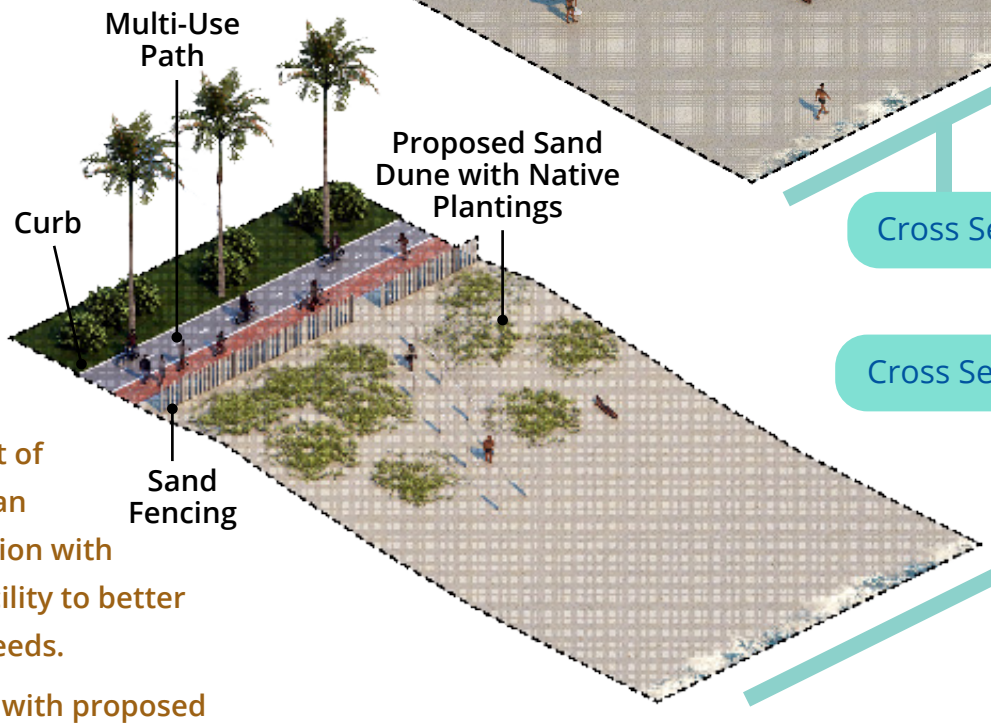
Project Concept E-1: Dunes

Objectives Implemented

Key Features

- Vegetated dune with native planting
- Multi-use path to connect San Diego River Trail, Dog Beach and Pier
- Beach accessways through dunes at key locations
- No change to parking

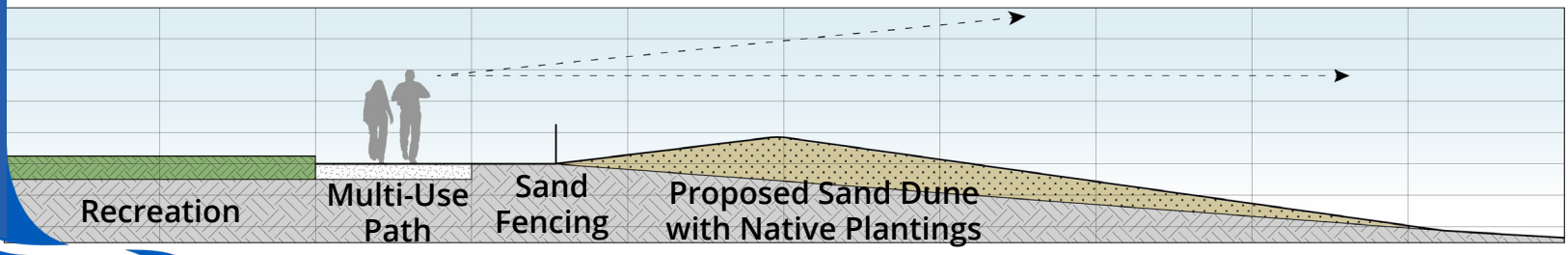
Cross Section 1



Cross Section 2

For Further Consideration

- Include replacement of the permanent Ocean Beach lifeguard station with a new, upgraded facility to better serve operational needs.
- Align project design with proposed enhancements to Veteran's Park and Saratoga Park.
- Evaluate stormwater conditions and potential infrastructure improvements.
- Consideration of opportunities to add additional recreational opportunities and play structures at Saratoga Park or Ocean Beach Veteran's Park.




