moffatt & nichol

555 Anton Boulevard, Suite 400
Costa Mesa, CA 92626

(657) 261-2699
www.moffattnichol.com

MEMORANDUM

To:	Leslea Meyerhoff, Coastal Administrator, City of San Clemente
From:	Justin Peglow and Chris Webb, Moffatt & Nichol
Date:	August 7, 2024
Subject:	Preliminary Conceptual Designs of Nature Based Sand Retention Structures
M&N Job No.:	221572

1 Introduction

This memorandum presents and describes proposed conceptual projects to address erosion along the City of San Clemente shoreline. It provides the background context for the existing coastal problems, summarizes current City efforts to address those problems, and then recommends several specific actions that can provide solutions to coastal erosion problems in the future.

1.1 Background

The City's coastal planning process was restarted in 2016 with a comprehensive update to the City's Local Coastal Program (LCP) Land Use Plan (LUP) which was certified by the California Coastal Commission (CCC) on August 10, 2018. This was followed immediately by City analysis of its shoreline for vulnerability to coastal flooding under existing conditions and then for future projected sea level rise scenarios. The Sea Level Rise Vulnerability Assessment, or SRLVA (Moffatt & Nichol 2019), identified sites susceptible to damage from coastal flooding now and potentially in the future. This study was followed by the City's Coastal Resiliency Plan in 2021 that presented approaches to address potential vulnerabilities (City of San Clemente, 2021). The City's LCP Implementation Plan (IP) was submitted to the CCC in April 2022 and remains an in-progress working draft.

Completion of the LUP, SLRVA and the Coastal Resiliency Plan represent the beginning of the phased adaptation efforts to advance coastal resiliency in the City. These documents outline a path forward for the City to reduce risks from, and exposure to, coastal hazards. The City's coastal resiliency planning efforts are ongoing as the understanding of the dynamic interplay among variables in climate science, including greenhouse gas emissions scenarios and sea level rise predictions, continues to evolve.

In 2022, the City of San Clemente initiated a process to identify feasible solutions to promote long term resiliency of the City's shoreline by retaining and reducing the loss of sand along the City's shoreline. Building on the momentum of recent planning actions, accomplishments, and past success achieved in part by grants awarded to the City, in March 2022 the City received notification of a fourth LCP Planning Grant (i.e., a CCC LCP Round 7 Grant) to support continued coastal resiliency building efforts in San Clemente. The focus of this latest grant funding is the advancement of key recommendations in the Coastal Resiliency Plan which include re-establishment of a shoreline monitoring program and development of one or more nature-based shoreline management projects. A key City goal is the protection of the public beach which serves as a natural shoreline protective buffer that supports a sustainable, healthy, and resilient environment for all.

The City is preparing a Nature Based Coastal Resiliency Project Feasibility Study (Study) focused on identification of critical erosion hot spots in the City and opportunities to develop one or more nature-based pilot project(s) that provide multiple public benefits (e.g., sand retention and ecosystem benefits). The City desires to identify one or more coastal resiliency pilot projects and /or strategies that are environmentally sensitive, financially feasible and that can be approved through the regulatory permitting process. This memo is one of the first steps in developing this Study. It presents the basic concepts for sand retention presented to the City and vetted through the public that may serve as the basis for the ultimate recommendations in the upcoming Feasibility Study.

1.2 Study Overview

The City's primary goal of this Study is to identify and evaluate locally appropriate, optimized coastal resiliency projects that are "nature-based" or "green infrastructure" projects or strategies. The City desires to conduct this effort as efficiently and economically as possible utilizing applicable and relevant scientific and technical data available to optimize utilization of available grant funding.

This Study builds on, and utilizes, the information collected under Shoreline Monitoring Program and is intended to facilitate key recommendations contained in the City's 2021 Coastal Resiliency Plan to promote long-term coastal resiliency in San Clemente. A key recommendation in the Plan (see Executive Summary, Page 7) is to "Prepare a feasibility study to identify critical erosion hot spots in the City and develop one or more pilot projects that provide multiple benefits (e.g., sand retention and ecosystem benefits) such as a living shoreline, coastal dune system or cobble berm structure."

The major study phases/tasks are summarized below.

- **Data Collection** to identify critical erosion areas/hot spots: This task will support an opportunities and constraints analysis and involve a literature review for data on the local sediment budget in this part of the Oceanside littoral cell, field reconnaissance and resource mapping, compilation of wind and wave run-up data. This task is complete.
- **Public Outreach & Involvement** activities and events will occur to ensure meaningful opportunities for public engagement throughout the multi-year Study process. The first public outreach meeting will likely be held via a City Beaches, Parks and Recreation Commission meeting to maximize stakeholder engagement and a total of four public outreach meetings are planned to obtain feedback from the community and interested stakeholders on locations and project types that should be considered as well as opportunities for public review and comment and contributions of citizen science, on the Draft Reconnaissance Study Report. This task is ongoing.
- **City & CCC Staff Coordination** will occur regular check in points, at least twice per year, for the duration of the Study. This task is also ongoing.
- **Development of Nature Based Resiliency Conceptual Designs** involves the preparation of 30% schematic conceptual designs for multiple, nature-based solutions for the City beaches developed with the benefit of public input. The preliminary design concepts will be evaluated for function and performance as well as for potential effects upcoast and downcoast and are intended to support future additional technical analyses, environmental review and permitting. This memo represents the first draft product for this task prior to analyses of function and performance.
- **Identify Permit Requirements, Data Needs and Funding Opportunities** to support the next phase of the Project. This list would be developed to identify all potential permits/approvals needed as well as the agencies responsible for issuing permits. This task will also identify the anticipated level of CEQA/NEPA review for the pilot projects and/or scaled up projects, as appropriate and any data gaps or additional technical studies and outlining performance goals and a monitoring program required to support project advancement and community buy-in. A preliminary list of funding

sources will also be identified. This task has been partially addressed but is still to be fully completed.

