Orange Coast District
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San Clemente, CA 92672
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September 11, 2019

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California Coastal Commission
San Diego Coast District
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Regarding: Proposed Shoreline Monitoring Program for Surf Beach at San Onofre State Beach

The following Shoreline Monitoring Program is intended to satisfy the monitoring requirements identified in the Special Conditions of State Park's Coastal Development Permit (No. 6-18-1089). The Permit, approved by the Coastal Commission on June 13, 2019, authorizes the retention of an existing 800-foot rock revetment at Surf Beach (within San Onofre State Beach) for the next five years, with monitoring as specified in the Special Conditions of the Notice of Intent to Issue Permit (NOI) issued on June 18, 2019. This proposed monitoring program specifically addresses Special Condition 3 (Revetment Monitoring Program), 7 (Interim Surf Monitoring), and 8 (Interim Shoreline Erosion Monitoring) and the methods State Parks will utilize to meet the stated monitoring objectives.

The monitoring strategies and methods proposed below were developed over an 18-month period with input from professional coastal engineers (Moffatt & Nichol and UC Irvine), academics (UC Irvine), data scientists (Surfline), environmental groups (Surfrider), the San Onofre Parks Foundation, and our own departmental leaders in the fields of natural and coastal resources management. State Parks also held two stakeholder meetings (July 26 and August 30, 2019) to listen to the concerns of stakeholders, explore management and monitoring options, and reach consensus on a set of monitoring strategies. Agendas and participant lists for these meetings are provided in Appendix A and B. The stakeholders agreed to meet annually to share observations and results from the monitoring programs and solicit feedback. Any proposed alternative method(s) for shoreline or surf monitoring originating from this stakeholder group would be provided to the Coastal Commission for review and approval.

Revetment Monitoring Program (Special Condition 3)

Special Condition (from NOI): To develop a long-term monitoring plan for the existing shoreline protective device: the approximately 800-foot long revetment.

Objective: To monitor and identify damage or changes to the revetment such that repair and maintenance is completed in a timely manner to avoid further encroachment of the revetment on the beach.

Proposed Method: In partnership with environmental engineers from UC Irvine, State Parks proposes to use a light-weight Unmanned Aircraft System (UAS) and Global Navigation Satellite System (GNSS) receiver to monitor for movement of the revetment and displaced rock. The UAS system will capture ortho-rectified aerial photographs at fine-scale resolution along the entire Surf Beach management unit, including above the revetment (Figure 1). The images will

be processed using Structure from Motion (SfM) photogrammetry to obtain orthophotos and digital topographic surface models of surveyed beaches. To achieve additional accuracy of the processed datasets, SfM processing will be constrained using surveyed ground control points, which will require field collection using RTK-GPS measurements of easily identifiable locations on the ground and within the UAS imagery along each surveyed beach. The GPS surveys will be carried out before or after the UAS campaign but will have negligible impact on park operations or public access.

We propose to conduct UAS surveys once every two months (six times per year) and following especially impactful erosional events (e.g. large, long-period swells events coupled with high tides) during clear weather and low tide conditions to obtain maximum beach exposure. Figure 1 shows the proposed take-off location, flight paths, and visual observer locations for the Surf Beach parcel. Blue crosses indicate approximate UAS take-off location, red crosses approximate visual observer locations. Following take off, the UAS will rise to an elevation of approximately 80 meters (262 feet) and then fly horizontally along a set survey flight path (green lines) at approximately 10 meters/s. The estimated flight time for Surf Beach would be only 14 minutes. The flight paths are pre-programmed onto the UAS and the survey will be flown in autonomous mode with the camera pointing at nadir.

Flights would be carefully coordinated with US Marine Corp Base staff at Camp Pendleton to avoid any potential conflicts with Base operations. State Parks is in the process of obtaining approval from the USMCB to conduct UAS surveys within San Onofre State Park.

