EXHIBIT 2

South Carlsbad Climate Adaptation Project

Long-Term Master Plan / Adaptive Management Plan

City of Carlsbad

28 February 2024

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1. Introduction

Traffic safety and environmental sustainability are top priorities for the City of Carlsbad. A California State Coastal Conservancy grant provided the city with an opportunity to advance both priorities by redesigning a section of Carlsbad Boulevard prone to flooding and other coastal hazards. The grant is intended to demonstrate how coastal cities can move and adapt infrastructure based on the latest modeling of sea level rise (SLR).

The South Carlsbad Climate Adaptation Project seeks to move the southbound lanes of Carlsbad Boulevard from Manzano Drive to Island Way to the east and repurpose city-owned land for other public uses and environmental restoration areas. The uses for this space and the future alignment of the road are focused on building resilience into the corridor with consideration of current and projected future coastal hazards; specifically, SLR and cliff/shoreline retreat over the next 100 years.

To meet these objectives, the proposed project involves a complete street to include coastal trails, bikeways and sidewalks that provide access to the coastline and community vision spaces (Figure 1). Complete streets are streets that are safe and inviting for all users, including people of all ages and abilities, regardless of whether they are driving, biking, or walking. Additionally, the project involves the use of nature-based design techniques and achieving habitat restoration where viable and appropriate – such as within the Las Encinas Creek area.

This Long-term Master Plan / Adaptive Management Plan (plan) was prepared to inform the management of the project elements over time in what is envisioned to be a phased plan in response to future coastal hazards. The plan presents physical thresholds for management actions (such as moving infrastructure elements landward) as coastal hazards impact and make coastal spaces unsafe for the public to recreate in.

It is important to note that the project design is still in the conceptual engineering phase (30% design) at the time of this plan's development. This plan may require revision during the final engineering and environmental phase to reflect any design changes that emerge.

Figure 1. ***South Carlsbad Boulevard Climate Adaptation Project Area***

2. Proposed Project

A preferred option was selected by the Carlsbad City Council on June 20, 2023, that balances the project goals of improving mobility and coastal access, while reducing the risk of infrastructure to hazards and increasing resilience to the corridor by moving infrastructure inland and out of coastal hazard zones. The primary elements of the project are to: 1) create a complete street along the existing northbound Carlsbad Blvd alignment; 2) enhance traffic circulation and safety through three roundabouts; 3) restore habitat and promote wildlife connectivity in Las Encinas Creek through construction of a 500' span bridge along new complete street; and 4) increase mobility through creation of a Class 1 bikeway facility and complete street elements on Carlsbad Blvd. The proposed project and primary components are shown in plan and section in Figures 2 through 4. Details on adaptation considerations for specific assets along the project area are further described in this report in Section 4.3.

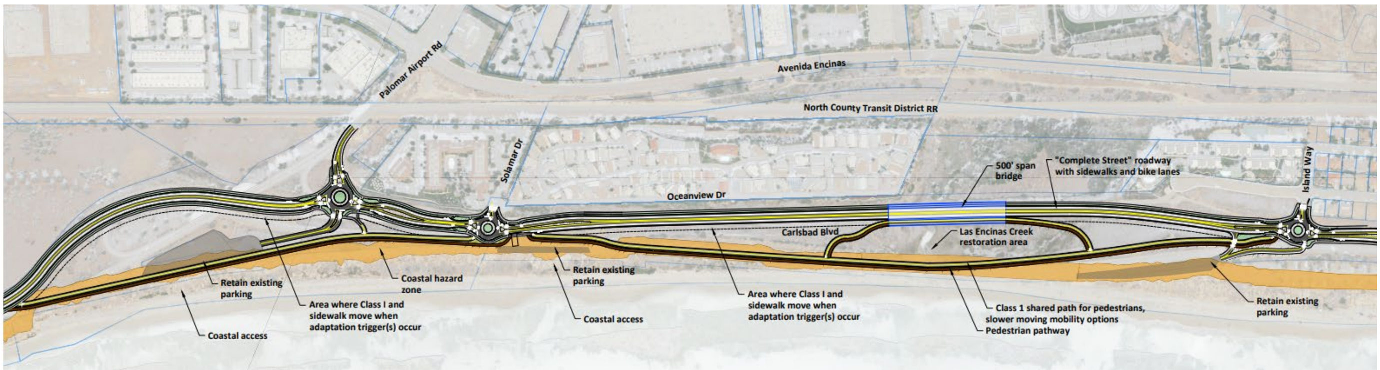


Figure 2. Preferred Project

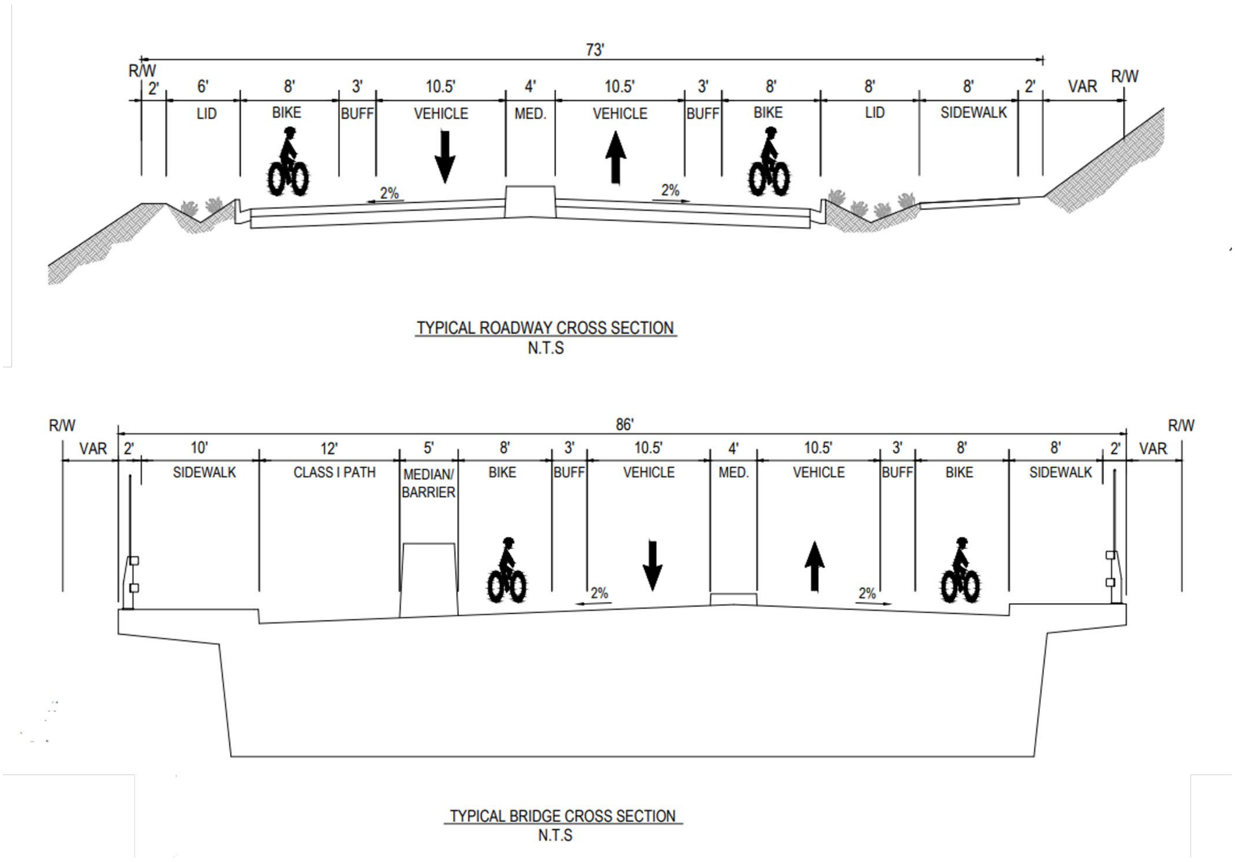


Figure 3. Typical Roadway (above) and Bridge (below) Cross Sections

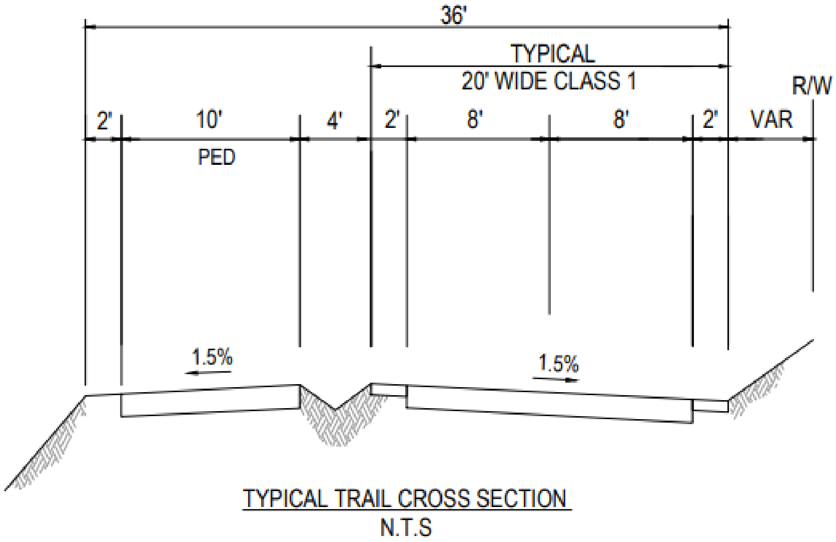


Figure 4. Typical Mobility Corridor Section

3. Coastal Hazards

Coastal flooding and cliff erosion are the primary hazards that present vulnerabilities to the project site. These coastal hazards have required temporary roadway closures and the installation of rock revetment along 1,300 LF of southbound Carlsbad Blvd. Assessment of future coastal hazards driven by climate change and SLR indicate that both flooding and erosion will increase over time, causing additional impacts to access and usability of infrastructure without the interventions proposed by the project and presented in this plan. The impacts from these hazards are the focus of the adaptive management principles identified in this plan. This report summarizes information on hazards with detailed analysis available in the Cliff Erosion Assessment Report and Coastal Hazards Memorandum.

3.1 Cliff Erosion

Currently, cliff erosion presents a significant hazard across the project area. Episodic cliff failure events have occurred within the project area which have led to substantial erosion (Photo 1). To understand the existing and projected future cliff hazards in the project area, Scripps Institution of Oceanography (SIO) conducted a study of cliff erosion. This study assessed existing conditions, developed historic retreat rates, and projected cliff positions with SLR rates consistent with the Ocean Protection Council (OPC) 2018 medium-high scenario. This effort was undertaken by using four cliff evolution models and hundreds of model runs. All four models assumed erosion is primarily driven by wave action. It is important to note that other erosive processes, such as rainfall and groundwater, were not explicitly modeled though are generally captured in the historic retreat rates used as a baseline input for the models.