Existing Lifeguard Tower
Proposed Sand Dune
Existing Vehicular Access
Proposed Multi-Use Path
Potential Accessways
Existing Parking
Proposed ADA Access
Emergency Access
Manual Beach Wheelchair at Lifeguard Station
Beach Access Mat
Cape May Place
Abbott St
Saratoga Park
Saratoga Ave
1
P
Ocean Beach Veteran's Plaza
2
Santa Monica Ave
Abbott St
Ocean Beach
Ocean Beach Pier
Newport Ave
Niagara Ave

Sunset Cliffs

Sunset Cliffs

Sunset Cliffs Boulevard is a two-way, two-lane roadway that runs north-south adjacent to the Sunset Cliffs Linear Park and along an actively eroding cliff to the west. Sunset Cliffs Linear Park runs between Adair Street to the north and Ladera Street to the south including an approximately 1.2-mile-long stretch of open space shoreline and coastal trail adjacent to the Pacific Ocean to the west and Sunset Cliffs Boulevard to the east.

One option for the Sunset Cliffs project includes a road reconfiguration on Sunset Cliffs Boulevard which would create a new separated path for pedestrians with a one-lane, one-way southbound vehicular travel lane.

Another option for the Sunset Cliffs project is to realign the parking lots along the northern portion of the project site away from the cliff edge. This option includes trail enhancements, revegetation of the linear park with native vegetation, drainage improvements as necessary and removal of the paved parking lots from the cliff edge to pull-in parking spaces along the roadway (refer to Concept F-1 figures).

Given the narrow cliff edges and limited amount of recreational space consisting of informal trails, a major focus for the Sunset Cliffs project is to enhance the existing resources without compromising the structural integrity of the cliff or current infrastructure.

Existing rip rap shoreline protection at Sunset Cliffs

Unstable cliffs areas at Sunset Cliffs

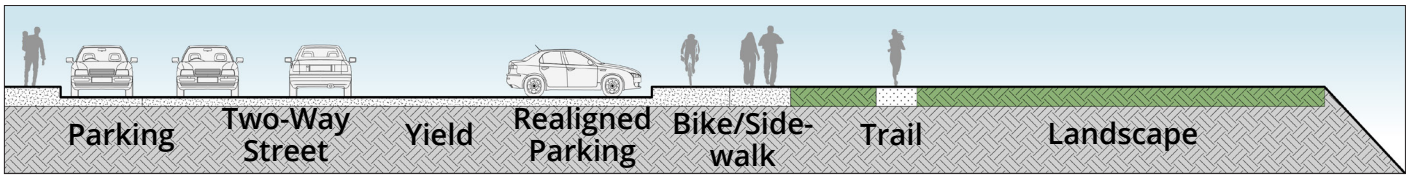
Project Concept F-1: Resilient Cliff Design Options