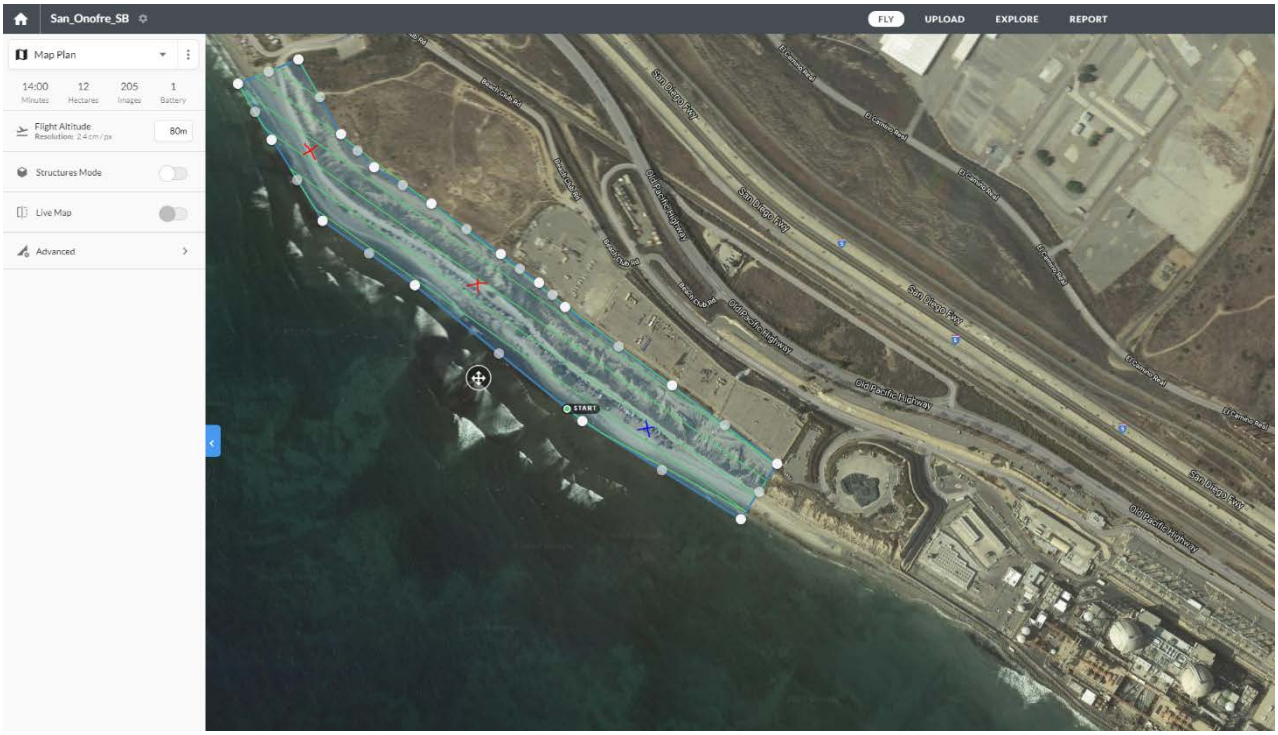


Figure 1. UAS Monitoring Area at Surf Beach.

Deliverables: The gathered data will allow for establishing the following information products and deliverables with respect to Special Condition 3:

1. Cross-sections of revetment and beach topography (i.e. beach profiles) at key locations, including along the length of the revetment.
2. Spatially distributed relative change measurement of revetment elevations to determine if settling or seaward movement of the revetment is taking place.

Rationale: There was strong support among stakeholders for this approach compared with using more traditional land survey equipment and methods because of the improved spatial coverage (the entire area of the revetment can be monitored and analyzed for movement with this method) and resolution. This UAS-based method was originally contemplated for monitoring potential beach erosion around and fronting the revetment (Special Condition 8) but since the UAS would capture images of the revetment itself, the exact same data and analyses would detect any movement of the revetment as well. As such, this approach is both effective and efficient, because it does not require separate and redundant survey and monitoring efforts. The proposed UAS monitoring approach has already been tested successfully at Doheny State Beach (See Figure 2 under the Interim Shoreline Erosion Monitoring section).

In addition to the UAS-based surveys, Parks staff will continue to regularly check the revetment in the field for any signs of damage such as out-of-section rock, especially during and following large wave events coupled with high tides. Any noticeable changes in the beach profile fronting the revetment shall be noted and documented with photographs.