Photo 1. Cliff Erosion within the Project Area near Palomar Airport Road (left) and Solamar Drive (right)
Source: Hayne Palmour IV (left), Sean Williams (right)

To derive retreat rates and corresponding cliff edge positions from the SIO model results, statistics (i.e., mean, median, percentiles, max/min) were calculated for each model run corresponding to the years of interest (2030, 2050, 2070, 2100). The SIO study did not extend beyond 2100, thus projections of cliff retreat were forecasted to a line of best fit to estimate year 2120. A spatial representative of these projected cliff edge positions (i.e., cliff hazard zones) was created using the average distance of each model run for the years 2070 and 2120. These results are presented graphically in Figure 5 with the statistical mean (i.e., average) projections of cliff retreat distances from the baseline cliff edge highlighted. A cliff erosion hazard zone was created from the results of the SIO study and is overlain on the project site in Figure 6.

Time Horizon	Distance from Cliff Edge Baseline (ft)
	Average
2050	22.6
2070	40.5
2100	77.5
2120*	**108.1**

SIO modeling does not project past 2100, interpolation was used to derive the 2120 value

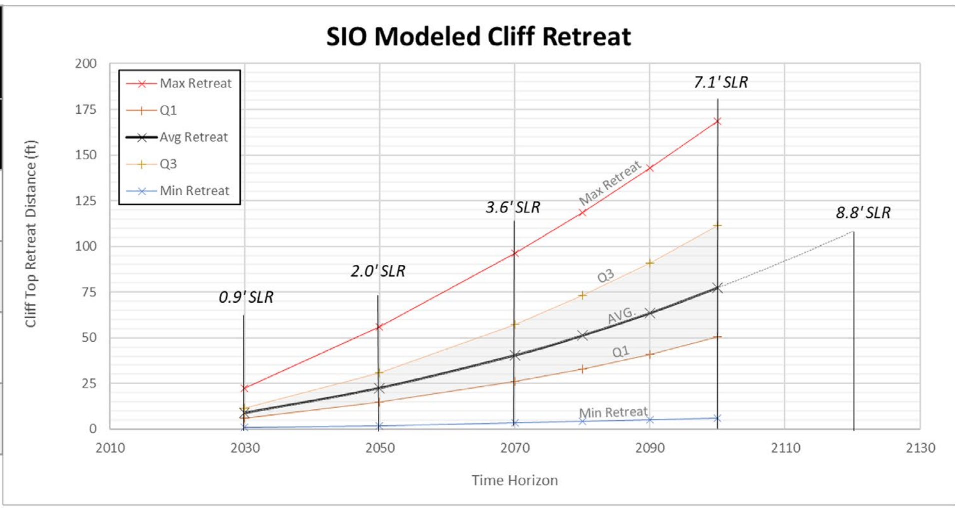


Figure 5. Modeled Average Cliff Retreat Distance in Tabular Format (left) and Graphical Format (right) (Derived from: SIO 2022)

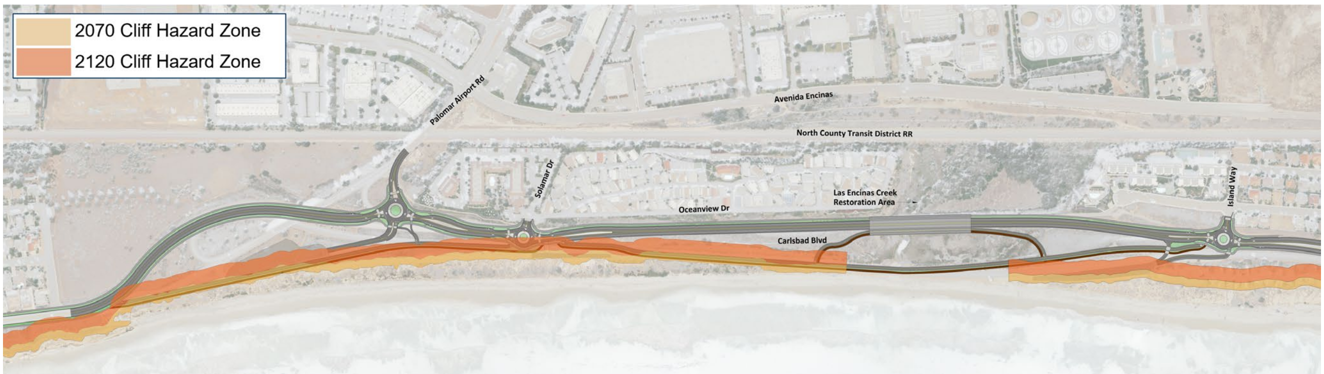


Figure 6. Cliff Hazards in the Project Area with Sea Level Rise Projections for 2070 and 2120

3.2 Coastal Flooding

Coastal flooding is when water floods (short duration standing water) or inundates (long duration standing water) over typically dry land as a result of tides and waves. Coastal flooding of low-lying shorelines will increase in frequency and severity as sea levels rise. Coastal flooding was assessed within the project area using USGS's CoSMoS 3.0 under the year 2050 (3.3-ft SLR scenario) and the year 2100 (6.6-ft SLR scenario). Flood hazards are focused along the low-lying areas around Las Encinas Creek (Figure 7). This finding is consistent with existing conditions, as the roadway currently experiences overtopping and closures at this location during extreme waves coincident with high tide events (Photo 2).

Photo 2. Coastal Flooding within the Project Area
(source: City of Carlsbad)

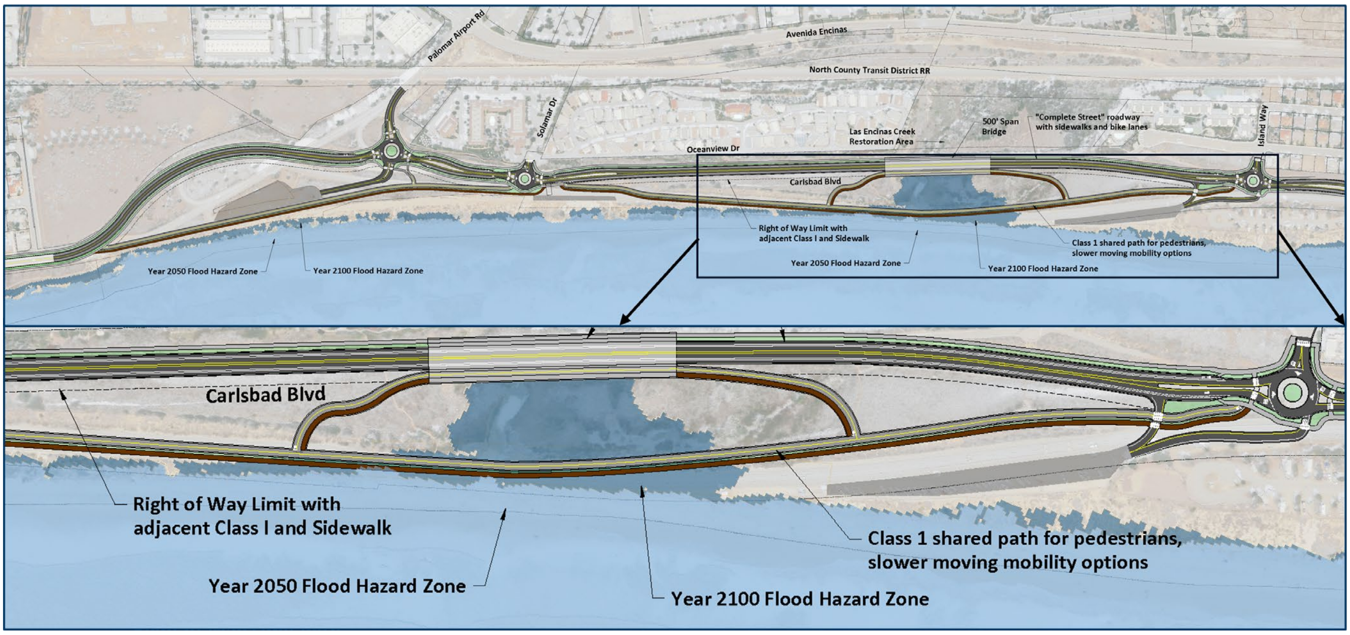


Figure 7. Coastal Flood Hazards in the Project Area – Entire Project area (top) and Las Encinas Creek (bottom) using CoSMoS 3.0 with 2050 – 3.3-ft SLR (light blue) and 2100 – 6.6-ft SLR (dark blue)

4. Adaptive Management Plan

An adaptive management approach will be used to inform project phasing over time with the overall goal of utilizing coastal spaces for public mobility and recreation until erosion or flooding make these spaces unsafe for the public to use. The Adaptive Management Plan presents adaptive pathways for each of the four project segments. These pathways outline a management and decision framework based on the coastal hazards that are anticipated to impact these areas over the next century. These pathways are comprised of monitoring thresholds for various metrics and management actions, which are described in detail in this section.

4.1 Project Segments

For the purposes of this Adaptive Management Plan, the project area was divided into four segments based on common vulnerabilities and how these infrastructure elements could be managed or adapted over time (Figure 8). These segments are described as follows:

1. <u>Palomar Airport Road Segment</u> - Encompasses the area from Manzano Drive to Palomar Airport Road. This segment includes the Turnarounds Parking Lot, owned by State Parks.
2. <u>Solamar Drive Segment -</u> Centered on the intersection of Solamar Drive and South Carlsbad Blvd. This intersection primarily serves as the main vehicular accessway for both the Solamar Community and Hilton Garden Inn. This segment also includes the City Parking Lot at Dave's Beach and the RC Flyers Lot.
3. <u>Las Encinas Creek Segment</u> – Centered at the Las Encinas Creek and includes the North Ponto State Beach Day Use Parking Lot.
4. <u>Island Way Segment</u> - Southernmost end of the project area that encompasses an intersection at Island Way located inland from the South Carlsbad State Beach Campground.

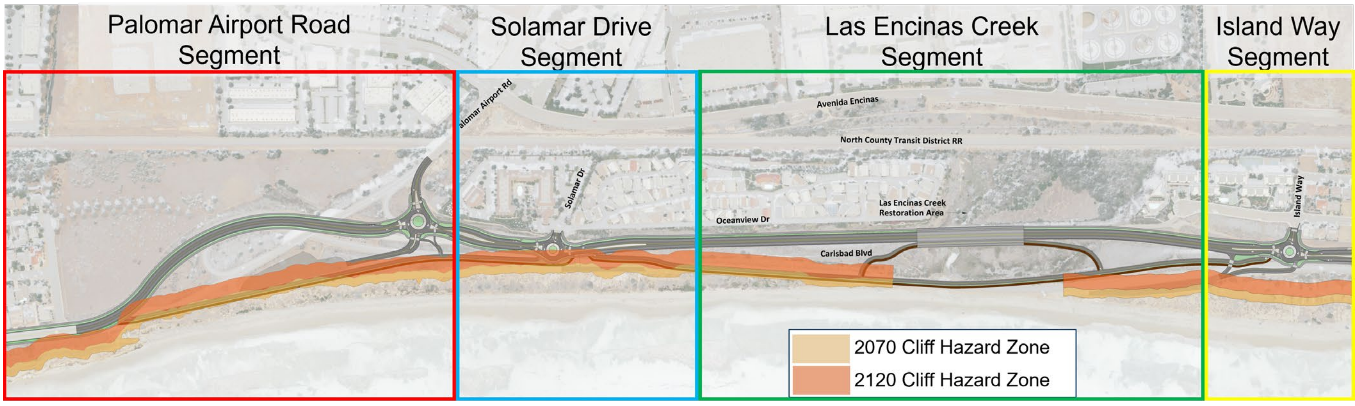


Figure 8. Adaptive Management Plan Project Segments

4.2 Selected Metrics & Thresholds

The physical metrics and thresholds that were selected to prompt management actions in the project area are tied to the vulnerabilities and public use of the site. The three selected metrics include: cliff erosion, coastal flooding, and armoring integrity. Example thresholds that would prompt adaptive management action for each of these metrics are provided below:

- Cliff erosion (e.g., cliff erodes within several feet from edge of buffer to bikeway),
- Coastal flooding (e.g., frequency of infrastructure flooding), and
- Armoring integrity (e.g., cost of maintenance and repair),

Site usability (by the public) was considered as a metric, however, to provide more objective thresholds it was not included as it was acknowledged that usability is captured indirectly across the other evaluated metrics. Further explanation of the thresholds selected for each of the metrics is provided in this section.