- **Prepare Preliminary Design & Final Feasibility Study Report** for public review and comment draft and preparation of a final report compiling/encompassing the information obtained from all previous tasks. It is currently envisioned that there will be a minimum 30-day public comment period for the public review draft Feasibility Study. The Final Feasibility Study will be revised to address public and CCC staff comments and will summarize all opportunities and constraints and include project recommendations for implementation and next steps for City consideration. Thiesetasks will be completed in 2025.

2 Design Concept Development Process

San Clemente's shoreline is experiencing significant widespread erosion (Moffatt & Nichol, 2023). In response, the City of San Clemente (City) has begun implementing a comprehensive shoreline management strategy involving (1) regional shoreline monitoring, (2) planned and opportunistic sand replenishment projects and (3) a study to evaluate the potential feasibility of optimizing the performance and economics of sand replenishment projects by adding structures that slow the alongshore movement of sand.

In 2022, the City obtained a grant from the California Coastal Commission to conduct a Nature Based Coastal Resiliency Feasibility Study (Study). The Study is intended to evaluate the feasibility of range of nature-based solutions to protect against beach erosion in concert with sand replenishment projects. The focus of the Study is sand retention coupled with beach nourishment to restore and widen City beaches over time. Sand retention features are being designed to replicate local, naturally occurring features such as reefs and headlands. Such natural features occur parallel, perpendicular, detached, or attached to the shoreline.

The main goal of the Study is to identify opportunities to design with nature, as a companion strategy to beach nourishment to increase the sand supply to the City resulting in increased beach widths and to sustain wider beaches over the long term. Sand replenishment could potentially be coupled with sand retention features such as headlands, peninsulas, finger reefs and similar natural (i.e., nature-based) structures to reduce wave energy at the beach and hold sand in place longer than would occur without retention.

In this Study, beach nourishment is referred to as Phase 0 since this phase is already underway by the City, while sand retention with nourishment is referred to as Phase 1 in this Study memo. Phase 1 would be implemented after initial nourishment and monitoring informs City decision-making. Phase 2 is implementation of other natural stabilization approaches such as living shorelines at the rear of the beach. Phase 2 would only occur after beaches demonstrably widen sufficiently to accommodate needed recreation and shoreline protection needs, while still providing space for a living shoreline footprint. The focus of this memo is on Phase 1 and thus Phase 2 concepts are not presented herein.

2.1 Initial Concepts Presented to the City and the Public

A set of initial concepts were presented to the City and the public for review and comment at various public meetings held in September 2023, February 2024, and in July 2024. The initial design concepts developed by the Team were presented to the public on September 27, 2023 and were made available for public review on the City website from September 29, 2023 through November 17, 2023. A total of 10 initial design concepts were presented at this initial public meeting to solicit feedback and input that could be used to refine the concepts.

Based on stakeholder feedback, the initial (Round 1) design concepts evolved into Round Two designs with five (5) Phase 1 designs and five (5) Phase 2 designs which were presented on February 29, 2024. These designs were made available for public review and comment from February 15, 2024 through April 29, 2024.

Based on stakeholder feedback, the Round Two designs evolved into the current Round Three designs which were presented to the public, via the Coastal Advisory Committee on July 18, 2024. The design concepts are available for public review and comment through September 6, 2024.

In addition to the community meetings, the Team also met with other identified stakeholder groups and representatives including the Orange County Transportation Authority (OCTA), Surfrider Foundation, Bring Back Our Beaches community group, Save Our Beaches community group, the North Beach Community Association, and the Capistrano Shores Homeowners Association. Sessions of individual stakeholder meetings were conducted in July-August 2023 and in June 2024, to obtain feedback for refinements prior to the September 2023 and July 2024 public meetings.

Key takeaways from the feedback received to date is summarized below:

- There is a wide diversity of opinions and perspectives;
- General lack of support for experimental or otherwise unproven techniques/strategies;
- Strong support for proven techniques used elsewhere in the region, state and beyond, so long as they are within similar oceanographic environments to San Clemente;
- Strong support for a City-wide program with options for all beaches, especially North Beach and beaches toward the southern end of the City;
- Strong support for large-scale, City-wide sand nourishment;
- Strong support for sand retention features if deemed required after sufficient nourishment has taken place;
- Greater support for shore-parallel (e.g., reefs, breakwaters, etc.) retention structures rather than shore-perpendicular retention structures, but feedback was mixed showing support for both types;
- Moderate support for living shorelines and dunes provided they do not result in a loss of towel space for the public;
- A lack of support for the cobble deltas though this concept originally emerged from the previous iteration of the City's Coastal Advisory Committee; and
- The need to closely track the City of Oceanside Re:Beach project and learn from their process and deliverables.

2.2 Revised Draft Concepts – Phase I (Short Term)

Descriptions of the revised draft concepts are provided below in the order of most likely to least likely to be implemented. The descriptions include a general discussion that is supplemented by specific details of each concept.

2.2.1 Concept 1, North Beach Multi-Benefit Emergent Breakwater

2.2.1.1 General Overview

The concept is an emergent rocky reef/breakwater situated between the north end of the North Beach Reach and the south end of the Capistrano Shores Manufactured Home community (Capistrano Shores community) Reach (Figure 1). It would be constructed of armor stone material and have a "barbell" shape design. The submerged, flared sides of the structure would gently slope down around the seaward and side edges for surfing, and the main segment would have a steeper slope on the shoreward and seaward sides of the structure to dissipate wave energy. The crest along the top of the reef/breakwater would be emergent at all times at an approximate design crest height of +10 feet relative to North American Vertical Datum

from 1988 (NAVD88) to be confirmed or possibly modified by further engineering in the future. The structure would be positioned parallel to the shoreline and just offshore of the coast. It would be designed to form a salient, or a bulge in the beach in its lee, caused by slowing of longshore sediment transport and reduction of incident wave energy. It would create both recreational and habitat opportunities and locally protect the North Beach and Capistrano Shores areas. These beaches have experienced significant beach erosion and undermining that has threatened shoreside infrastructure. Unique amenities exist at North Beach, and the design concept could supplement them to increase potential benefits of revitalizing and protecting this reach of the shoreline. This concept was taken from the City of Oceanside Sand Replenishment and Sand Retention Project (GHD, 2021).