Interim Surf Monitoring (Special Condition 7)

Special Condition (from NOI): The permittee shall submit a plan for monitoring the wave breaking patterns of the surf beach area. The surf plan shall involve the following dataset collection: Wave breaking pattern in front of the revetment shall be monitored through collection of video imagery when the surf report forecasts wave heights of three feet or greater, and regardless of forecasts, at least four times a month, unless an alternative monitoring frequency is deemed more appropriate by the stakeholder group (paraphrased from the NOI, p. 7). Video should be collected at mid-tide to provide a known vertical reference and in such a way as to capture a complete range of wave break characteristics that can then be averaged to evaluate the spatial extent for the given wave conditions. Wave observations shall include wave height, period and wave break character. Monitoring data shall be submitted annually with any inferences and recommendations.

Objective: To document changes in surf conditions over time in front of the revetment.

Method(s): In partnership with Surfline©, we propose to monitor surf conditions using video imagery from HD Quality Outdoor Rated Security Cameras mounted on existing power pole(s) overlooking Surf Beach. Video imagery will be captured on a near continuous basis (except for when cameras are off-line for maintenance, malfunctions, and the like), vastly exceeding the four times per month minimum requirement. Video imagery will also be auto-analyzed using emerging artificial intelligence (AI) technology developed by Surfline© to capture a variety of parameters that are reasonable proxies for surf quality. These parameters include number of surfers at the "Point" in front of the revetment, numbers of waves ridden, take-off locations, and length of rides. This data can be retrieved for any given time point or averaged over any period of time, and correlated/compared with environmental data like wave height and period, wind speed and direction, and tide levels. Raw video footage can also be archived, searched and filtered (by time, tide, wave height, period, etc.), and analyzed by humans to investigate other wave phenomena like frequency of backwash events.

Deliverables: The gathered data will allow for establishing the following information products and deliverables with respect to Special Condition 7:

1. Raw data and archived video imagery upon request as practical/feasible.
2. An annual report summarizing the yearly monitoring data, including summary statistics on the average number of surfers at "the Point", numbers of waves ridden, and average length of ride. Annual data will also be compared and contrasted with previous year's data to

assess and interpret observed changes over time. Observations of and trends in backwash events fronting the revetment will also be discussed.

There is some concern among stakeholders that the surf monitoring data, as rigorous as it may be at revealing patterns of change over time in surf conditions, is unlikely to tell us what is causing any observed change, including the role of the revetment. Identifying the role of any one variable, in this case the revetment, is a challenge because beaches—and surf breaks—are very dynamic systems. They constantly change in response to many different and interacting forces (e.g. swell direction, wave height, swell period, tides, currents, sediment transport, wind, etc.) which operate at multiple spatial and time scales (e.g. hourly, daily, seasonally, and annually). The susceptibility of a surf break to change is also influenced by its position along the coastline, its proximity to new sand supplies (e.g. a nearby river), and its exposure to wave action. To complicate matters further, we are likely to experience accelerating rates of sea-level rise across our coastlines in the coming decades. Therefore, it may be very challenging to disentangle the impact of the revetment on surf conditions from everything else that is changing in the shoreline environment. None the less, the proposed methods and frequency of data collection should capture the variation in surf conditions present at Surf Beach, how that variation changes over time, and how surfers respond to (or are affected by) changing conditions.

Interim Shoreline Erosion Monitoring (Special Condition 8)

Special Condition (from NOI): The permittee shall submit a plan for monitoring the down-coast erosion of the Surf Beach area ("Erosion Plan"). The plan shall at a minimum:

1. Monitor beach profiles, including mean high tide line location, along Surf Beach
2. Monitor two or more down-coast monitoring sites for potential effects
3. Monitor two or more up-coast monitoring sites "as controls"
4. Describe all the methods, including volunteer training if appropriate
5. Submit data and a monitoring report annually

Special Condition 8 also required that stakeholders be involved in the monitoring plan to be sure shoreline monitoring is robust, informative, and addresses any major concerns.

Objective: To monitor and identify demonstrably altered beach erosional patterns immediately down-coast of the revetment compared to elsewhere at Surf Beach (based on comparisons with control transect data and/or other available shoreline data).