4.2.1 Cliff Erosion

The cliffs within the project area are vulnerable to erosion primarily as a result of waves attacking the cliff face, resulting in instability and surface runoff physically eroding the cliffs. For the purposes of evaluating metrics and setting thresholds for cliff erosion, both setback and buffer distances are being used. Cliff erosion setback refers to the distance from the top of cliff edge to a buffer. Recognizing potential safety concerns with infrastructure abutting a cliff edge, a cliff erosion buffer was applied as a threshold for management actions. Cliff erosion buffer refers to the distance from the setback to the asset (e.g., trail, roadway, etc.). These terms are illustrated schematically in Figure 9. By having the setback relate to the buffer allows additional time to plan management actions and safe use of the asset during that time.

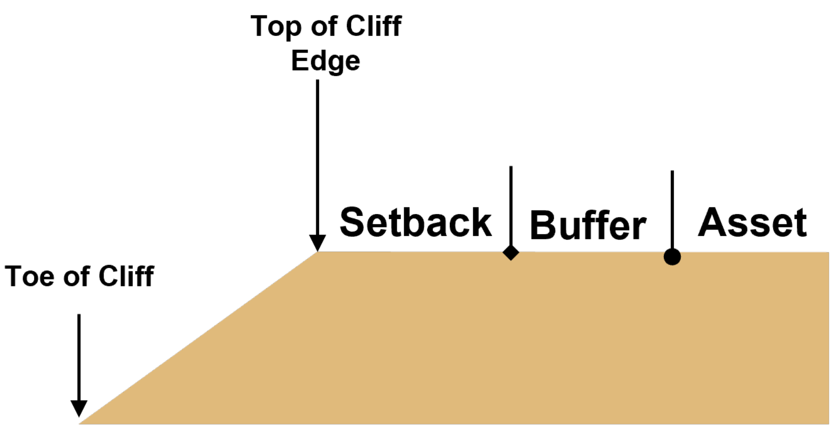


Figure 9. Diagram of Cliff Erosion Illustrating Specific Terms

The setback distance from the buffer to the top of cliff edge was selected as the most appropriate threshold for cliff erosion. To determine the appropriate setback distance threshold, the approximate lead times for the various management actions was discussed with city staff. Lead times for the relocation or realignment of proposed project infrastructure (primarily the bikeway corridor) ranged from three to 10 years across the segments. When comparing this to the localized cliff erosion projections (Figure 10) using the average cliff erosion, the 10-ft setback is projected to provide roughly 10 years of lead time between 2030 and 2090, and roughly five to seven years of lead time at the end of the century. This lines up with the expectations for planning, design, fundraising, and implementation of the management actions identified. A buffer distance of five feet was determined appropriate to allow for time and space for safe usage of the asset during lead times and allows for the uncertainties in the magnitude of future bluff failures.

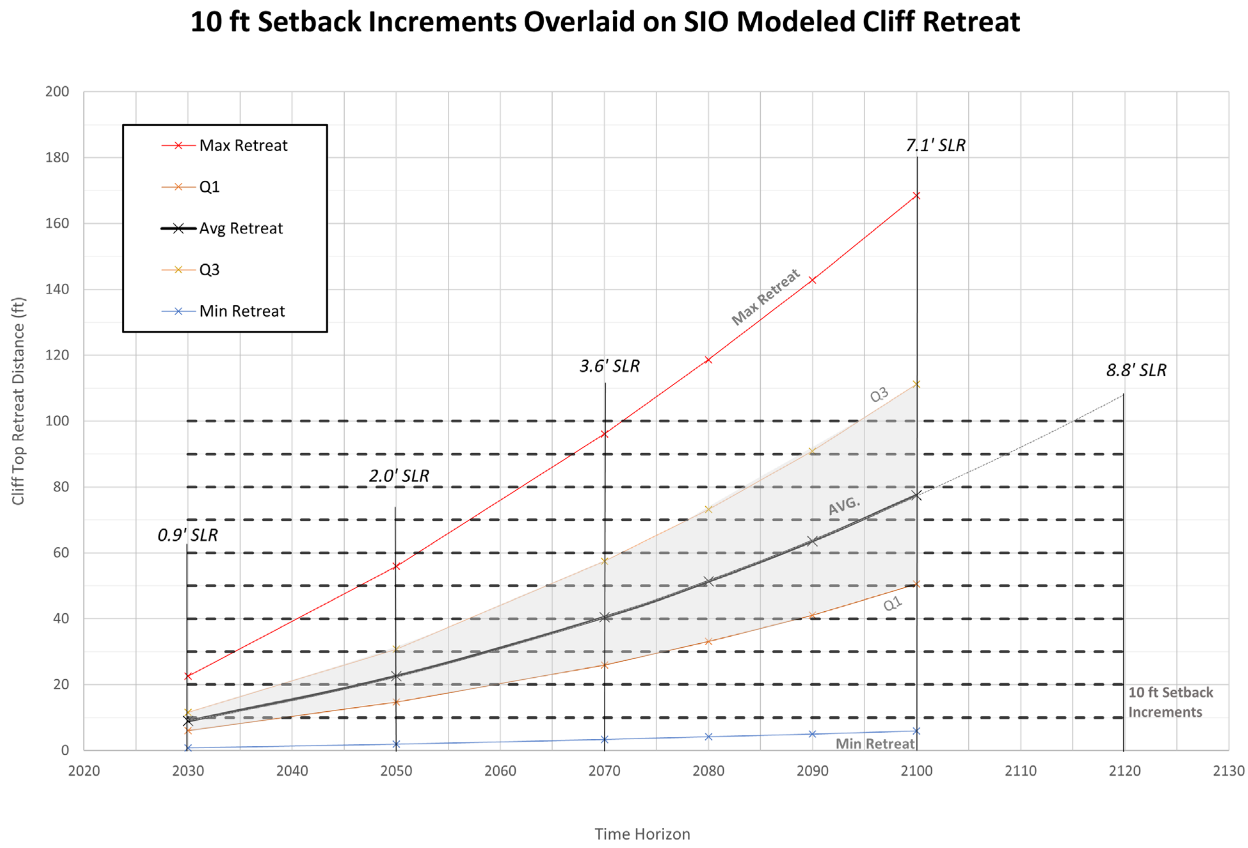


Figure 10. Increments of 10-ft Setbacks Across the SLR Projections of Cliff Top Retreat

4.2.2 Coastal Flooding

Infrastructure in the project area is vulnerable to coastal flooding as a result of the proximity to the ocean and the elevation of infrastructure in the Las Encinas Creek vicinity. Coastal flooding of public spaces is a safety hazard and can result in road closures. This metric consists of partnering with SIO to use combined tidal conditions (predictions and observations) and wave modeling outputs to determine and validate flood elevation thresholds (e.g., minor, moderate, significant) and track flooding over time. For example, some overtopping of the roadway that does not impact vehicular use could be considered minor flooding, while overtopping sufficient to close the roadway to vehicles could be considered significant flooding. The exact elevation and oceanographic conditions to define flooding thresholds will be determined and validated at a later date. This information could be added to the existing SIO website[1] and linked through a city webpage. Automated emails to city staff could be generated in anticipation of forecasted flood events. This could be supplemented with site observations captured during extreme events with a field sheet and/or photos. Based upon the current frequency of extreme flooding and overtopping observations, a flooding threshold was defined as significant flooding of infrastructure 10 times in one year (i.e., 12-month period). Once validated, this method could be used to identify and track these flooding events.

4.2.3 Armoring Integrity

Should the beach undergo significant erosion, the rock revetment currently stabilizing southbound Carlsbad Blvd will be vulnerable to damage, which could impact its effectiveness at protecting the roadway. Damage has been documented previously during the 2015-2016 El Niño event, which compromised the integrity of the roadway and required emergency repairs and road closures. The need to extend or repair a significant segment of rock revetment (i.e., 500 LF) was selected as the threshold for armoring integrity. A financial threshold was also selected alongside this that would be met if repair, maintenance, or damage to the rock revetment exceeds $5M (2023 dollars) over two years (i.e., 24-month period).

[1] An example of this system for Imperial Beach is available here: **https://siocpg.ucsd.edu/data-products/coastal-focus-sites/ch-imperial-beach/ib-flood-forecast/**

4.3 Adaptation Pathways

This section presents the adaptive pathways for each of the four project segments. Each of the pathways presented begins with Phase 0, which is considered the constructed project as currently proposed. The pathways then propose a number of future phases (i.e., management actions) and the thresholds/triggers that would cause the city to begin planning or implementing that future project phase. Understanding that each management action takes several years to implement, appropriate lead times were incorporated into the pathways. These lead times were derived from conversations with city staff and based upon analogous projects that have been implemented in the city.

4.3.1 Palomar Airport Road Segment

The main vulnerability of concern in this segment is cliff erosion. Four potential phases have been identified in the adaptive management plan for this segment (Figure 11). The overall theme of these phases is to narrow and eventually relocate the proposed trails over time with the goal of keeping this mobility corridor in close, but safe, distance from the ocean to maximize coastal views from the trails.