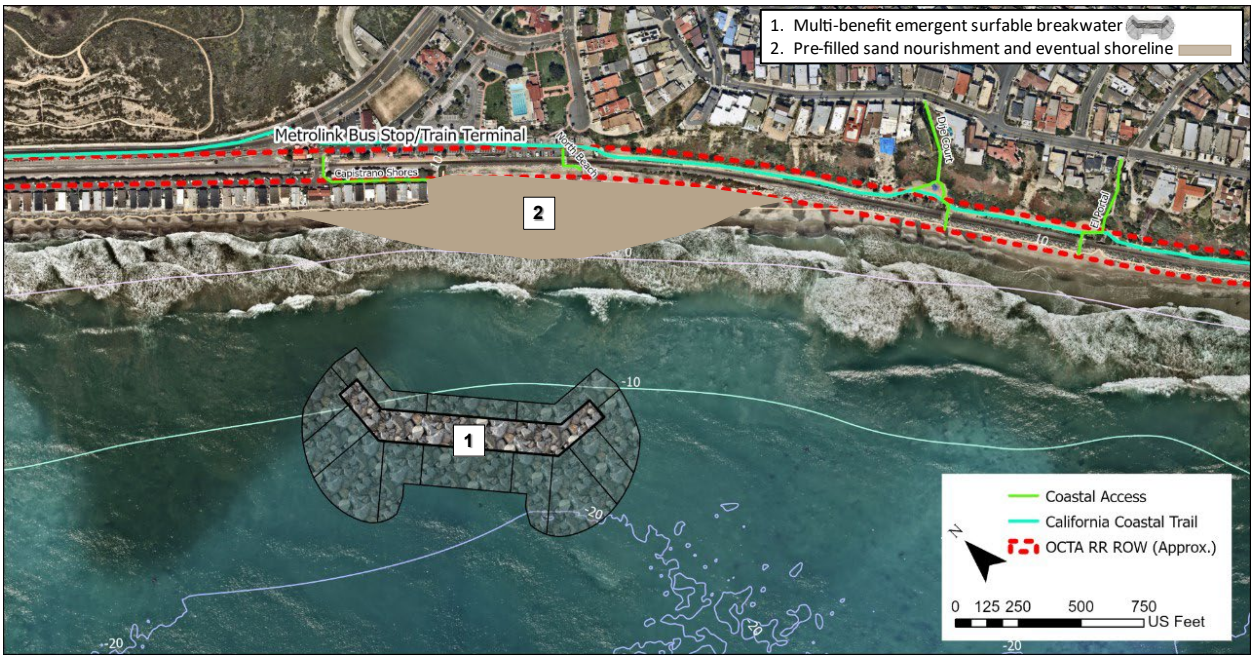

Figure 1: Conceptual Schematic for North Beach Multi-Benefit Emergent Breakwater

2.2.1.2 Site-Specific Opportunities

Locating this structure between North Beach and south Capistrano Shores has the potential to provide additional recreational and socioeconomic benefits. North Beach is one of only four City-owned shoreline beach access points that provides adjacent public parking facilities. The City's primary Metrolink train stop is located at North Beach, offering public transit options for visitors.

The beach at North Beach is currently heavily undermined and actively eroding according to the ongoing shoreline monitoring program results (Coastal Frontiers Corporation, 2024). The current beach is composed of both sand and cobble, making it a less desirable location for users compared to other beaches. The existing concessions operation on the beach is compromised due to undermining and currently closed as a result.

The City is currently revitalizing North Beach and the surrounding Los Molinos District to bring more tourism, commercial business and restaurants, and attractions to this historic district. Concurrently improving the beach and installing the offshore proposed structure would help maintain the shoreline, boost recreation, and protect infrastructure from coastal hazards while improving habitat. A pilot project installed in this location would serve as a supplement both the community enhancement and coastal resiliency efforts underway by the City.

Fronting the Capistrano Shores community, there is effectively no dry sand beach above the mean high tide line and the homes within this beachfront community are under increasing threat from coastal erosion and flooding. Establishing a sand retention feature and prefilling the beach could greatly benefit both North Beach and Capistrano Shores by offering protection from erosion. It would also help establish and maintain a beach at the south end of the Capistrano Shores community. Widening this portion of the beach would be a public benefit due to proximity to available public parking and access and would also restore lateral local and regional coastal access from the south end of the City into Dana Point.

2.2.1.3 Dimensions, Position and Pre-Fill Volume

The shore-parallel, hybrid breakwater/reef would be located offshore of a portion of North Beach and the southern end of the Capistrano Shores community shoreline. The footprint of the “barbell” shaped structure would be approximately 1,300 feet (ft) long, 350 ft wide in the center along the midpoint, and 700 ft wide at the ends. It would be situated approximately 900 ft offshore to form a salient, or a bulge in the beach. The salient would be created by slowing of longshore sediment transport and the reduction of incident wave energy. At this location, this places the majority of the structure in a depth of water of between 10-20 ft.