Proposed Methods

A. **Unmanned Aircraft System (UAS) Monitoring.** Again, the stakeholder group agreed that a light-weight Unmanned Aircraft System (UAS) and Global Navigation Satellite System (GNSS) receiver to monitor for shoreline erosion. The UAS system will capture ortho-rectified aerial photographs at high resolution along the entire Surf Beach management unit (see Figure 1), as well as up-coast and down-coast sections of beach as reference control sites (see Figure 3). Images will be processed and analyzed for shoreline erosion in the same manner as the revetment monitoring (see Methods for the Revetment Monitoring Program above). We propose to conduct UAS surveys once every two months (six times per year) and following especially impactful erosional events (e.g. large, long-period swells events coupled with high tides) during clear weather and low tide conditions to obtain maximum beach exposure.

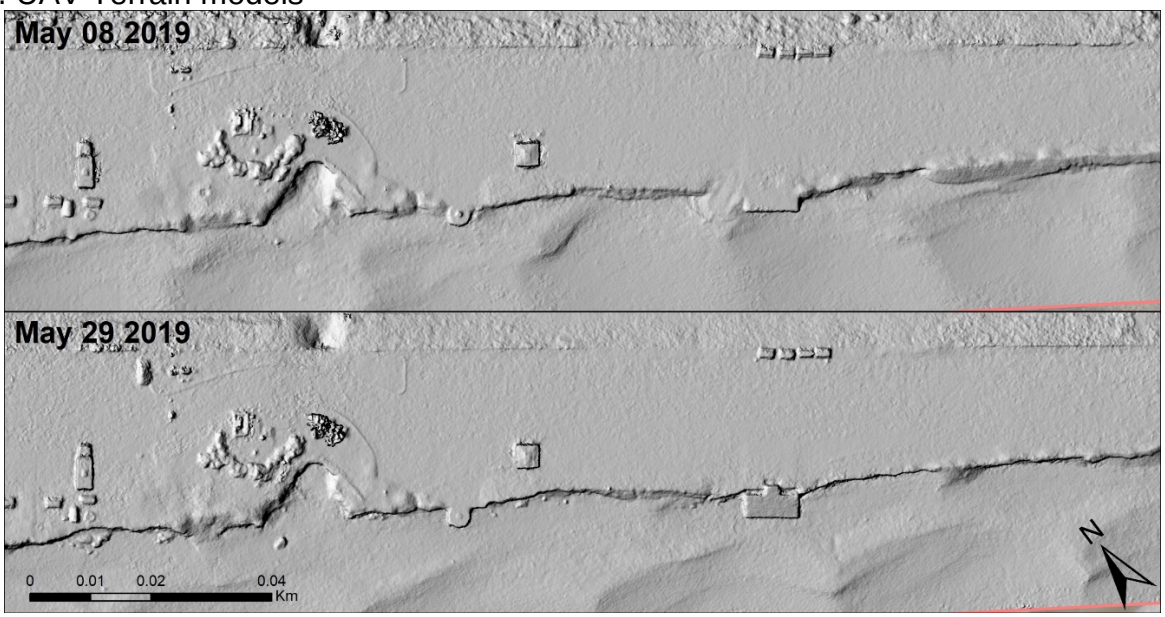
   Deliverables: The gathered data will allow for establishing the following information products and deliverables with respect to Special Condition 8:

1. Cross-sections of sub-aerial beach topography (i.e. beach profiles) at key locations
2. Maps of spatially distributed relative change of beach elevations, up-coast, down-coast, and fronting the revetment
3. Relative change of beach sand volume
4. Spatial erosion/accretion rates based on the temporal resolution of the collected data
5. Maps of the mean high water (MHW) level along the beach as a result of beach elevation at time of survey
6. Shortest distance between critical infrastructure and the MHW level based on the temporal resolution of the collected data

Figure 2 below shows two ortho-rectified aerial images from portions of the south day-use area of Doheny State Beach taken 21 days apart in May of 2019, and the change in topography and sand distribution (both accretion and erosion) between those two time points (Figure 2.3).