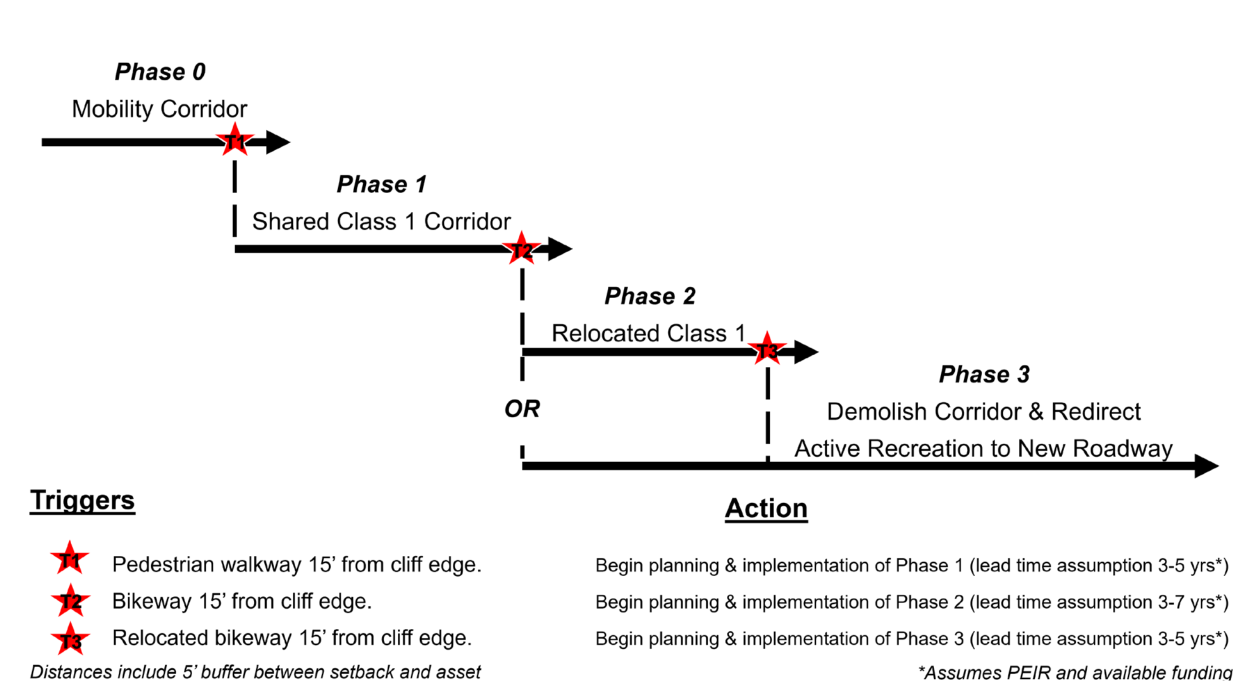


Figure 11. Adaptive Pathway for Palomar Airport Road Segment

The first line of infrastructure to be impacted by cliff erosion in the future would be the Class I pedestrian and bicycling trail in Phase 0, the as-built condition (Figure 12). The first adaptive phase is triggered once the cliff edge encroaches within 15' of the proposed pedestrian trail, which includes the 5' buffer. Phase 1 would then transition the pedestrian trail and bikeway into a shared use, Class 1 corridor (Figure 13). A combined pedestrian and bike corridor is a common configuration along the Coastal Rail Trail in North County San Diego, likely requiring a minimal learning curve for users as the pedestrians and bikes are merged into a single multi-use trail.

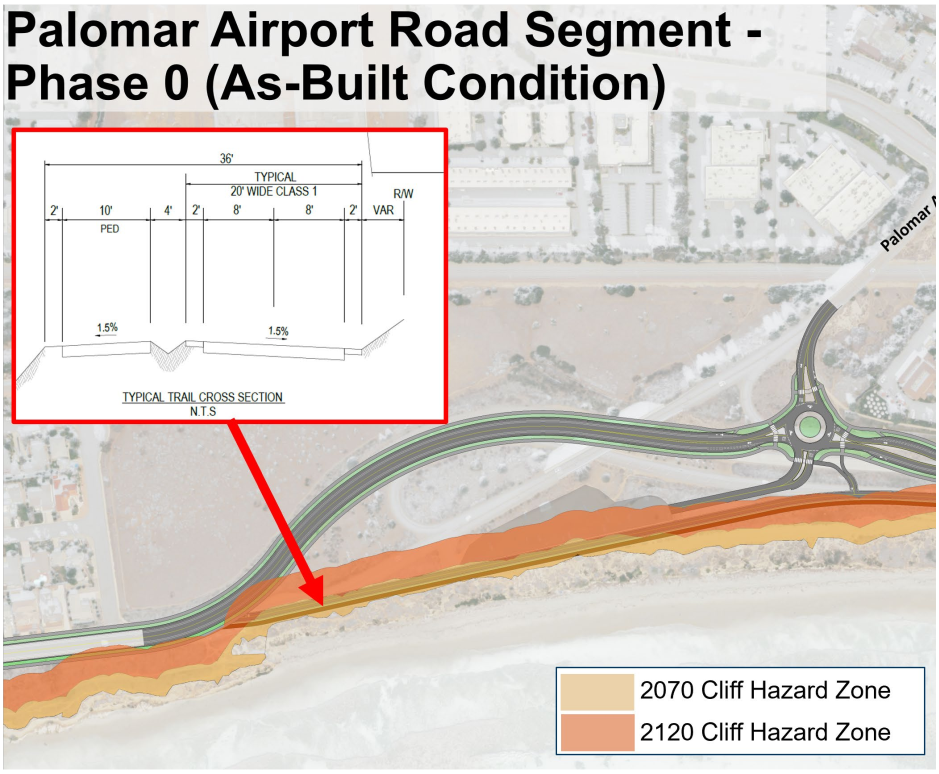


Figure 12. Phase 0 (as-built condition) of Palomar Airport Road Segment

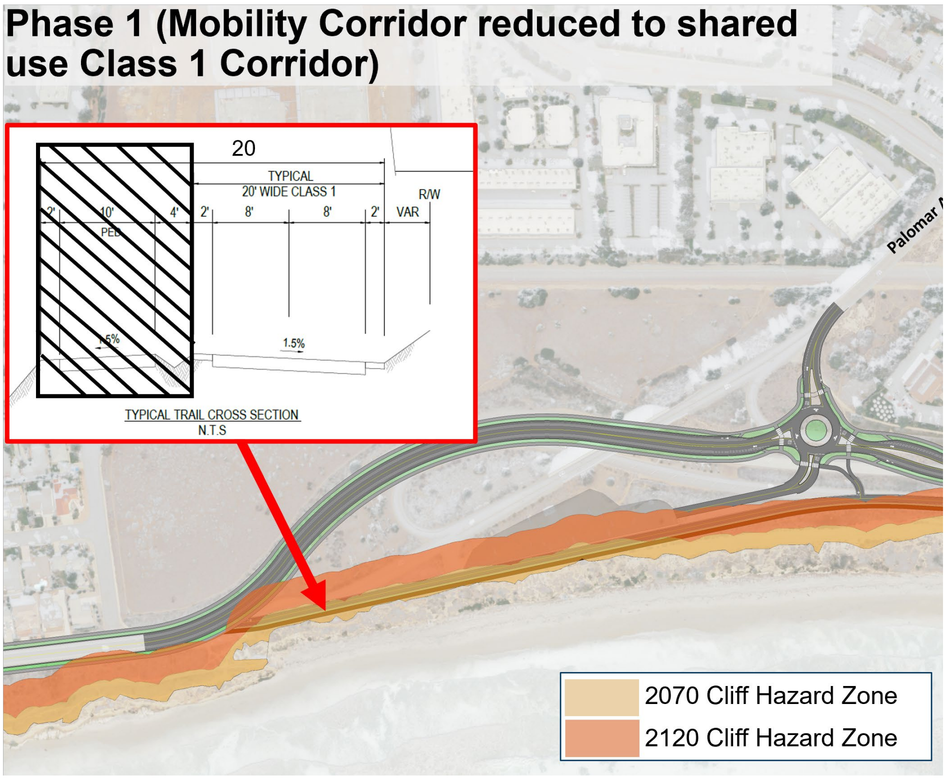


Figure 13. Palomar Airport Road Segment – Adaptive Phase 1

As the cliff top continues to erode and becomes within 15’ from the shared use trail, the next phase would relocate the trail landward in incremental steps (Phase 2) (Figure 14). The relocated trails could be developed with low cost and less permanent materials, allowing for lower expenditure and increased flexibility in the modifications. As an alternative phase to Phase 2 and/or when a trail would be infeasible, the city could decide to demolish the built trail corridor and redirect all active recreation to the proposed complete street roadway (Phase 3) (Figure 15).