Objectives Implemented

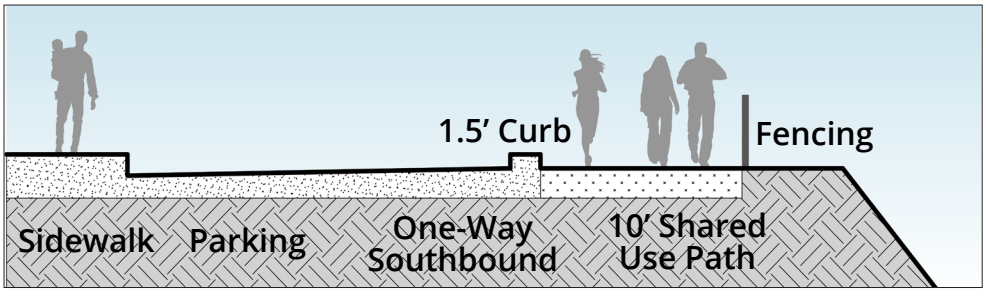
Design Options

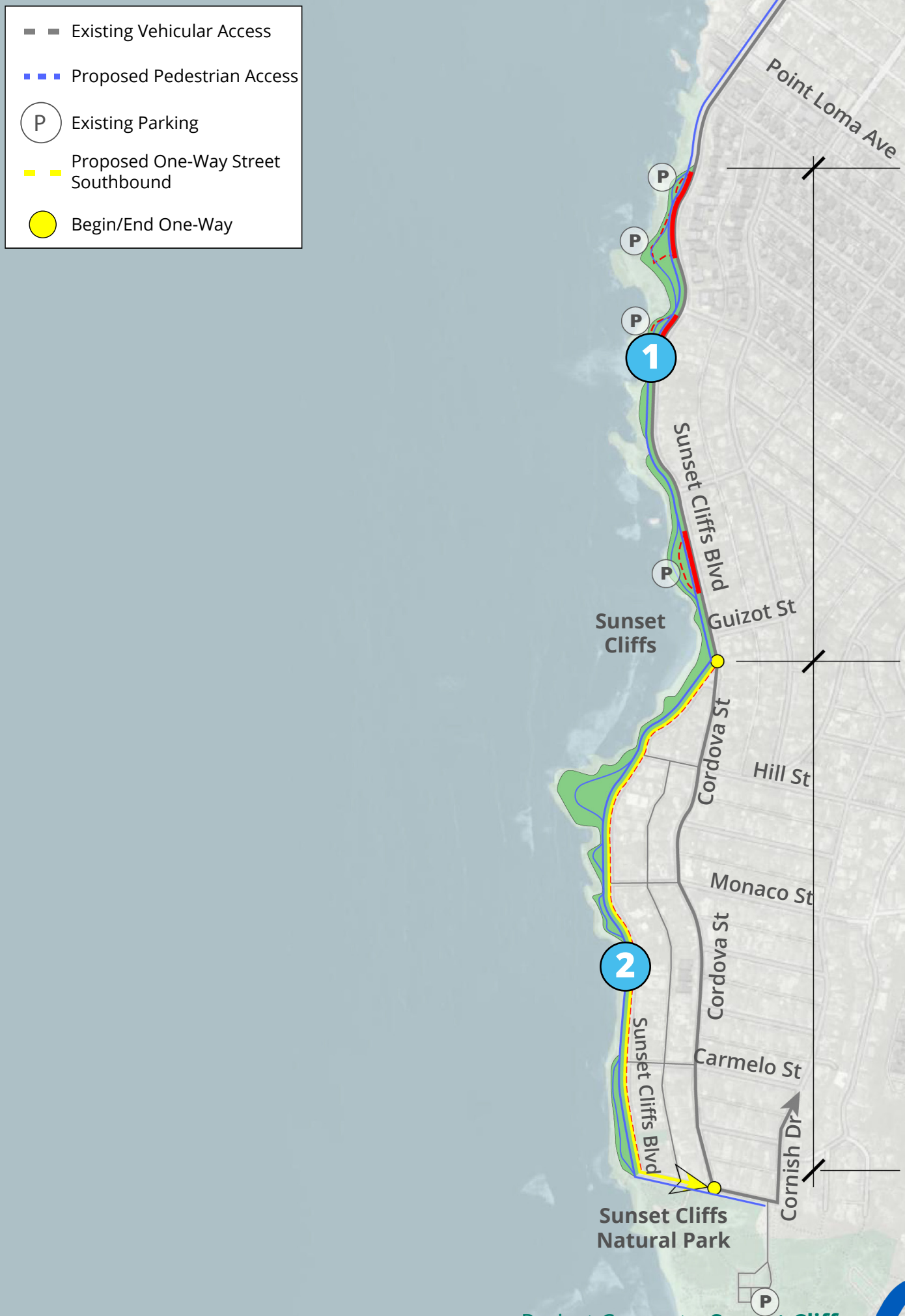
Sunset Cliffs Natural Park Master Plan, City of San Diego, July 2005

- Preserve existing two-way street until intersection of Cordova Street
- Realign existing parking lots pulled back from cliffside
- Propose protected dedicated paths for pedestrians adjacent to realigned parking areas
- Re-vegetate clifftop with native plantings to strengthen cliff structure and provide additional green space



- Propose one-way street from Cordova Street intersection south to Ladera Street
- Preserve parallel parking spaces along the eastern edge of the street
- Propose protected dedicated paths for pedestrians
- Re-vegetate clifftop with native plantings to strengthen cliff structure and provide additional green space
- Propose shared-lane (sharrow) with bikes and vehicles adjacent to path




Existing Vehicular Access
Proposed Pedestrian Access
P
Existing Parking
Proposed One-Way Street Southbound
Begin/End One-Way
Point Loma Ave
Sunset Cliffs Blvd
Guizot St
Sunset Cliffs
Cordova St
Hill St
Monaco St
Cordova St
Carmelo St
Sunset Cliffs Blvd
Cornish Dr
Sunset Cliffs Natural Park
1
2
P