A crest approximately 1,000 ft long and 130 ft wide would be emergent at all times. The crest planform would be angled (“doglegged”) at about 45 degrees towards shore for the last 200 ft of each end. The emergent crest would be constructed to an elevation of +10 ft North American Vertical Datum of 1988 (NAVD88). This implies that under current sea level conditions, at the lowest spring tides about 11-12 ft of the breakwater crest would be exposed and at the highest spring tides approximately 2-3 ft of the breakwater crest would be exposed.

A prefill of sand would be placed (number “2” in Figure 1) that mimics the anticipated salient that would eventually form leeward of the structure. Sand pre-filling of the salient is done to prevent littoral drift from accumulating in the deposit causing deprivation to the downcoast beach. The prefill would be shaped to form a beach that is approximately 300 ft wide at its widest point directly behind the breakwater, eventually tapering down to meet the existing pre-project shoreline position moving farther away from its protective shadow. This would likely encompass an area that is approximately 400,000 square feet (sq ft) in size, thus requiring approximately 600,000 cubic yards (cy) of material to establish.

2.2.1.4 Construction and Performance Monitoring

The hybrid breakwater/reef is proposed to be constructed out of 2–10-ton armor stone, with the specific sizes to be determined more precisely by future engineering efforts. The exact size of stone required would be developed during the pre-construction, design engineering phase which would follow the current Feasibility Study phase.

Monitoring will be required to quantify the performance of the project. Actions will include physical monitoring of the shoreline, waves, and the structure, and biological monitoring of habitat at the site and in the nearby coastal reach. Results of the monitoring would be used to determine if the project performed as intended or needs to be modified to improve/optimize its performance. For example, the feature could be modified or raised to provide continued protection under rising seas. Biological monitoring would clarify whether habitat colonized the structure and how the added beach affected sand dwelling organisms and species that feed on them.

Conversely, if the monitoring shows that there are negative effects to the adjacent shoreline or safety concerns as a result of its construction then the quarry stone could be removed or scattered over the seabed. It could be dismantled and/or spread out along the nearshore seabed to provide new hard-bottom subtidal habitat or be fully removed from the site using marine construction equipment.

2.2.1.5 Ecological Benefits

In the area where the reef/breakwater is proposed, existing available survey and aerial photography data indicate that the majority of the seafloor is low relief seabed composed of sandy bottom or low relief, highly scoured reef. Data suggests the site is largely absent of higher relief, high quality reef habitat that could be affected by an offshore structure. Since the proposed reef is to be constructed out of armor rock, situating it in an ecologically low-quality area could enhance the habitat potential for subtidal and intertidal species colonization and use (similar to the SONGS Wheeler Reef mitigation project reef modules located further offshore in deeper water). The structure could also be enhanced to maximize habitat potential, biodiversity, and species recruitment by installing an outer surface layer composed of biological growth promoting material and of higher surface complexity than armor stone alone (e.g., possibly ECOncrete casts or other types of naturalized features, etc.).

Establishing a wider beach provides an opportunity for shorebirds, native vegetation, and intertidal infaunal and fish species that inhabit sandy beaches to utilize the space as an expanded local habitat. It may also provide an opportunity for sensitive species (grunion), threatened or endangered species such as least terns and snowy plovers and back beach, dune vegetation to expand within their regional distribution range.

2.2.1.6 Recreation and Access Benefits

The hybrid reef/breakwater is designed with a barbell-style planform shape and sloping submerged edges to focus and refract incoming wave energy in a way that creates conditions for surfing. It is conceptually designed to create waves breaking in two directions (to the left and to the right) on the north and south side of the structure, respectively. For non-surfers, the salient and sand accumulation leeward of the reef/breakwater would provide a protected wading and swimming area.

By placing the structure at the northern end of North Beach, the adjacent 204's surf break would not be affected. The prefill and sand accumulation of the project would be a sufficient distance from the 204's surf break to not result in any long-term or permanent changes in nearshore bathymetry. Since the surf at North Beach is generally lower quality, the project should improve surfing opportunities at North Beach and south Capistrano Shores.

2.2.1.7 Concept Summary

In summary, the reef/breakwater at the north end of the City has emerged as a preferred Phase I project concept because of the wide variety of benefits the structure would provide for sand retention, coastal access, and shoreline protection purposes. These benefits work synergistically with the unique characteristics specific to North Beach and Capistrano Shores to enhance resource opportunities. The benefits offered by the structure at this location and reasons for its consideration as a preferred project concept are as follows:

- The breakwater/reef will significantly reduce wave energy and coastal erosion impacting the shore at North Beach and the south end of the Capistrano Shores community.
- Slowing of longshore sediment transport by the structure will allow for sand accumulation and retention along the shoreline in its lee and immediately up- and downcoast of the structure.
- The prefill of sand behind the structure will establish a revitalized beach for recreation and habitat at North Beach and the south end of the Capistrano Shores community.
- The sand will offer further protection of the shoreline and adjacent infrastructure by buffering wave energy, especially for structures on the beach such as the concessions/restroom at North Beach and the homes at south Capistrano Shores.
- The reef will enhance surf resources in an area where the surfing potential is relatively low (though not absent) as determined through mapping of surf sites as part of this project with the assistance, review, and consultation of long-time local surfers. It will be designed to establish a higher-quality surfing resource for varying skill levels.

- A low wave/current energy, shallow, sandy wading/swimming zone will be established leeward of the breakwater for beachgoer recreation.
- The surf resources, low energy wading zone, and improved wide, sandy beach will create a draw for tourism and visitation to the beach. This will aid in revitalizing a location that contains unique resources. These include nearby public parking, the City's primary Metrolink train/bus stop, lifeguard facilities, concessions/restrooms, a tot-lot, and other existing beachside amenities enjoyed by residents and visitors to the City.
- The sandy beach may help establish a new habitat and foraging area for shorebirds and other species. The reservoir of sand at the back of the beach may be able to eventually be used as a living shoreline with plantings to form a dune-type ecosystem in later phases of the project.
- The rocky reef structure will establish a complex, hard-bottom subtidal and intertidal habitat that will attract a higher biodiversity and species richness than is made up by the relatively low quality sandy bottom habitat that currently exists in its proposed footprint.