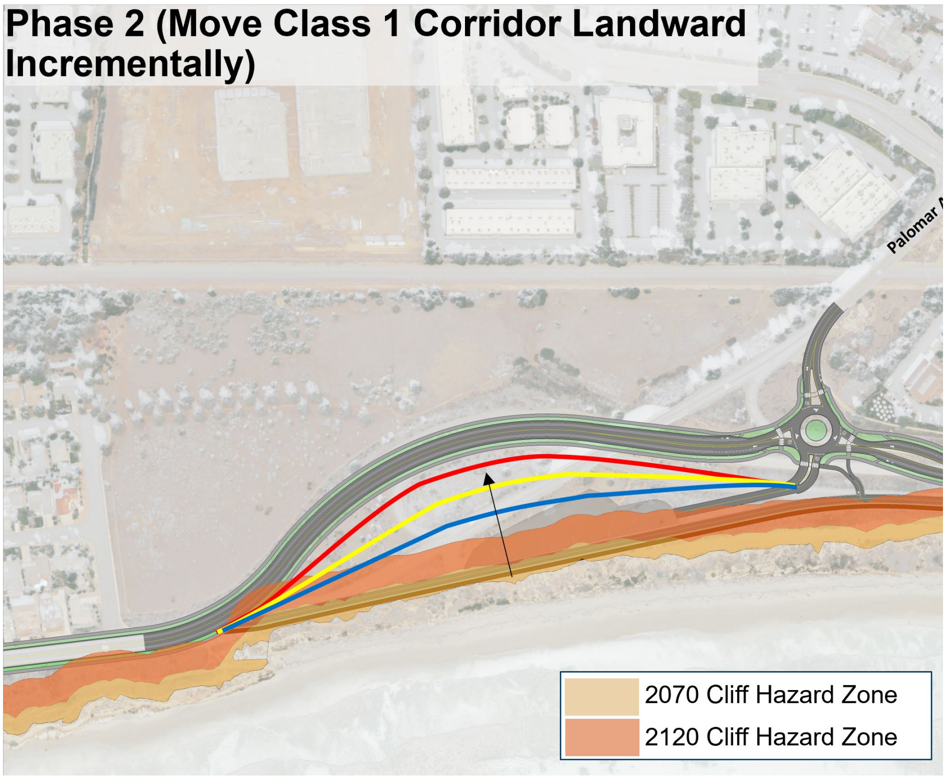


Figure 14. Palomar Airport Road Segment – Adaptive Phase 2

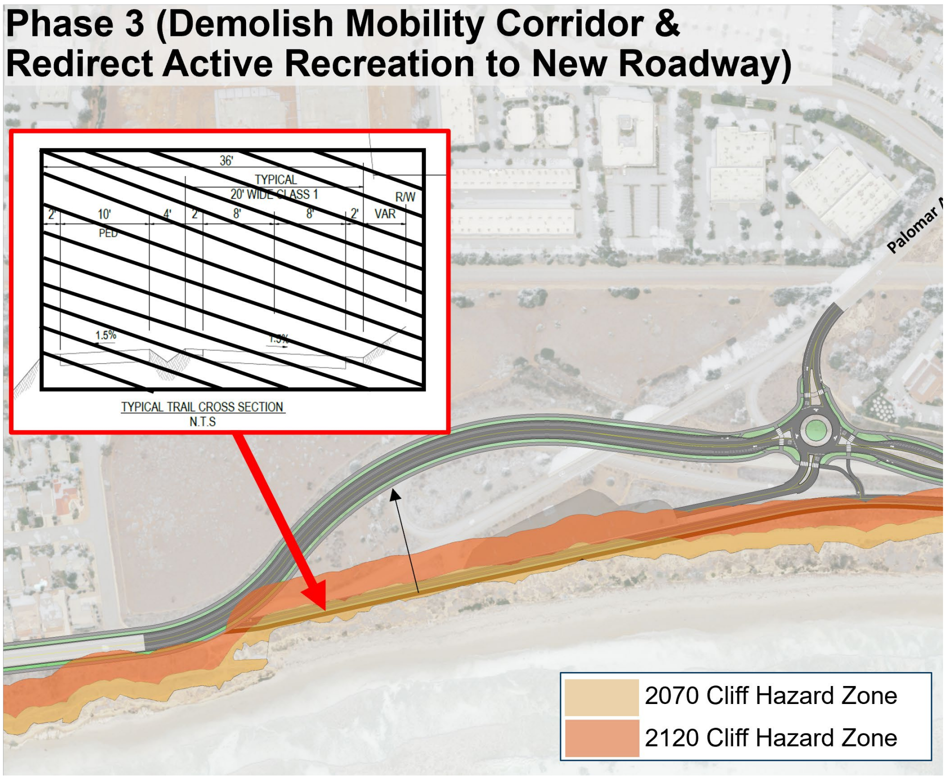


Figure 15. Palomar Airport Road Segment – Adaptive Phase 3

California State Parks owns and manages the land where informal parking occurs (commonly referred to as Turnarounds Lot). The city is actively coordinating with State Parks as part of this project; however, adaptation of the parking lot is not included in this Plan. Future phases of the project would provide more details on how the project interacts with this parking lot and how the parking lot could adapt over time.

4.3.2 Solamar Drive Segment

The main vulnerability of concern in the Solamar Drive Segment is cliff erosion. One phase with two potential options has been identified in the Adaptive Management Plan for this segment (Figure 16). The overall themes of these phases are to utilize the roundabout as long as feasible with options to explore increased access and stabilization (i.e. erosion control) alternatives as well as potentially changing the roundabout to a signal to regain some space.

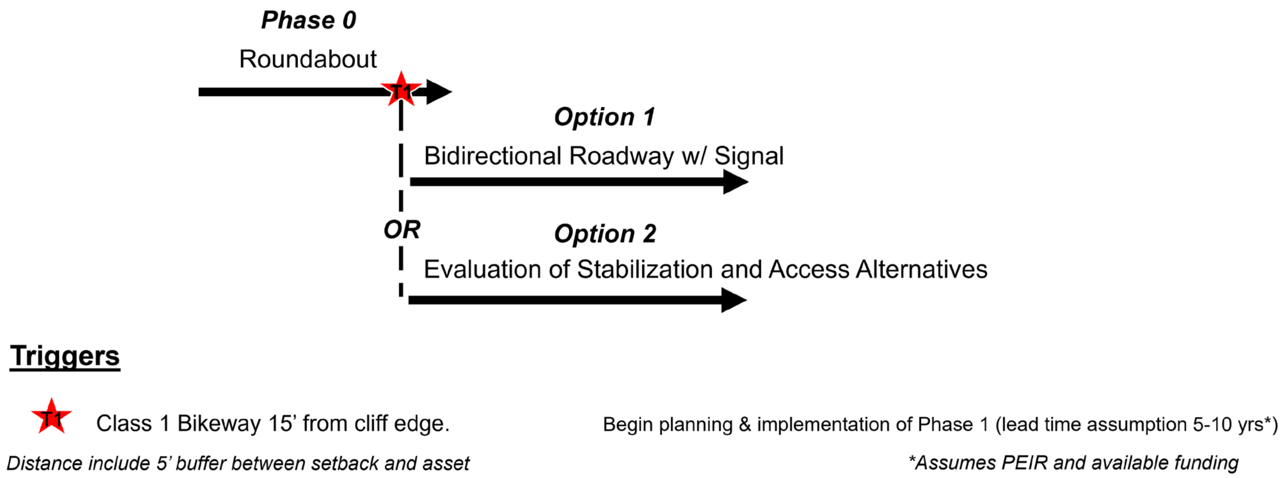


Figure 16. Proposed Adaptive Pathways for Solamar Drive Segment

The first line of infrastructure to be impacted by cliff erosion in the future would be the pedestrian trail in Phase 0, the as-built condition (Figure 17). The 2070 Cliff Hazard Zone encroaches on the proposed pedestrian trail. By 2120, the Cliff Hazard Zone is projected to encroach to the middle of the proposed roundabout (Figure 17).

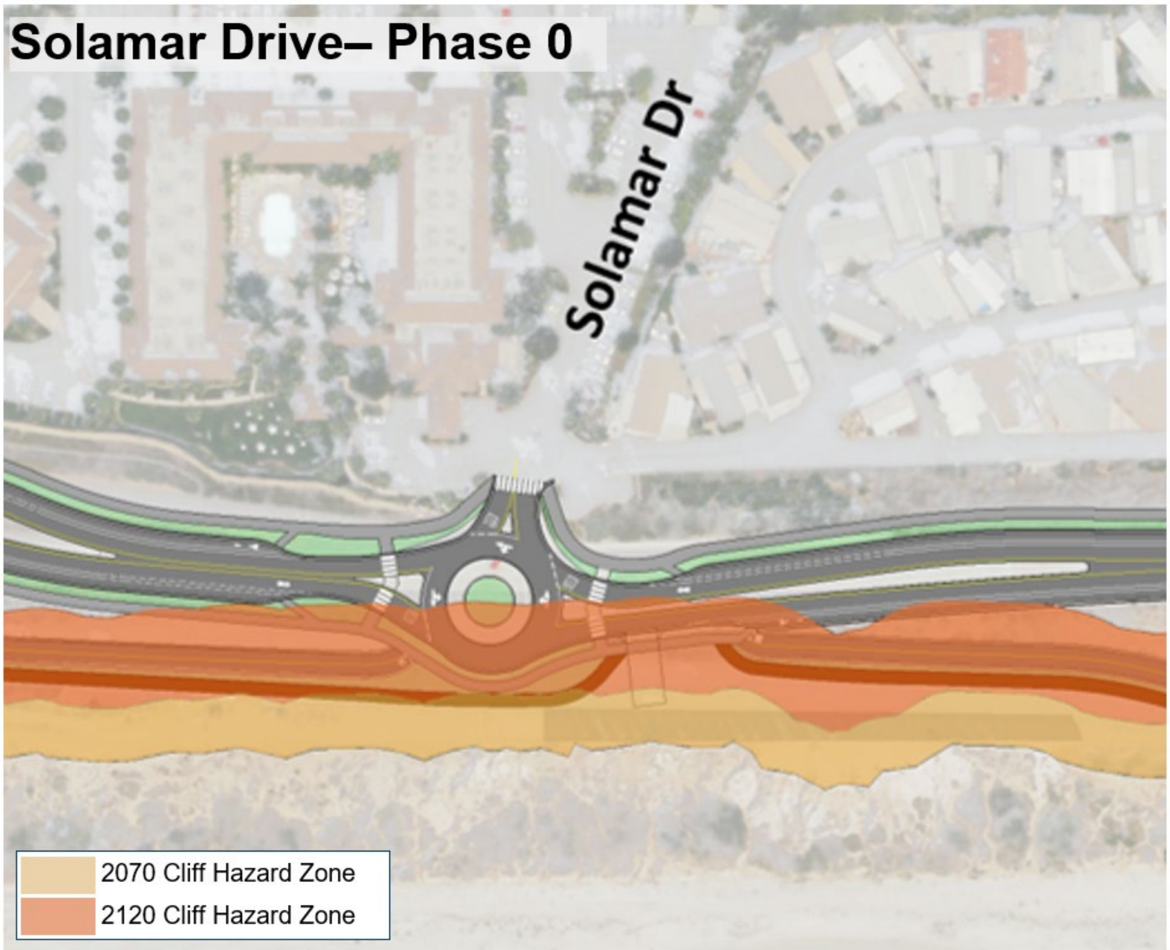


Figure 17. Phase 0 (as-built condition) of Solamar Drive Segment

Phase 0 (as-built) positions infrastructure as landward as possible to achieve the project goals. As the cliff erodes and encroaches on the roundabout, two options are available that would address the functionality and usability of the intersection and coastal resources. Option 1 would involve the planning and implementation of transitioning the roundabout to a signalized intersection that requires less space (Figure 18). Concurrently or independently to Option 1, Option 2 would explore cliff stabilization and erosion control techniques coordinated with a new formalized vertical access point to achieve multiple benefits at this location. For example, a wooden staircase, similar to nearby accessways, that blends into the coastal cliff landscape could be feasible at this location. An example of a nearby formalized cliff access point that could inform Option 2 is provided in Figure 19. This accessway would relieve the need for multiple desire paths that currently exist along the cliff face where beachgoers and surfers traverse down the cliff to reach the shore. A multi-benefit solution exists to provide cliff stabilization and erosion protection at the landing of this accessway on the beach. The erosion protection would be designed to the minimum necessary footprint and the accessway designed to allow safe and appropriate width access to the beach while increasing the stability of the cliff fronting the roundabout at Solamar Drive. Both Option 1 and Option 2 could be pursued once the cliff erodes within a distance of 15’ from the vehicle lane which includes a 5’ buffer.