Key Features

- Parking lot realignment
- Trail realignment and/or enhancements
- New multi-use path with reconfigured roadway
- Native plantings

Shoreline protection at Sunset Cliffs facing south

For Further Consideration

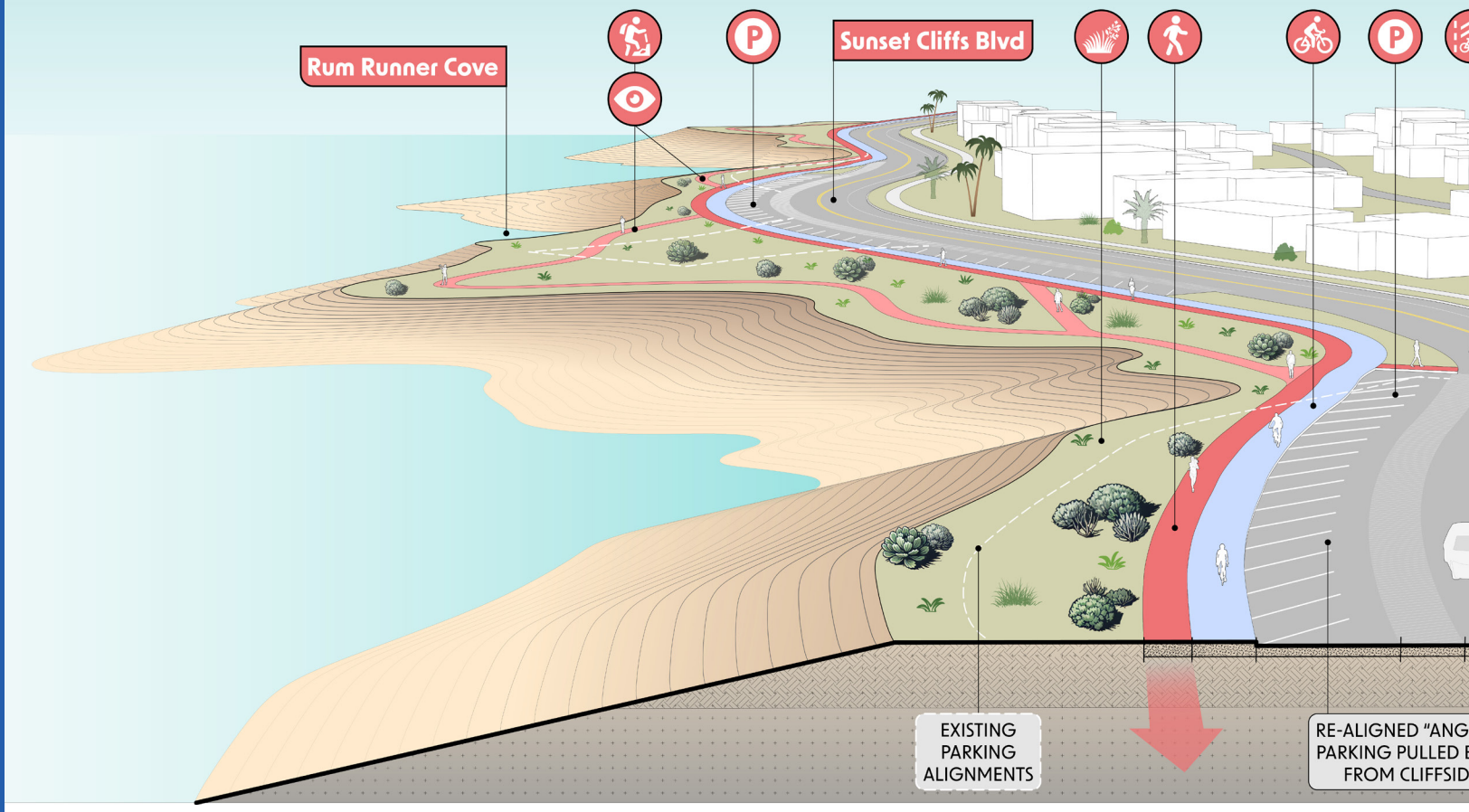
- Consider inland drainage components to further reduce stormwater flow on and through the cliffs, as this drainage has potential to increase coastal erosion. Drainage capture, transport and discharge infrastructure improvements at the individual street level could help reduce additional contributions to cliff erosion.
- Consider parking options along stretch of Sunset Cliffs to support public safety, visitor access and coastal resilience, including but not limited to: timed or paid parking and realignment of parking.
- Evaluate traffic flow with proposed road reconfiguration. Complete traffic studies and evaluate opportunities to enhance pedestrian and bicyclist safety, such as through high visibility crosswalks, roundabouts and speed bumps.
- Consider opportunities for educational signage regarding site geology, local history and habitat.