1. Ortho-rectified aerial photos (below images are 3 cm resolution).

2. UAV Terrain models



3. Topographic elevations

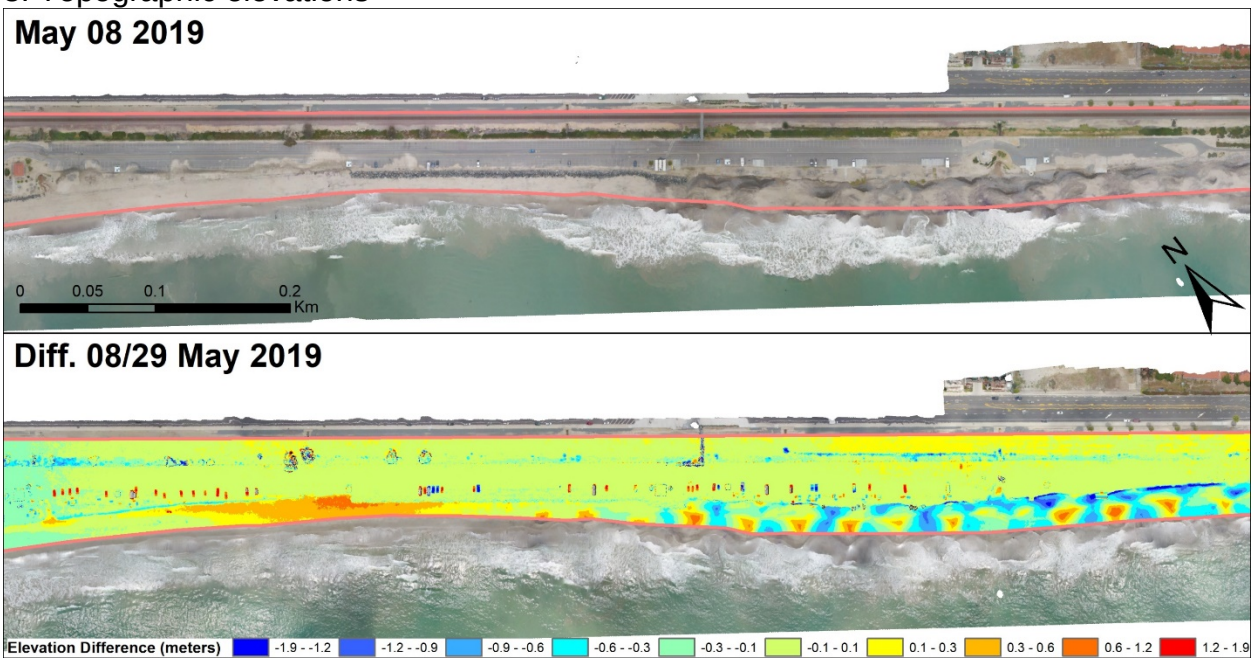


Figure 2. Examples of data products from the proposed UAS monitoring approach. Examples below are from Doheny State Beach.

B. **Beach Profile Transect Monitoring.** While UAS-based monitoring will yield tremendous insight in to changes along Surf Beach and at up- and down-coast reference control areas, it is not yet effective for monitoring changes that occur beneath the surface of the water. To monitor for change in the submerged, near shore environment, State Parks will conduct beach profile transect monitoring. There are two types of beach profile monitoring which can be conducted in the field to provide shoreline information: a) surveys along full-length profiles from the toe of the bluff out to the offshore "depth of closure" and b) surveys along shorter transect out to wading depth (wading depth transects). Due to the significant cost involved with the former, full-length profiles, State Parks will consider the full-length transects only if additional funding becomes available. All transects will be perpendicular to the shoreline.

a. Wading Depth Transects. Six wading depth transects (W1 to W6 shown by black circles on Figure 3) will be established along Surf Beach to record beach profiles fronting the revetment and restroom facilities, as well as immediately up-coast and down-coast of the revetment.

We will record wading depth profiles by extending data collection along each transect from the toe of the bluff to wading depth. As part of the wading depth surveying, the width of different features of Surf Beach will be monitored, including the width of the road, dry beach berm, and cobble field.

Figure 3: Beach Profile Monitoring Transect Locations along Surf Beach.