2.2.2 Concept 2 - Capistrano Shores Breakwater and Sand "Speed Bumps"

2.2.2.1 General Overview

Concept 2 is a traditional breakwater proposed to be positioned directly seaward of the middle of the Capistrano Shores community, with two flat, rocky platform "speed bumps/mini-headlands" attached to the shoreline at either end of the reach (Figure 2). Compared to the hybrid, emergent reef/breakwaters proposed in the Preferred Concepts 1 and 3, the Capistrano Shores Breakwater would be submerged and longer, but linear in planform and narrower in width. This could result in an overall smaller areal footprint on the seafloor of the structure in comparison to the other two concepts, depending on its water depth. The idea for speed bump/mini-headland concepts was borrowed from the City of Oceanside Re:Beach Project (International Coastal Management, 2023).

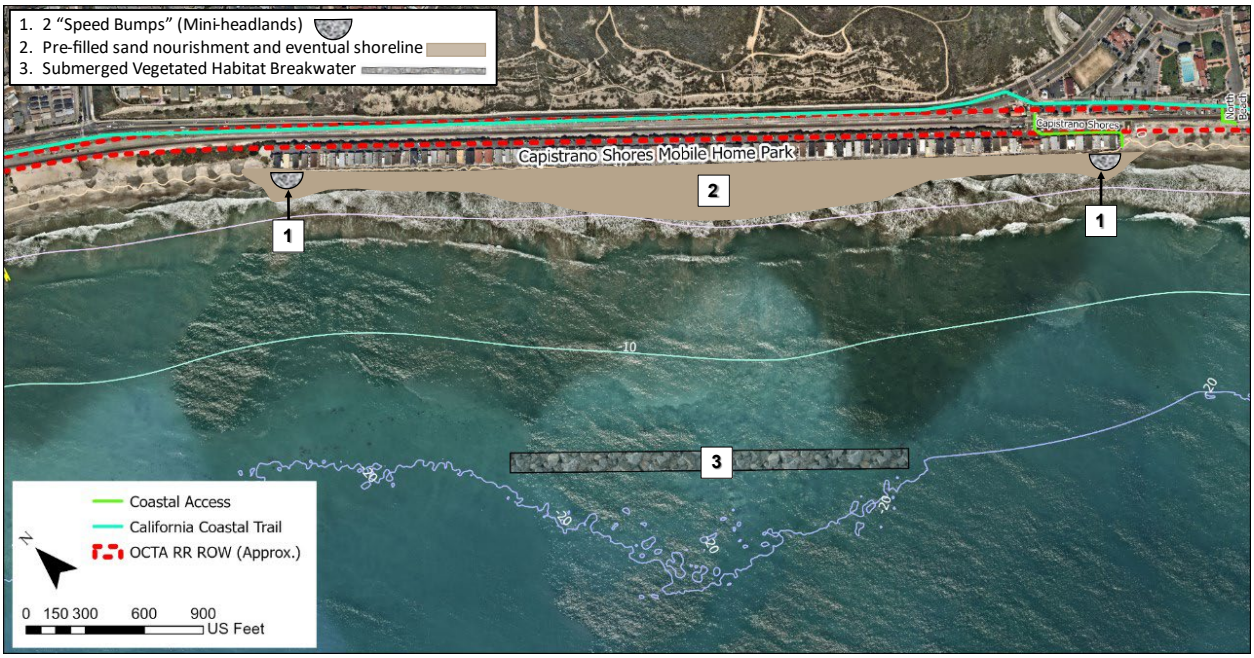

Figure 2: Conceptual Schematic for Concept 2 - Capistrano Shores Breakwater and Sand "Speed Bumps"

The structure would be situated parallel to the shoreline and just offshore. It would be designed to form a salient, or a bulge in the beach in its lee, caused by slowing of longshore sediment transport and decreased incident wave energy behind the structure. It would create both recreational, coastal public lateral access

and habitat opportunities and locally protect the Capistrano Shores community shoreline, which currently and historically has experienced significant beach erosion that has threatened the homes. The rocky platform speed bumps/mini-headlands situated at either end of the reach would be placed to slow alongshore littoral drift.

2.2.2.2 Site-Specific Opportunities

No beach currently fronts Capistrano Shores above the high tide line and the homes within this beachfront community are under increasing threat from coastal erosion and flooding. The 90 residences that make up the Capistrano Shores community are the only residential buildings/structures in San Clemente built to the west of the OCTA railroad line. Due to the imminent threat of continued shoreline erosion and property damage to these homes, this is one of the most critical areas along the San Clemente shoreline needing intervention. Installing a sand retention feature and beach could greatly benefit the community via providing enhanced protection from coastal erosion and recreation.

The homes within the Capistrano Shores community are situated on private land parcels and access to the shoreline for the public other than the homeowners is only available from North Beach or Poche Beach on either end of the community. Establishing and maintaining a wide sandy beach in front of the Capistrano Shores community would create a recreation area for beachgoers via the adjacent coastal access points with significant public parking that exists at North Beach.

The speed bumps/mini-headlands installed at either end of the beach would provide public access points and overlooks and may provide a localized increase in beach area in their immediate vicinity. This effect may occur by encouraging sand settlement around them as well as from sand accumulation behind the breakwater. As a result, the lateral beach access may improve for the general public.