Circulate Walk Audit, Sunset Cliffs Boulevard

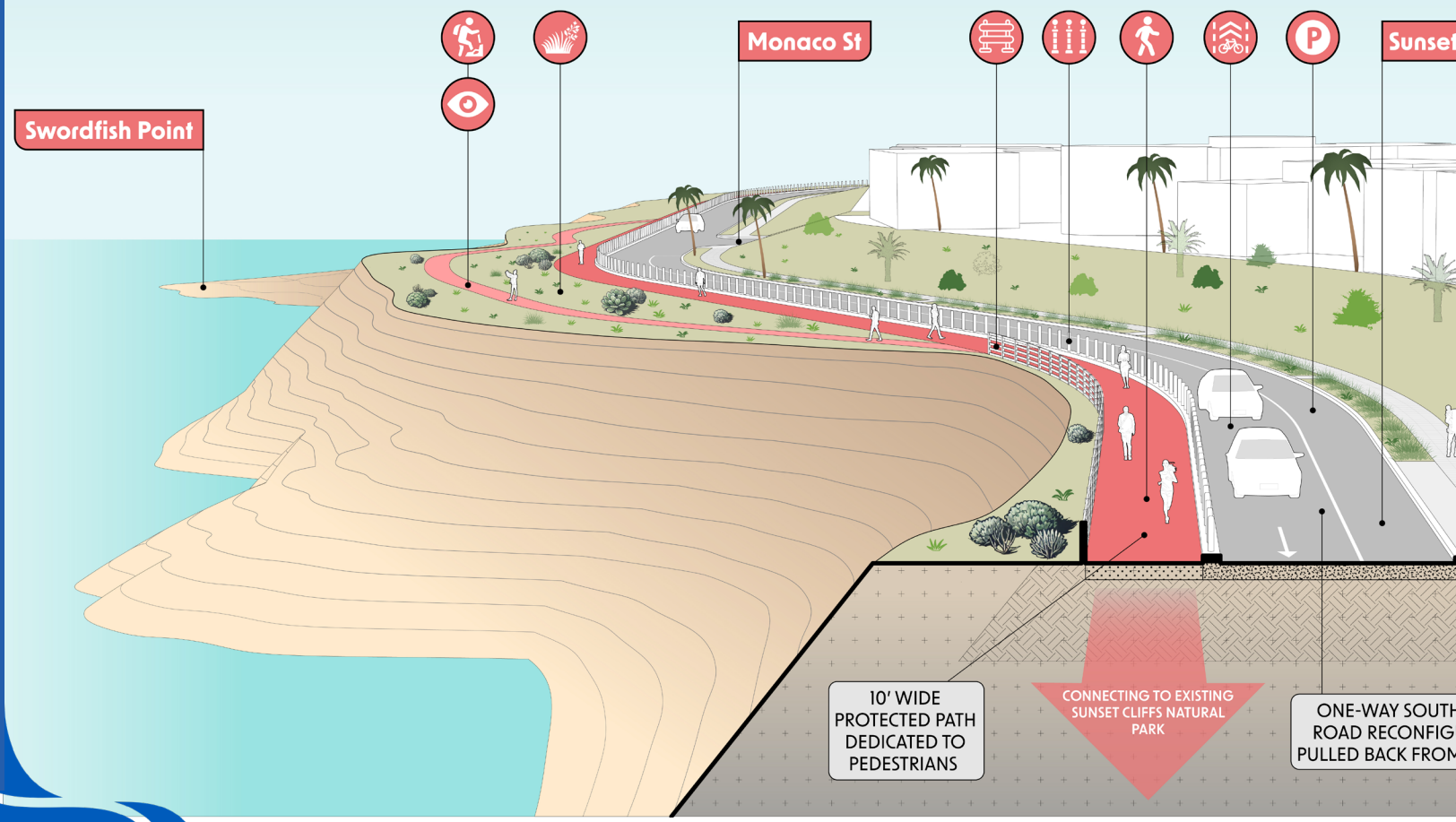
In May 2024, Circulate San Diego held a walk audit along Sunset Cliffs Boulevard to identify safety hazards and gaps in the pedestrian and bicyclist network between Froude Street and Ladera Street. The walk audit identified many opportunities for increased pedestrian and bicyclist safety along this stretch of roadway, including the addition of traffic calming measures, crosswalks, and protected pathways for pedestrians. In particular, the audit notes the limited space for pedestrians between Monaco St. and Ladera St. and the need for more uniformity of the pedestrian network.