The Emery beach profiling method will be used to collect data on beach width and elevation along the wading depth transects. The Emery beach profiling method is a simple, reliable technique to measure width and elevation change along the beach relative to a non-moving point, the horizon. The method uses two 1.5 m long measuring rods connected by a 2 m long rope. Rods are held vertical and extended in a line perpendicular to the shoreline (i.e. a transect). The horizon line is used to estimate the difference in elevation between the two positions (See Figure 4). The method is repeated along a transect line from a fixed reference mark on the upper part of the beach (e.g. base of the coastal bluff) towards the ocean. Measurements can be taken into the surf zone to generate profiles at wading depth. The method generally requires three people (staff and/or volunteers); two to hold and move each rod and one to record data on a field form.

In addition to documenting change in the beach profile over time, the resulting transect data will be used to locate the approximate mean high tide line (or mean high water level (MHW)) along the beach profile. Based on the nearest NOAA tide gage, the MHW for Surf Beach is approximately +4.6 feet relative to the mean lower-low water (MLLW) datum. The location of the MHW elevation intersection on the beach profile can be interpolated from the recorded transect information and its position relative to the toe of the bluff can be tracked over time.

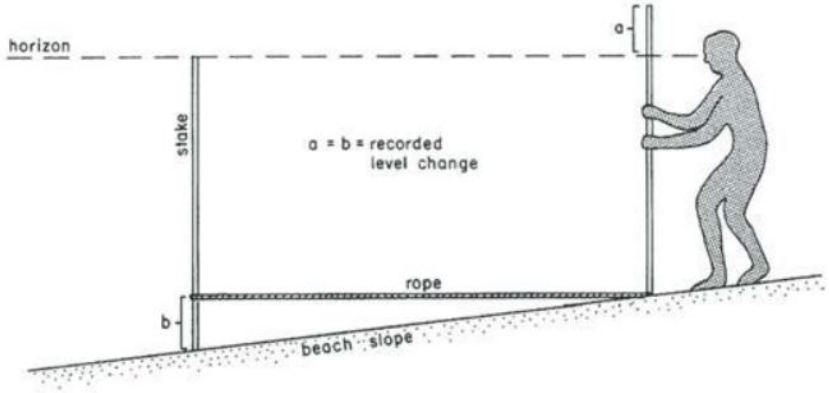


Figure 4. The Emery Method for beach profiling.

b. Full-Length Transects (Pending additional funding)

As funding allows, monitoring of six full-length transects may be considered to better understand long-shore sediment transport dynamics in front of Surf Beach and the amount of sand in the near shore environment that could potentially nourish the beach. Four full-length transects along Surf Beach (including SB1 and SB2 transects immediately up-coast and down-coast of the existing emergency revetment, respectively) and two full-length control transects farther up-coast and down-coast of Surf Beach would be established and monitored, as shown in Figure 3. The control transects will provide data to understand regional conditions. The SB1 and down-coast control transects correspond to historical USACE monitoring at transects SO-1530 and SO-1470, respectively (Figure 5). The depth of closure in the area is approximately -20 feet MLLW, based on USACE Wave Information Studies; surveying along transects out to the depth of closure provides information regarding cross-shore (shore-perpendicular) sand movement which typically occurs on a seasonal basis.