The City's primary Metrolink train stop is located near North Beach, offering public transit to the local beach for beachgoers. Having a larger usable public beach in this vicinity that is accessible from the North Beach Metrolink stop could increase visitation. In addition, the City is currently revitalizing North Beach and the surrounding Los Molinos District to increase tourism, commercial business and restaurants, and attractions in this area. Concurrently improving the beach would help maintain the shoreline in this general area, boost recreation, improve habitat conditions, and protect infrastructure from coastal hazards. This would serve as a significant supplement to the City's community enhancement effort.

2.2.2.3 Dimensions, and Position and Pre-Fill Volume

The breakwater would be approximately 2,000 ft long and 100 ft wide along its length. The breakwater would also be considered "submerged" with a top elevation of the crest of the structure at approximately 0 ft NAVD88. As a result, the structure would not be visible from the shoreline (i.e., does not penetrate the water surface under calm seas conditions) other than during spring low tides when it may extend up to 2 ft above the water surface.

The structure would be positioned approximately 1,500 ft offshore from the middle of the Capistrano Shores community in order to form a salient on the beach in its lee, similar to that described for the Preferred Concept 1. The structure would be placed in approximately 15-20 ft of water. It would be oriented parallel to shore along its entire length.

The speed bumps/mini-headlands at each end of the reach would be designed to slow littoral drift and keep sand behind the breakwater on the shore. These would be located along the shoreline at the ends of the community. They are proposed to be semi-circular in planform with dimensions of 150 ft alongshore and 50 ft shore-normal. They would be constructed with slopes of armor stone and a top filled with sand-sized material. The top of the platforms would reach approximately +16 ft NAVD88 in elevation.

Sand would be used to "pre-fill" the salient (number "2" Figure 2) to prevent littoral drift from accumulating in the deposit causing deprivation to the downcoast beach. The salient could be nearly 300 feet wide at its

widest point and taper back to the existing pre-project shoreline position near the rocky speed bumps/mini-headlands on either end. This area would encompass approximately 900,000 sq ft of new beach space. The amount of prefill material needed to achieve this profile along this stretch would be approximately 1.4 million cubic yards (mcy) of sand.

2.2.2.4 Construction, and Performance Monitoring

The breakwater would be constructed out of large armor stone sufficient to remain stable during design storm wave events (i.e., likely between 2-10 tons to be determined by future engineering efforts). The exact size of stone required would be developed during the pre-construction, design engineering phase which would follow the current Feasibility Study phase. In addition, the feature could be modified or raised to provide continued protection under rising seas.

Conversely, if there are negative effects to the adjacent shoreline or safety concerns as a result of its construction then the quarry stone could be removed or scattered over the seabed. It could be dismantled and/or spread out along the nearshore seabed to provide new hard-bottom subtidal habitat or be fully removed from the site using marine construction equipment.

2.2.2.5 Ecological Benefits

At the location of the proposed breakwater, existing available survey and aerial photography data suggest that the majority of the seafloor is relatively flat and has a sandy layer. This potentially indicates there is a sand or low-relief reef seabed that exists in this area. This seabed condition may be relatively low in habitat quality compared to higher relief reef. Situating the breakwater in a relatively lower quality habitat area could enhance the habitat potential for subtidal and intertidal species by establishing new hard-bottom substrata.

The structure would be proposed to be constructed in a way that maximizes habitat potential, biodiversity, and species recruitment by using biologically promoting surface materials (e.g., possibly something like ECOncrete materials or others if suitable, etc.). The reason for considering alternative materials such as ECOncrete is it could create higher surface complexity facades that mimic real-world reef habitats in comparison to armor stone alone. In addition, the chemically-balanced concrete composition more suitable for biologic colonization success on the outside layer of the structure would enhance the habitat potential if it can be effectively adhered to the stone composing the breakwater.

Establishing a wider beach leeward of the structure provides an opportunity for shorebirds, native vegetation, and intertidal benthic infaunal species (sand crabs and bean clams) that inhabit sandy beaches to utilize the space as an expanded local habitat. It may also provide an opportunity for sensitive species (grunion), threatened or endangered species (least terns and snowy plovers), and vegetation species to have more space to expand within their regional distribution range.

2.2.2.6 Recreation and Access Benefits

Locating the breakwater offshore in front of Capistrano Shores would effectively dissipate a large proportion of wave energy on the structure instead of closer to or directly on the shoreline. Since there are no known quality surfing resources fronting the Capistrano Shores community, the installation of the breakwater would not result in any diminished surf opportunity as a result of the structure itself. The formation of the salient and sand accumulation leeward of the breakwater should establish a shallower bottom and wading/swimming area with reduced wave energy behind the structure. However, since the breakwater is designed as a submerged structure, some amount of wave energy will reach the shoreline creating conditions for smaller wave surfing.

2.2.2.7 Concept Summary

In summary, the submerged breakwater and speed bumps/mini-headlands located in front of the Capistrano Shores community is a proposed Phase I project concept due to the multiple benefits the structure would provide for the area. The residential community would be offered protection from coastal storm damage. In addition, a beach would be established that would restore lateral access in the City and could be utilized by the public for walking and sandy shore-dwelling floral and faunal species. In summary, the benefits offered by the structure at this location and reasons for its consideration as a preferred concept are as follows:

- The breakwater will significantly reduce wave energy and resultant erosion impacting the shoreline along the extent of the Capistrano Shores Manufactured Home community.
- Slowing of longshore sediment transport by the structure will allow for sand accumulation and retention along the shoreline in its lee.
- Speed bumps/mini-headlands installed as low-lying rocky platforms attached to the shore on either end of the community will interrupt littoral drift, promote sediment accumulation and beach stabilization within their vicinity, and help to retain sand behind the breakwater.
- The prefill of sand behind the structure will establish a revitalized beach for recreation in front of Capistrano Shores with restored lateral public access.
- The sand will offer protection of the shoreline and homes along the extent of Capistrano Shores by buffering wave energy that impacts the shoreline.
- A lower wave energy, shallow, and sandy wading/swimming zone will be established leeward of the breakwater, enhancing recreation potential for beachgoers.
- The expanded wide, sandy beach will create a draw for tourism and visitation. There is abundant nearby public parking and a Metrolink train/bus stop within close vicinity of access to the beach.
- The sandy beach may help establish a new habitat and foraging area for shorebirds and other shore-dwelling species.
- The breakwater structure will establish a complex, hard-bottom subtidal and intertidal habitat that will attract much higher biodiversity and species richness than the relatively low quality low-relief sandy or reef seabed that currently exists. The site could be enhanced with bio-promoting surface material and structural complexity that will optimize the habitat potential of the structure.