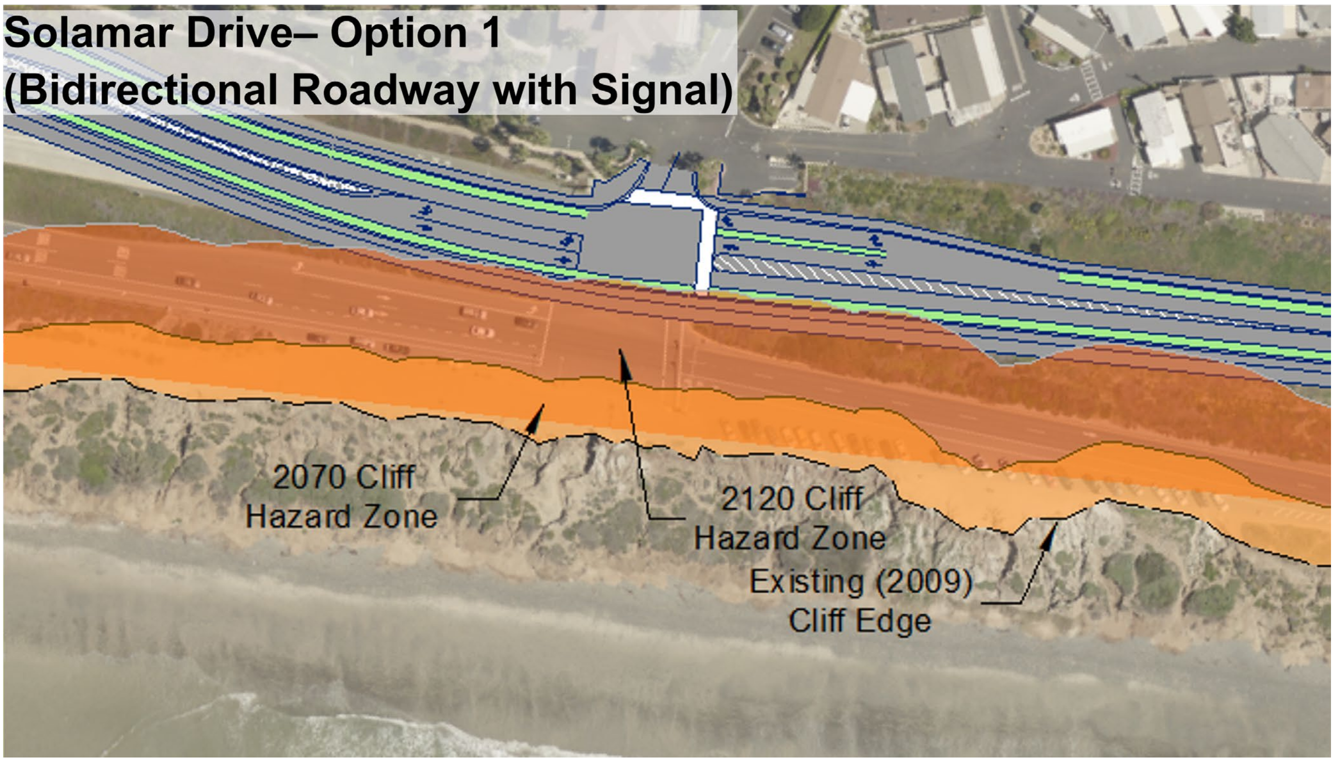


Figure 18. Solamar Drive Segment – Option 1

Figure 19. Current Intersection at Solamar Drive and Informal Beach Accessways (left) Compared with a Nearby Example of a Formalized Staircase at South Carlsbad State Beach (right) as an example to inform Option 2.
Source: Copyright © 2002-2019 Kenneth & Gabrielle Adelman, California Coastal Records Project, www.californiacoastline.org

4.3.3 Las Encinas Creek Segment

The vulnerabilities in the Las Encinas Creek segment are cliff erosion and coastal flooding, with coastal flooding within the “dip in the road” along southbound Carlsbad Blvd at the mouth of Las Encinas Creek being the primary concern (Figure 20). Both of these vulnerabilities can be seen in present day as the cliffs have been protected by a rock revetment and the road periodically floods when waves overtop this structure.

Two different project options have been identified in this segment for how and when infrastructure is adapted each with different levels of hazard exposure. These options, called 1) Phased Adaptation and 2) Retreat Now, result in differing adaptation pathways. The Retreat Now option builds the project segment to the ultimate 2120 condition immediately, while the Phased Adaptation option repurposes the coastal infrastructure by creating a mobility corridor upon it in the as-built or Phase 0 of the project, to be used for as long as it is safe for the public. These options present key project decisions to be made by the City Council with input from the community and other affected stakeholders, and, ultimately, come down to how they would like to use these spaces now and in the future and what funding sources could be identified for improvements.

The Encina Wastewater Authority (EWA) provides wastewater treatment services to more than 379,000 residents in northwestern San Diego County with a facility located inland of the project area. The EWA has an existing ocean outfall that extends roughly 1.5 miles offshore to a water depth of 150ft. The outfall pipeline intersects southbound South Carlsbad Blvd approximately 200ft south from the centerline of the Las Encina Creek bridge (see callout for existing 48” EWA outfall in Figures 21 and 22). As-builts indicate that the pipeline is approximately 5ft below the current grade of the roadway. All adaptation options for the roadway will need to account for the protection of the existing EWA outfall pipeline. Further coordination with EWA will be needed during the next phase of this project (i.e., final engineering) to refine protection or accommodation options. as this infrastructure is outside of the City’s sole jurisdictional authority.

The two adaptation options being considered for the Las Encinas Creek Segment are further described below:

- Phased Adaptation: This would either leave in place or partially remove the southbound Carlsbad Blvd infrastructure for interim passive or active recreational uses until coastal hazards overwhelm the repurposed space. Once one of the identified triggers is met, the southbound roadway would be demolished, and recreational uses would shift to either the new complete street corridor or a new Class 1 boardwalk, depending on the identified trigger. Major infrastructure elements (e.g., the complete street roadway) would be constructed at its ultimate location while other temporary/movable, low-cost project features would provide amenities in the interim in spaces currently identified as being vulnerable to projected coastal hazards. The existing rock revetment will persist to support the use of the newly created space on the southbound roadway. Phased Adaptation is shown graphically in Figure 21.

- Retreat Now: This option refers to the naturalization of the southbound roadway area by removing infrastructure within the 2100 projected Coastal Hazard Zone and restoring the La Encinas Creek estuary system. More specifically, this alternative seeks to establish a more natural cross-shore gradient promoting morphological processes that support the formation and resilience of a coastal pocket beach, dune, and dune-slack wetlands. The Las Encinas Creek estuary and beach would be allowed to evolve naturally and without major maintenance after the project is constructed. The infrastructure to be removed includes the existing southbound Carlsbad Boulevard bridge structure, 1,300 LF of rock revetment, and the existing roadway surface (i.e., asphalt) and fill prism (i.e., compacted dirt used to form the roadbed). The goal would be to reuse rock from the deconstructed revetment in other areas of the larger project that may require stabilization material (e.g. bridge abutments or EWA outfall protection). The Retreat Now option is shown graphically in Figure 22.

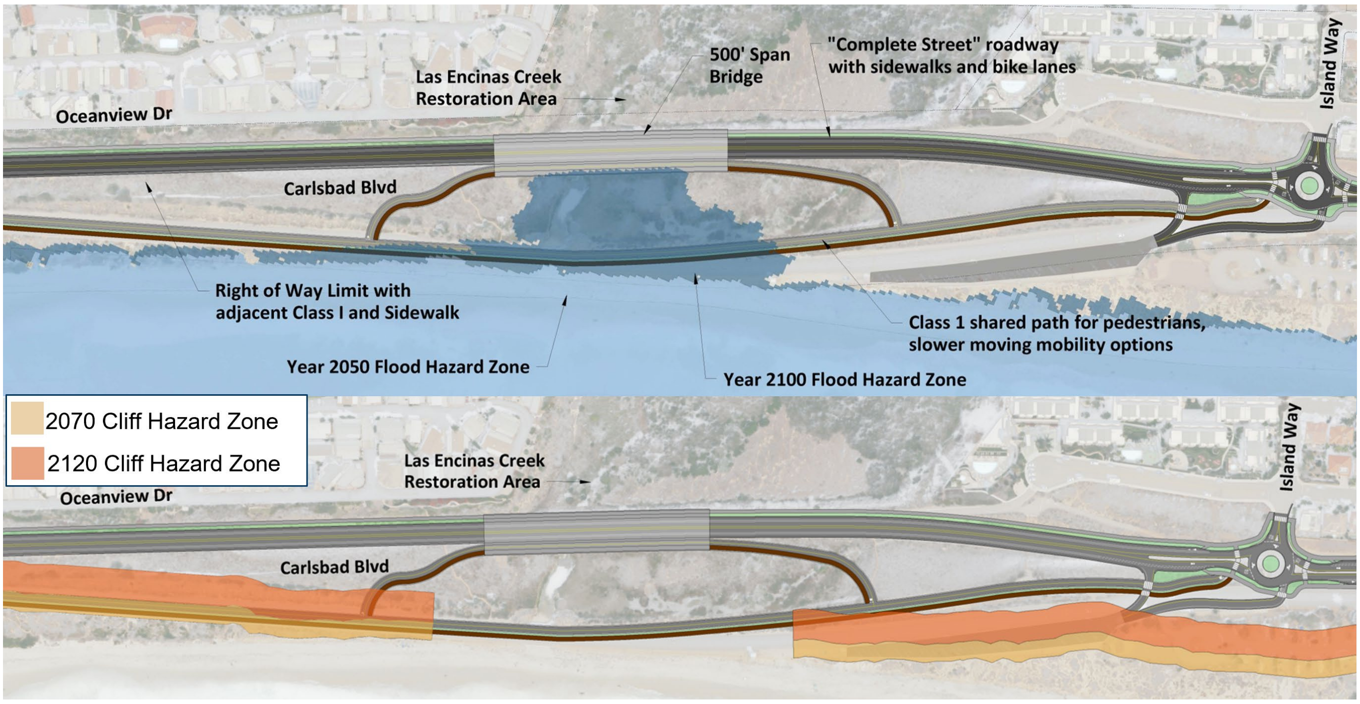


Figure 20. Phase 0 in the Las Encinas Segment overlaid with flood (top) and cliff erosion (bottom) hazards.