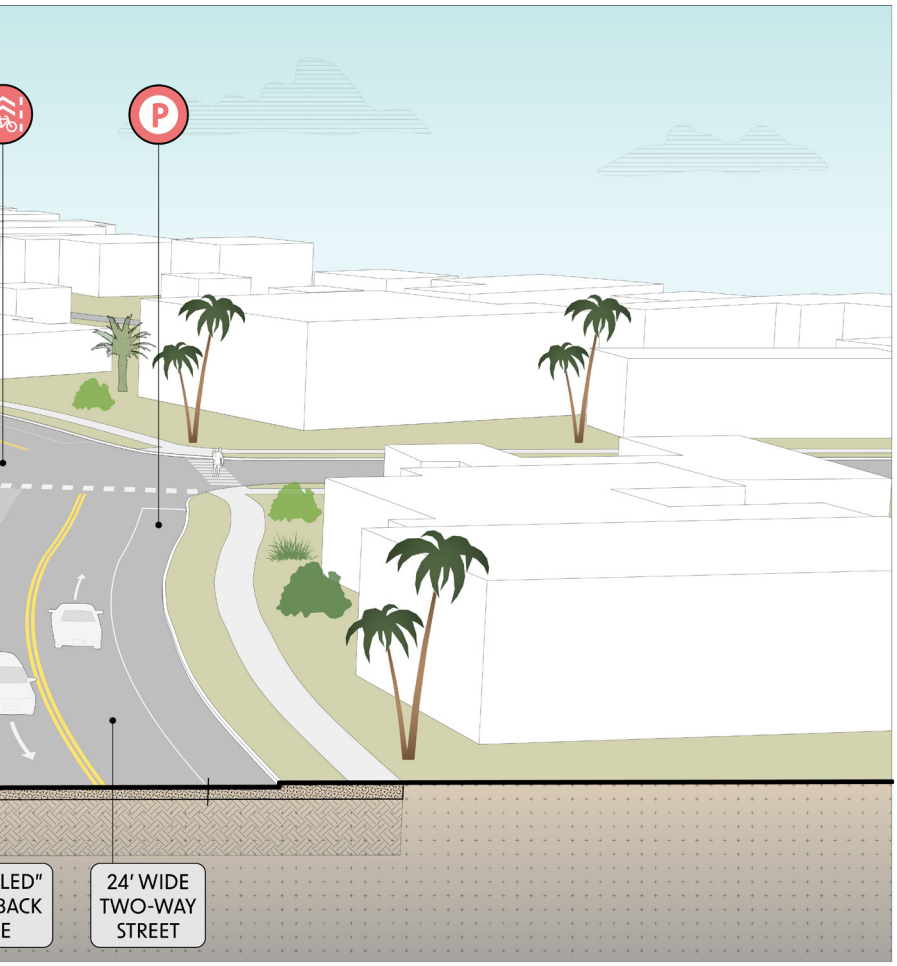
Circulate San Diego 2024

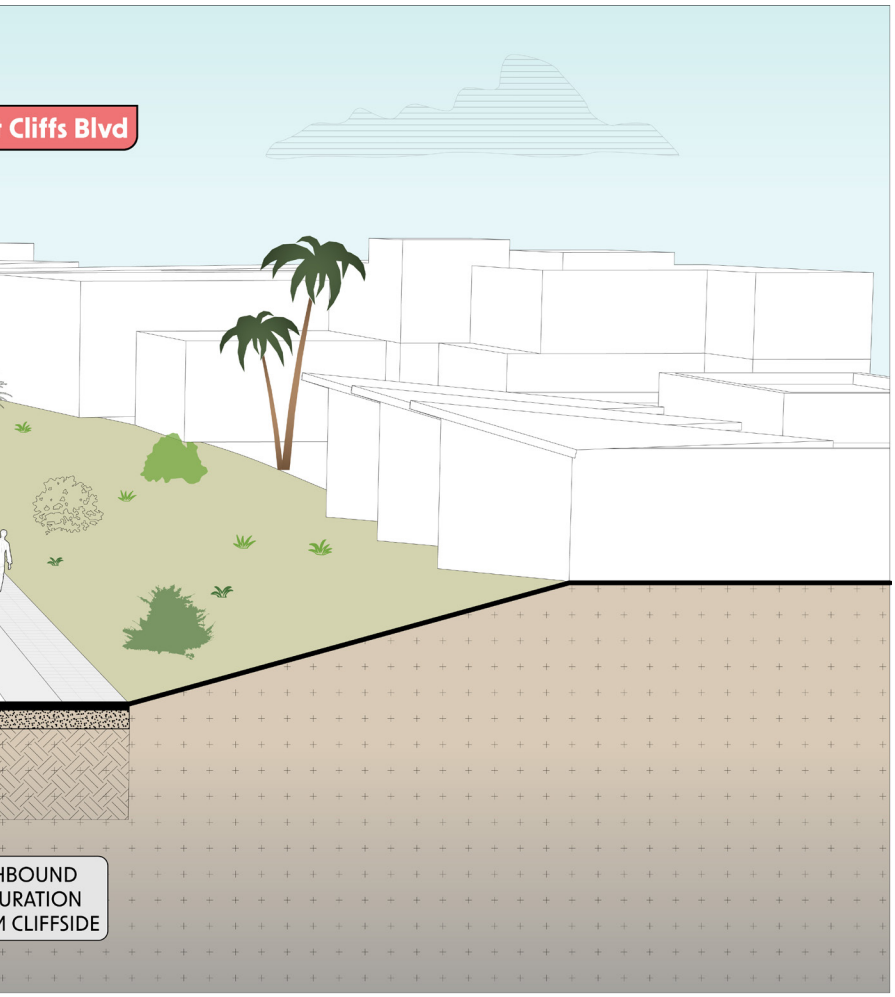
Sunset Cliffs North - Draft Project Concept



Sunset Cliffs South - Draft Project Concept







Coastal Trail

Viewpoint

Bollards

Path/Walk

Re-Vegetation

Shared Lane

Biking

Fencing

Next Steps

Moving the Projects Forward

The CRMP includes concept level designs for six locations along the coast. Following adoption of the plan, it is anticipated that these project designs will be further refined through both internal and external engagement. The City will continue to engage with Tribal Nations and stakeholders, including community members, to inform the project designs and implementation. The next phase of the plan will include moving three project sites forward to initial engineering. As part of this phase, the City will complete technical studies, including coastal engineering analysis, materials sourcing, ecological basis of design, baseline geotechnical, additional environmental analysis and other assessments as needed. This may include site-specific numerical modeling to predict the performance of the proposed concepts, such as the sand dunes, in order to refine the project specifications (e.g., widths, heights and volumes). This additional analysis will provide insight on the potential performance of the project across a range of sea level rise projections and storm conditions. Additional technical studies to evaluate the impact of climate change on both terrestrial and marine species may also be required to inform coastal resilience planning