2.2.3 Concept 3 – State Beach Multi-Benefit Emergent Breakwater

2.2.3.1 General Overview

Concept 3 is similar to the emergent rocky reef/breakwater hybrid structure proposed for the Preferred Concept 1, however it would be sited at the south end of the City at a critically eroded beach (Moffatt & Nichol, 2023). It would be located in front of San Clemente State Beach, which is near the northernmost end of the Cyprus Shore, Cyprus Cove, Breakers and Cotton's Point Estates residential communities at the south end of the City (Figure 3). As with Concept 1 at North Beach, it would be constructed of armor stone material and have a "barbell" planform design. The submerged flared sides of the structure would gently slope down around the seaward and side edges to provide a recreational surfing resource, while the main body of the structure would have steeper slopes shoreward and seaward to dissipate wave energy. The crest along the top of the reef/breakwater would be emergent at all times. This concept was taken from the City of Oceanside Sand Replenishment and Sand Retention Project (GHD, 2021).

Figure 3: Conceptual Schematic 3 – State Beach Multi-Benefit Emergent Breakwater

The structure would be positioned parallel to the shoreline and just offshore of the coast. It would be designed to form a salient, or a bulge in the beach in its lee, caused by slowing of longshore sediment transport and reduction of incident wave energy. It would create both recreational and habitat opportunities and locally protect the south State Beach shoreline and the beach adjacent to the four residential communities at the City's south end. This area currently and historically has experienced significant beach erosion and undermining that has threatened shoreside infrastructure, particularly the OCTA railway and revetment.

2.2.3.2 Site-Specific Opportunities

Locating this structure at the south end of the San Clemente State Beach has recreational and socioeconomic benefits for State Parks, the City, public beachgoers and visitors, the OCTA, and the private homeowners of the four southern residential communities with increased lateral beach access in the vicinity and larger beach area for recreation due to their proximity. The local beach along residential communities is actively eroding according to the ongoing shoreline monitoring program results (Coastal Frontiers Corporation, 2024). Due to the recently increasing threat of shoreline erosion to the adjacent OCTA railway infrastructure, the transportation agency placed additional armor stone in 2023 and 2024 to fortify its tracks / revetment just south of the proposed location of the reef/breakwater under an Emergency Coastal Development Permit. Establishing a sand retention feature and prefilling the beach would greatly benefit the railway by offering protection from coastal erosion and re-establishing a recreation area for beach users where public access is available via the State Park.

The surf resource opportunities provided by the feature would also likely enhance recreation appeal to the beach and attract City and State Parks visitation and revenue. Finally, the only currently available coastal access point for the southern residential community members (containing 426 homes) known as "North Gate" is repeatedly flooded and has been regularly under threat from coastal erosion in recent years. Placing the hybrid reef/breakwater just upcoast and nourishing the nearby beach would likely offer some protection for this important accessway for the community. In addition, the widened shoreline may potentially restore beachside access from the southern residential communities to San Clemente State

Beach, with the ultimate vision being restoration of lateral coastal access along the beach allowing residents and visitors to once again walk to south to Trestles and San Onofre State Beach.

2.2.3.3 Dimensions, Position and Pre-Fill Volume

The shore-parallel, hybrid breakwater/reef would be located at the southern end of the San Clemente State Beach shoreline. The footprint of the "barbell" shaped structure would be approximately 1,300 feet (ft) long, 350 ft wide in the center along the mid-point, and 700 ft wide at ends. It would be located approximately 600 ft offshore in order to form a salient, or a bulge in the beach. The majority of the structure would be in a depth of water of between 10-20 ft.

The crest would be approximately 1,000 ft long and 130 ft wide and be emergent at all times. The crest would be doglegged at approximately 45 degrees towards shore for the last 200 ft at each end. It would be constructed to an elevation of +10 ft NAVD88. This implies that under current sea level conditions, at the lowest spring tides about 11-12 ft of the breakwater crest would be exposed and at the highest spring tides approximately 2-3 ft of the breakwater crest would be exposed.

A prefill of sand would be placed (number "2" in Figure 3) that mimics the anticipated salient extent that would eventually form leeward of the structure. Sand pre-filling of the salient is done to prevent littoral drift from accumulating in the deposit causing deprivation to the downcoast beach. The prefill would be shaped to form a beach that is approximately 300 ft wide at its widest point directly behind the breakwater, tapering down eventually to meet the existing pre-project shoreline position beyond the protective shadow of the structure. This would likely encompass an area that is approximately 400,000 sq ft in size, thus requiring about 600,000 cy of material.

2.2.3.4 Construction and Performance Monitoring

The hybrid breakwater/reef is proposed to be constructed out of 2–10-ton armor stone, with the specific sizes to be determined by future engineering efforts. The exact size of stone required would be developed during the pre-construction, design engineering phase which would follow the current Feasibility Study phase. In addition, the feature could be modified or raised to provide continued protection under rising seas.

Conversely, if there are negative effects to the adjacent shoreline or safety concerns as a result of its construction then the quarry stone could be removed or scattered over the seabed. It could be dismantled and/or spread out along the nearshore seabed to provide new hard-bottom subtidal habitat or be fully removed from the site using marine construction equipment.