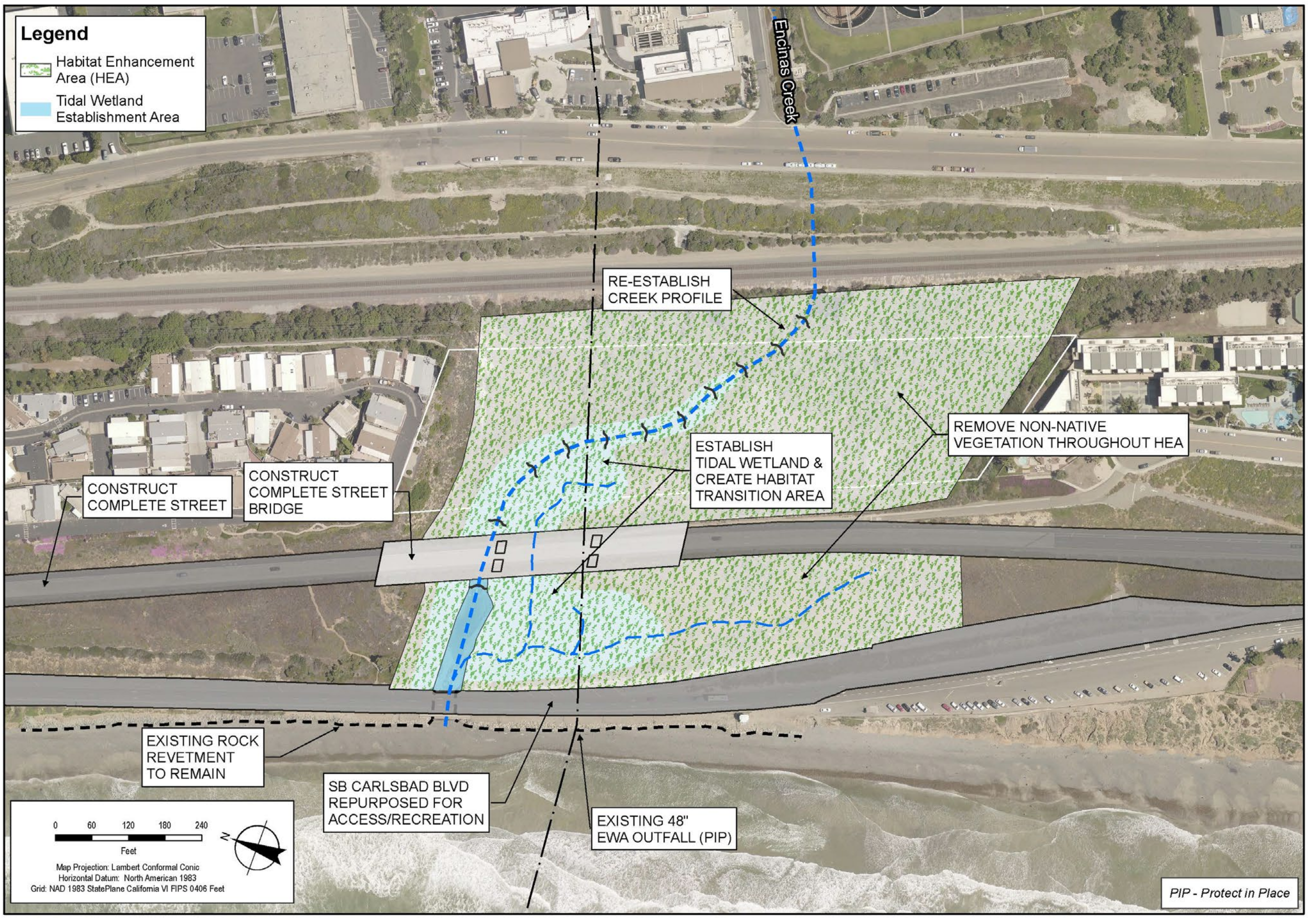


Figure 21. Phase 0 (as-built conditions) for the Phased Retreat Alternative

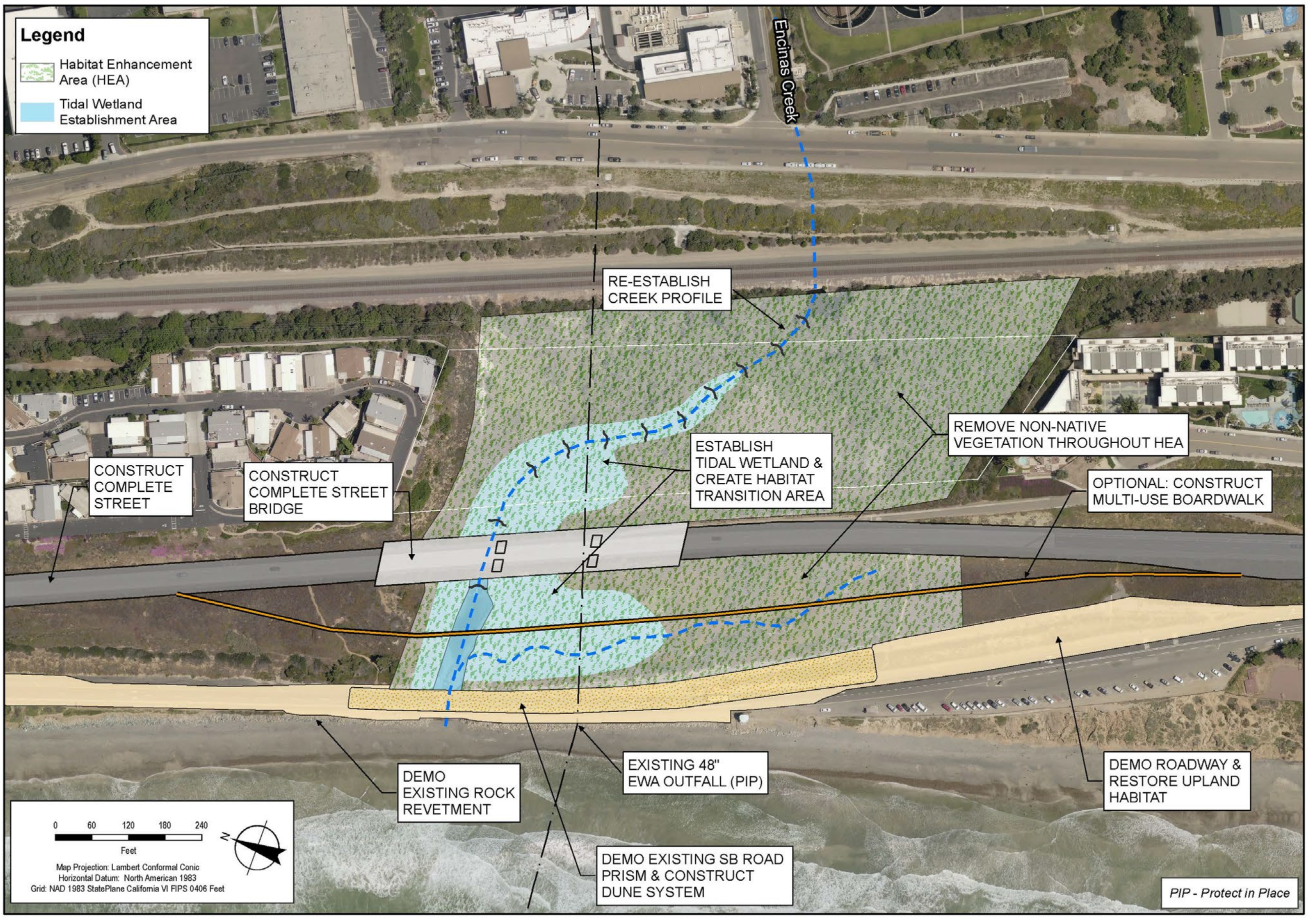
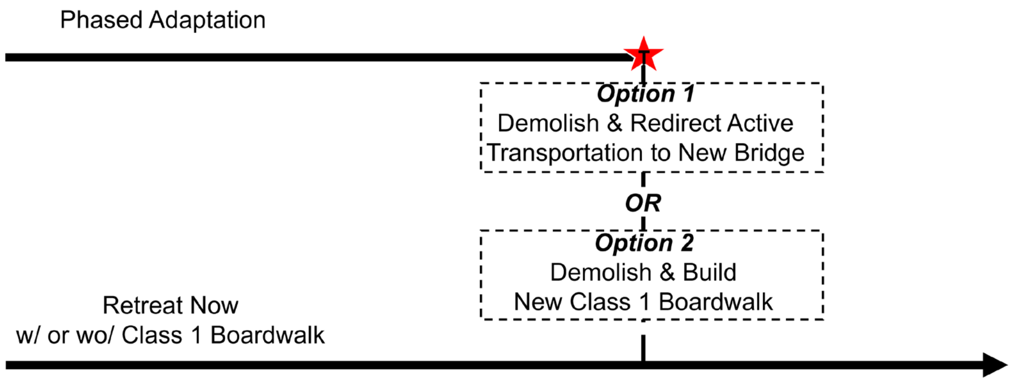


Figure 22. Phase 0 (as-built conditions) for the Retreat Now Alternative

4.3.3.1 Adaptive Pathways

Key themes around adaptive pathways for this segment hinge on which option is pursued in this segment (Phased Adaptation or Retreat Now). Since the Retreat Now option is built to a year 2120 resilient location, an adaptive pathway was not developed for that option. The proposed adaptive pathway for the Phased Adaptation option is shown in Figure 23. As shown, two triggers were identified that would signal the need to begin planning and implementation of the removal of the southbound roadway and shifting active transportation users to a new boardwalk or the complete street roadway and bridge. Triggers identified include rock revetment armoring integrity, and flood frequency. A lead time of five to 10 years was identified as sufficient time to plan and implement this management action, assuming the action is included in a programmatic environmental document (assumed PEIR) and funding exists.



Triggers

- T1 Armoring Integrity: Rock revetment repair & maintenance – need to extend or repair a significant segment of rock revetment (500 LF). Repair or damage exceeds $5M (2023 dollars).
- T2 Flood Frequency: Significant overtopping of rock revetment and flooding of Mobility Corridor 10 times in one year (i.e., 12 month period).

Action

Begin planning & implementation of Option 1 or 2 (lead time assumption 5-10 yrs*)

**Assumes PEIR and available funding*

Figure 23. Adaptive Pathways for Las Encinas Creek Segment

4.3.3.2 Trade-offs between Phased Adaptation and Retreat Now Options

The options of Phased Adaptation and Retreat Now each have unique advantages, disadvantages, and trade-offs that warrant evaluation. Table 1 summarizes these to aide in the decision-making process.

Table 1. Summary of Key Advantages, Disadvantages and Trade-offs between the Phased Adaptation and Retreat Now Options

Category	Phased Adaptation	Retreat Now
Permitting and Construction: *Can all elements of the design be implemented at once?*	No. This option would occur in phases. Construction, disruption to traffic flows, and permitting would need to occur one or more times once a trigger is met.	Yes. This option would perform all actions at one time, not requiring any additional permitting or construction.
Financial: *What are the differences in costs between the two options (qualitatively)?*	This option may be less expensive in the short-term because it would repurpose the existing southbound roadbed into a mobility corridor. Thus, the project would not require the demolition of the bridge, rock revetment or roadway. This option may have more expensive construction costs over a 20-50 year period because it results in more planning and construction activities spread out over time. Factors to consider include mobilization/demobilization, pulling construction permits (e.g., traffic control, etc.), escalation of material and labor costs, increase in construction costs, and scarcity of future funding. By waiting until impacts are realized, addressing all future adaptation needs and costs could vary greatly, likely being much higher than addressing components all at once. Additionally, this option does not take full advantage of the current availability of state and federal grants to support projects of this type. The availability of these funding sources for future phases of the project is unknown.	Higher costs to construct because it includes the demolition costs of the bridge, rock revetment and roadway. This option would need to protect the existing EWA outfall, likely with rock reused from onsite materials (deconstructed revetment), which adds additional cost in the short-term. This option may be less expensive over a 20-50 year period because it would construct everything at once in today's dollars (i.e., reduced escalation). Additionally, this option could take advantage of ample state and federal funding that exists for coastal resilience projects today. This funding is forecasted to be available at least over the next 5 years, which could support implementation costs.
Coastal Hazards & Public Safety: *Would the option provide public protection from existing and projected future coastal hazards?*	Yes. This option would repurpose the roadway for recreational uses until it becomes unsafe to use for this purpose. The existing rock revetment would remain in place to protect the roadway from erosion. Triggers described within this plan identify when the space needs to be abandoned.	Yes. This option would relocate public infrastructure out of the Coastal Hazard Zone for the next 100 years. Recreational uses of the abandoned space would be protected through nature-based design techniques (e.g., cobble-sand dune system).
Sandy Beach: *Will the alternative sustain a dry, sandy beach in the study area?*	No. The existing beach is narrow. It is anticipated that with 1.7' of SLR, the existing narrow beach within the Las Encinas Creek study area will be completely eroded/inundated, assuming no other management actions occur.	Yes. This option is anticipated to result in a localized increase in beach area immediately through removal of the roadway. Preliminary modeling suggests this pocket beach may sustain through 6.6' of SLR as the beach and created dune are allowed to transgress landward.
Access: *What are the differences in public access and use between the two options?*	This option provides active transportation along the southbound roadway, closer to the coast and similar to current conditions. Until triggers are met and the space needs to be abandoned, access would feel safer and likely more welcoming given the elimination of vehicular traffic. Recreational opportunities along the beach would remain constrained due to increasingly narrow beach widths as sea levels rise.	Active transportation uses would be focused along the enhanced roadway, which would be located further from the coast and elevated, a changed user experience from present day. The removal of the southbound roadway would enhance existing, and create new, recreational opportunities from the additional beach space.
Habitat Restoration*:* *How would these options benefit the restoration of Las Encinas Creek?*	The southbound roadway area will be restored to coastal strand once the trigger is met. The area to be restored and viability of the habitat may be lower than if the habitat was built initially due to elevated water levels and more frequent wave attack.	This option restores the southbound roadway to coastal strand habitat immediately. The coastal strand habitat has more space and time to establish prior to increased water levels and wave attack, making it a more resilient system.