efforts that support habitat creation and restoration along San Diego's coast and bays. Project design will consider best practices to support terrestrial and marine species while also accommodating other uses, such as recreation, as needed. Reflecting community input, project designs will also incorporate educational, art and cultural features. Contingent upon availability of funding and resources, the projects will then move into final design, permitting and construction.

As noted earlier, the CRMP addresses select, prioritized sites that are well suited for nature-based solutions. It is anticipated that as projects move forward to implementation and as the City completes regular updates to vulnerability assessments and Climate Resilient SD, the CRMP will be updated to include additional sites. Site selection will consider updated science, Indigenous knowledge and community needs and priorities.

Funding Opportunities

The City will continue to identify grant opportunities to advance the projects evaluated in the CRMP and when feasible, to evaluate future sites for coastal improvements. Incorporating nature-based solutions as a climate resilient strategy is being prioritized across the federal government and the State of California, from the Inflation Reduction Act to California's statewide Climate Adaptation Strategy and Natural and Working Lands Climate Smart Strategy. Tied to federal and state ambitions are funding opportunities to plan for and implement nature-based solutions for coastal resiliency. At the federal level, these include:

- NOAA's Climate Resilience Regional Challenge (NOAA 2024b)
- FEMA's Building Resilient Infrastructure and Communities program (FEMA 2024b)
- National Coastal Resilience Fund from the National Fish and Wildlife Foundation (NFWF 2024)