2.2.3.5 Ecological Benefits

Aerial photography and survey data indicate that there may be some existing rocky bottom habitat where the reef is being proposed. More investigations incorporating higher resolution, detailed bathymetric and biologic surveying in the area of proposed placement would need to occur in order to verify conditions and determine any design refinements to avoid negative ecological impacts. An evaluation of the quality of any potential habitats in this area should also be performed.

Since the reef is proposed to be constructed out of armor rock, situating it in an ecologically low-quality area could enhance the habitat potential for subtidal and intertidal species colonization and use. The structure could also be enhanced to maximize habitat potential, biodiversity, and species recruitment by installing an outer surface layer composed of biological growth promoting material and of higher surface complexity than armor stone alone (e.g., possibly a product such as ECOncrete casts, and/or other natural features if feasible, etc.). Ecological pros and cons associated with this design concept would need to be evaluated in the next phase.

Establishing a wider beach in this vicinity provides an opportunity for shorebirds, native vegetation, and intertidal infaunal and fish species that inhabit sandy beaches to utilize the space as an expanded local habitat. It may also provide an opportunity for sensitive species (grunion), threatened or endangered species such as least terns and snowy plovers, and special status vegetation species to have more critical habitat space to expand within their regional distribution range.

2.2.3.6 Recreation and Access Benefits

The hybrid reef/breakwater is designed with a barbell planform shape and sloping submerged edges to focus and refract incoming swell energy in a way that generates a surfing resource opportunity. In doing so, it is designed to create both a left and a right breaking wave on the north and south side of the structure, respectively. For non-surfing visitors, the formation of the salient and sand accumulation leeward of the reef/breakwater would establish a wading area for swimmers. In this zone there would likely be minimal wave energy due to the blocking of surf by the emergent breakwater crest.

The structure would be placed at the southern end of the State Beach and situated in a location that does not impact surfing at nearby North Gate, South Gate, or the primary surf spots along the State Beach shoreline. Similarly, it is intended to be situated a sufficient distance from the high-quality surf resource of Cotton's Point that it would not have any impacts on the surf quality of that site.

The prefill and anticipated sand accumulation of this feature is intended to be a sufficient distance from all notable surf breaks to avoid any long-term or permanent changes in nearshore bathymetry that may negatively affect nearby surfing resources. In effect, the hybrid reef/breakwater structure would be designed to improve the local surfing resource opportunities where it is sited.

2.2.3.7 Concept Summary

In summary, the hybrid reef/breakwater structure placed at the southern end of the State Beaches is a proposed Phase I project concept due to the wide variety of benefits the structure would provide for sand retention, coastal access, recreation and shoreline protection purposes. The placement of the structure in this area would likely directly benefit a wide array of stakeholders due to its location within the City along a State Parks property and where the OCTA railway is significantly threatened by coastal erosion. Recreation and habitat enhancements are also afforded as well. In summary, the benefits offered by the structure at this location and reasons for its consideration as a project concept are as follows:

- The breakwater/reef will significantly reduce wave energy and resultant erosion impacting the shore at the south end of San Clemente State Beach. It may also benefit the beach adjacent to the southern residential communities which is currently almost completely eroded above the mean high tide line.
- Slowing of longshore sediment transport by the structure will allow for sand accumulation and retention along the shoreline in its lee and immediately up- and downcoast of the structure.
- The prefill of sand behind the structure will establish a revitalized beach for recreation and habitat at the south end of the State beach.
- The sand will offer further protection of the shoreline and coastal infrastructure by buffering wave energy.
- The reef will enhance surf resources in an area where the surfing potential is relatively low. It will be designed to establish high-quality surf breaking both left and right with varying wave types that cater to different skill levels of surfing.
- A low wave energy, shallow, sandy wading/swimming zone will be established leeward of the breakwater for beachgoers.
- The surf resources, low energy wading zone, and improved wide, sandy beach will create a draw for tourism and visitation to the beach, which will benefit State Parks as well as the City of San Clemente.

- The sandy beach may help establish a new habitat and foraging area for shorebirds and other species.
- Over time, if the beach becomes wide enough, the back of the beach may be able to be used as a living shoreline with plantings to form a dune-type ecosystem in later phases of the project.
- The rocky reef structure will establish a complex, hard-bottom subtidal and intertidal habitat that will attract a much higher biodiversity and species richness if placed in an area where the habitat quality is relatively low.
- Installing a sand retention feature at the south end of the City could restore lateral coastal access along the beach allowing people to once again walk south to Trestles and San Onofre State Beach.

3 Next Steps

These concepts will be developed further after public input on the third round of concepts has been considered. The concepts will be presented in a Draft Feasibility Study in early 2025. Feasibility will consider the function and performance of the concepts, as well as for potential effects upcoast and downcoast. The Study will present path forward for future additional technical analyses, environmental review and permitting, and economic analyses.

Data gaps will be identified and suggested approaches to resolving them will be recommended. Examples of data gaps may include items such as:

- existing offshore sand sources to build the projects,
- more current marine biology of the project sites,
- existing longshore sand transport rates and directions, and
- detailed bathymetric and biologic surveying in the area of proposed placement

The Draft Feasibility Study will be issued for public review and comment. A final version of the Study will then be prepared based on comments and input from the public. The entire process is currently anticipated to be complete in Summer 2025. The Final Study will provide the City with a road map to move forward, with timelines for each step and likely funding needed to keep all work progressing toward implementation.

4 References

City of San Clemente. (2021). *City of San Clemente Coastal Resiliency Plan*. December 2021.

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Moffatt & Nichol. (2023). *San Clemente Nature-Based Adaptation Project Feasibility Study: Subtask 2.2 - Critical Erosion Hotspots Report.*