4.3.4 Island Way Segment

The main vulnerability of concern in the Island Way Segment is cliff erosion. The first line of infrastructure to be impacted by cliff erosion in the future would be the South Carlsbad State Parks Campground day use lot and overnight areas (Figure 24). Given that the proposed roadway is inland of these campground facilities and significantly inland from the cliff edge, an adaptive pathway was not developed for this segment. Instead, it is recommended that the city continues to coordinate with State Parks regarding their plans to adapt these facilities.

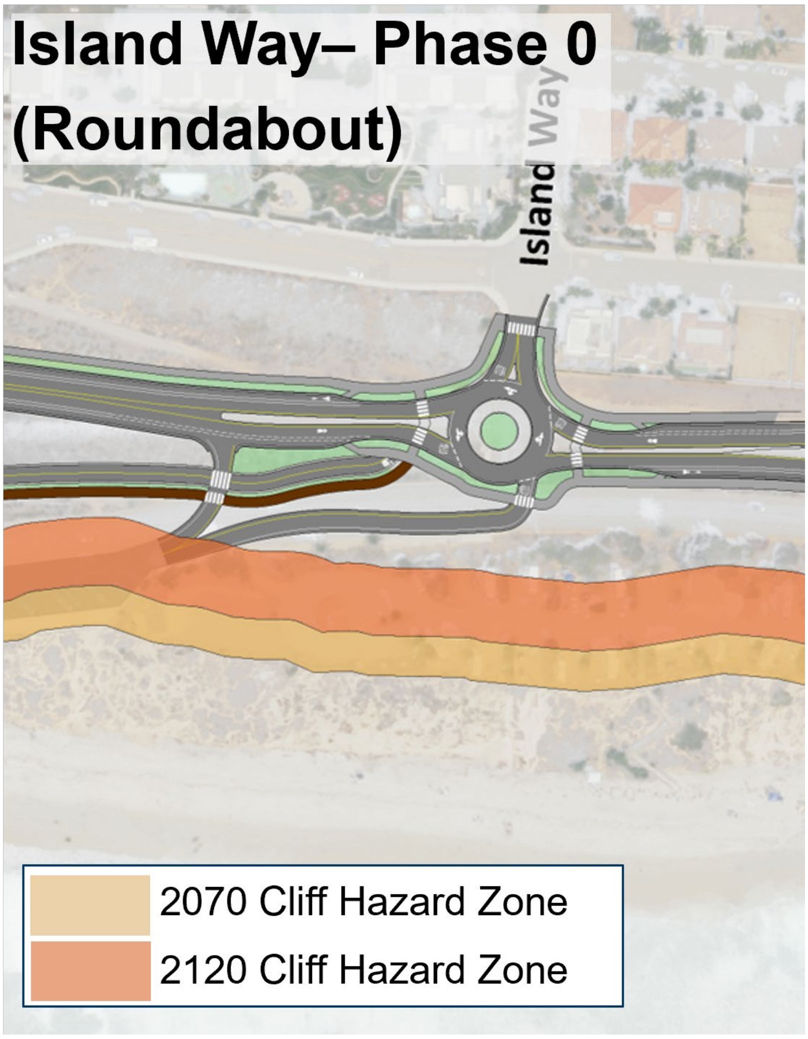


Figure 24. Phase 0 (as-built condition) of the Island Way Segment

5. Monitoring Framework

Based upon the thresholds identified within the adaptive pathways for each project segment, monitoring will be required to help understand when a threshold has been met. A monitoring framework was developed with potential methods and data collection frequencies shown in Table 2 below.

Table 2. Proposed Monitoring Activities to Inform Proposed Adaptive Pathways

Metric	Monitoring Method		Frequency
Cliff Erosion	High-tech / Data driven	Topographic surveys (traditional survey profiles, orthophotogrammetry, LiDAR)	Semi-annual Surveys Extreme Events
	Low-tech/ Interpretive	Site amenities (e.g., colored pavers, benchmarks, signs) indicating bluff top edge erosion and encroachment into established thresholds	Continuous
Beach Erosion	Beach profile surveys (back beach to depth of closure) Subaerial beach surveys via orthophotogrammetry or LiDAR		Semi-annual Surveys Extreme Events
Rock revetment / Armoring Integrity	Topographic Survey (traditional survey profiles, orthophotogrammetry, LiDAR) Structural condition inspection		Annual Post Extreme Events
Roadway Maintenance Costs	Financial tracking of cleanup and repair activities		Annual
Flood Frequency	Flood elevation thresholds (e.g., minor, moderate, significant) are determined and tracked by combined tide and wave observations outputs in coordination with SIO; Supplemented by site observations and closure tracking.		Continuous Extreme Events Annual
Public Access / Usability	Site Observations Closure Tracking Aggregated Big Data Sources		As Needed Extreme Events

Further description of the monitoring approach for each of the metrics is provided below:

- Cliff Erosion: Since the setback (i.e., distance from the cliff edge to the buffer) is a key threshold in the adaptive management pathways for the segments, cliff monitoring will be important to inform this plan. Two options exist to track cliff erosion in the project area – dubbed low-tech and high-tech options. The high-tech option leverages cliff monitoring currently performed by SIO periodically; however, monitoring at an increased frequency, such as semi-annual, may be necessary to detect and track changes. Monitoring can be performed via traditional survey methods or via drone or plane overflight using orthophotogrammetry or LiDAR methods. If the city notices significant erosion it may elect to complete an additional survey(s) accordingly. The low-tech option utilizes low-cost methods that may be adequate for certain areas along the project site given the nature of bluff erosion. Benchmarks integrated within the infrastructure amenities could serve as a passive method for tracking cliff erosion. For example, markers or pavers between the setback and buffer could have a progressive color scheme that would identify the setback encroaching on the buffer. Added benefits of this low-tech monitoring technique would be the easy ability of maintenance staff to track changes in the bluff visually, as well as serving as an educational opportunity for the public.

- Beach Erosion: Though not explicitly called out as a threshold in the adaptive management pathways, beach conditions have a significant effect on other metrics within this plan – specifically cliff erosion, armoring integrity and flood frequency. Thus, monitoring beach changes quarterly is recommended within the project area. Monitoring should consist of traditional beach profile surveys (back beach to depth of closure) or capturing the subaerial beach with orthophotogrammetric or LiDAR methods. SIO already performs quarterly beach monitoring at South Carlsbad State Beach that can be leveraged to track changes in beach conditions over time.

- Rock Revetment / Armoring Integrity: The rock revetment could shift and become increasingly destabilized as waves of greater magnitude more frequently impact the structure with SLR. The rock revetment is currently monitored annually as part of the city's CDP with the Coastal Commission. It is recommended that this program continue and potentially be increased in frequency as the structure becomes increasingly impacted (e.g., post-extreme event condition surveys). It is also recommended that a coastal engineer or a civil/structural engineer with experience with coastal structures inspect the structure annually to assess its condition.
- Roadway Maintenance Costs: Keeping a ledger on annual expenditures for roadway cleanup and repair is important to understand escalating costs of maintaining public use along the repurposed southbound roadway. This monitoring metric requires a city staff person to organize cost data from various departments into a ledger.
- Flood Frequency: This metric consists of partnering with SIO to use combined tidal conditions (predictions and observations) and wave modeling outputs to determine and validate flood elevation thresholds (e.g., minor, moderate, significant and track flooding over time. The exact elevation and oceanographic conditions to define significant flooding will be determined and validated at a later date. Once validated, this tool could be used to identify and track flood events to discern if the threshold of 10 flood events in 12 months is triggered. This information could be added to the existing SIO website and linked through a city webpage. Automated emails to city staff could be generated in anticipation of forecasted flood events. This could be supplemented with site observations captured during extreme events with a field sheet and/or photos.
- Public Access / Usability: Though not explicitly called out as a threshold in the adaptive management pathways, site usability is anticipated to change over time as assets experience impacts. These changes can be documented to supplement the objective thresholds selected (e.g., erosion, flooding, and armoring integrity). Methods for tracking this could include site observations, closure tracking of key pieces of infrastructure (e.g., bikeway, roadway, etc.) or through aggregated big data sources which can show usage patterns derived from cell phone data.

6. Conclusions

This Adaptive Management Plan presents adaptive pathways for the project, divided into four discrete segments. These pathways identify future management actions that will be taken once coastal hazards meet certain thresholds or triggers. These thresholds vary from proximity to the proposed infrastructure elements, flood frequency, and armoring integrity and maintenance costs. A monitoring framework was developed to help the city identify and track metrics over time to determine when thresholds are met.

The adaptive pathways for each of the four project segments are summarized below:

- Palomar Airport Road: Four potential adaptive phases were identified in the plan for this segment. The overall themes of these phases are to narrow and eventually relocate the proposed bikeway corridor over time with the goal of keeping this mobility corridor in close, but safe, distance from the ocean to maximize coastal views from the trails.
- Solamar Drive: One potential adaptive phase was identified in the plan for this segment with multiple options. The overall themes are to maximize the use and function of the roundabout and explore multi-benefit opportunities for enhanced access. One option is to evaluate erosion control and cliff stabilization methods which could be pursued in conjunction with a beach access stairway at this location. Another option would be to change the proposed roundabout to a signal to regain some space and distance from the cliff erosion hazard.
- Las Encinas Creek: Adaptive pathways for this segment hinge on which project option is pursued (i.e., Phased Adaptation or Retreat Now). Since the Retreat Now option is built to a year 2120 resilient location, an adaptive pathway was not developed for that option. The proposed adaptive pathway for the Phased Adaptation option includes two triggers that would signal the need to begin the planning and implementation of the removal of the southbound roadway and shifting active transportation users to a new boardwalk or the complete street roadway and bridge. Triggers identified include rock revetment armoring integrity and flood frequency.
- Island Way: Given that the proposed roadway is inland of State Parks campground facilities and significantly inland from the cliff edge, an adaptive pathway framework was not developed for this segment. Instead, it is recommended that the city continues to coordinate with State Parks regarding their plans to adapt these facilities.

It is important to note that the project is still in the preliminary engineering phase. Thus, this plan is based upon a conceptual understanding of how particular assets and features throughout the project are situated. This plan may require revision as additional engineering details are refined.