In addition, there are numerous potential funding sources from the State of California, including:

- State Coastal Conservancy
- California Coastal Commission
- Ocean Protection Council
- California Office of Planning and Research Integrated Climate Adaptation and Resiliency Program

The City will also continue to monitor alternative funding mechanisms such as a climate resilience districts, sales tax measures and bonds. The ability to create a climate resilience district was authorized under Senate Bill 852. Climate resilience districts can be formed for the purposes of raising and allocating funding for climate resilience projects that address sea level rise. Establishing a climate district would allow the City to adopt a resolution allocating tax revenues to the district, subject to certain requirements. It would provide for the financing of the activities of the district by, among other things, levying a benefit assessment, special tax, property-related fee, or other service charge or fee and may require a ballot measure with voter approval depending upon the finance mechanism selected. Additional analysis of this opportunity is necessary.

The City may also consider other financing mechanisms, such as green bonds. Green bonds are public sector, private sector or multilateral institution debt issuances used to finance climate-friendly or other environmental projects. Green bonds can raise money for any environmental purpose, including projects that do not directly reduce greenhouse gas emissions—for example, water management, pollution control, toxic waste cleanup or climate adaptation (Chiang 2017).

Monitoring and Implementation

Monitoring of the City's coastline is critical for assessing resources as impacts are realized and to continue informing coastal management and individual project development. A coordinated monitoring program is vital to track coastal changes, create a catalogue of hazard impacts and management activities and monitor the performance of implemented projects.

Currently, as a part of the SANDAG regional shoreline monitoring, semi-annual (i.e., twice a year) shoreline transect monitoring occurs in the spring and fall throughout the County of San Diego with 14 of these transects lying along the City of San Diego: Ocean Beach (1), Mission Beach (4), Pacific Beach (1), La Jolla/ Scripps Pier (4) and Torrey Pines/Blacks (4). These transect surveys are intended to understand the seasonal and long-term changes of beach width and nearshore volume along each profile. This provides an understanding of the natural sediment processes on the City's beaches and how management efforts contribute to these shoreline changes.

The SANDAG shoreline change monitoring efforts can be supplemented by additional monitoring of coastal processes, including coastal erosion, cliff erosion and failure and flooding events. As projects are implemented, monitoring programs should be designed to integrate with adaptive management pathways developed for each project. The following table provides a general overview of potential monitoring that should be considered to assess the performance of the projects once constructed, identify needed maintenance activities and track impacts over time to better inform future adaptive management actions.

Conceptual Monitoring for Implemented Projects

Metric	Monitoring Method		Frequency
Beach Erosion	Beach profile surveys (back beach to depth of closure) Subaerial beach surveys via photogrammetry or LiDAR		Semi-annual Surveys Extreme Events
Flooding	Flood elevation thresholds (e.g., mild and moderate) are determined and tracked using combined tide and wave observations. Site observations and asset closure tracking.		Ongoing Extreme Events
Cliff Erosion	High-tech	Topographic surveys	Semi-annual Surveys Extreme Events
	Low-tech	Site amenities (e.g., colored pavers, benchmarks, signs) indicating bluff erosion	Ongoing
Biological	Surveys for vegetation and key species usage (e.g., shorebirds)		Annual
Maintenance Costs	Financial tracking of repair and hazard cleanup activities		Annual
Feature Integrity	Structural condition inspection or protective features		Annual Post Extreme Events
Public Access/ Usability	Site observations Closure tracking Aggregated Big Data sources		As Needed Extreme Events

Photo by GHD

Adaptive Pathways Approach

As the project concepts are further developed and refined through technical studies, an adaptive pathways approach can assist with long-term decision-making processes and the phasing of adaptation strategies. Adaptive pathways are a management approach that leverage observations to track impacts over time, assess the performance of implemented adaptation strategies and inform ongoing management and maintenance to guide the City's coastal resilience planning and implementation efforts.

An adaptive pathways approach means creating a framework for implementing adaptation strategies with physical or observational thresholds identified, that can signal when a transition from one strategy to another may be necessary. This approach will require assessing the interplay and feedback loop between implementation and monitoring, integrating both elements to present adaptive pathways, potential thresholds and a monitoring framework. It is important to note that specific project level designs are still in the conceptual phase at the time of the CRMP development. Additional technical studies, community outreach and design refinement are required in order to develop a detailed adaptation pathways approach for each project.

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