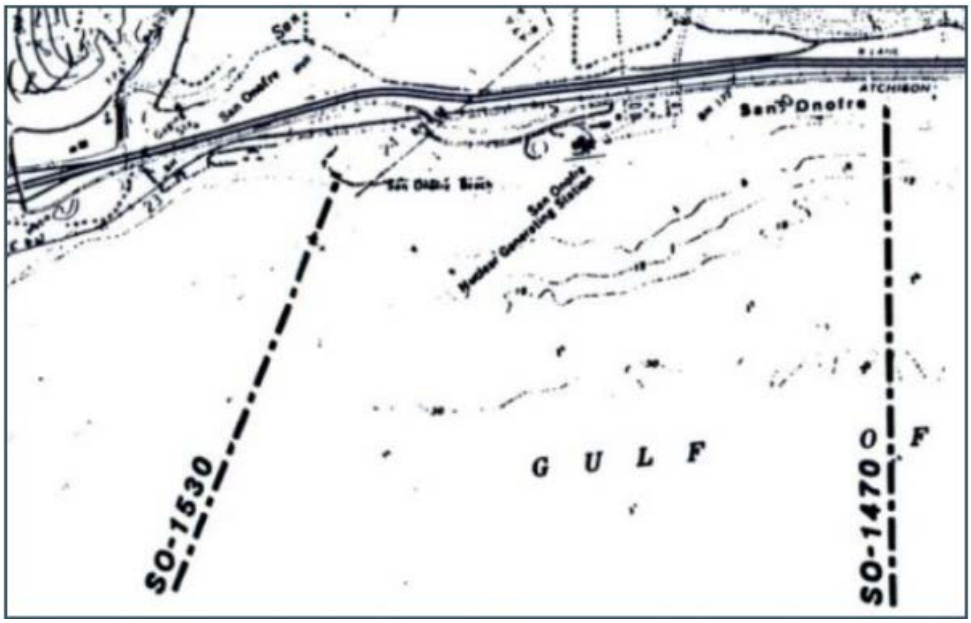


Figure 5: Historical USACE Transect Locations along San Onofre State Beach.

Additionally, State Parks will monitor and record the number of times per year wave overtopping events occur, their magnitude, and when road repairs are required and made along the entire stretch of road, including along the existing revetment section. This will allow us to document the number of wave events that overtop the revetment and cause substantial damage to public access.

Bathymetric survey of the elevations along each profile out to the closure depth will likely be done by boat and typical side-scan sonar imaging. In addition to data on beach elevation and width, the full-length profile monitoring will also collect information on beach road width, road conditions, coastal infrastructure conditions, and the risk level of Surf Beach facilities where applicable.

C. **Photo Monitoring**

Finally, State Parks staff will continue to regularly monitor the beach for any obvious signs of sand erosion or damage to Park facilities, especially during and following large wave and high tide events. Any noticeable changes in the shoreline fronting the revetment shall be

noted and documented with photographs. Parks will take photographs from several fixed photo point locations to monitor change in the shoreline. Photos will capture beach profiles at the revetment as well as up- and down-coast. Notes and photographs will also be taken to document scour pockets, evidence of wave overtopping, scarps present, and severe erosion.

Reporting

Monitoring data and results from all monitoring efforts will be summarized and reported to the Coastal Commission on an annual basis. The annual report will also address the extent to which (based on monitoring data) the revetment is shifting, causing down-coast erosion, affecting surf conditions, or having other adverse impacts at Surf Beach. Finally, the report will include recommendations for adapting the monitoring plan methodology over time.

Annual reports and data will also be made publically available through a webpage on the official California State Parks San Onofre State Beach website. The page will contain links to annual reports, data (extracted from video footage), and figures as they become available. The webpage will also contain links to this shoreline monitoring plan and the *Long-Term Shoreline Management Alternatives Analysis Report for Surf Beach* submitted in October of 2018. Finally, a State Parks email address will be provided to visitors of the webpage to share comments with Park staff leading the monitoring effort. Comments received via the website will be reviewed and shared in the annual reports.

In conclusion, State Parks is proud to propose this shoreline monitoring program to the Coastal Commission. It is our hope that this program, which brings together the perspectives, foresight, and expertise of multiple partners, both public and private, will serve as a model for other coastal monitoring programs. And by meeting with stakeholder annually to review the program, we can ensure stakeholder concerns and the latest science and most effective methods are informing our coastal management decisions.

Should the Coastal Commission have any questions or concerns about the proposed plan, please do not hesitate to contact me at (949) 324-9130 or via email to riley.pratt@parks.ca.gov.

Sincerely,

Riley Pratt, Ph.D.
Sr. Environmental Scientist
California State Parks
Orange Coast District

Appendix A. Stakeholder Meeting Agenda for Surf Beach Shoreline Monitoring (July 26, 2019).

Stakeholder Meeting Agenda for Surf Beach Shoreline Monitoring
July 26, 2019
10AM-12PM
District Training Room
3030 Avenida del Presidente
San Clemente, CA 92672-4433

Attendees
Riley Pratt, Ph.D., Sr. Environmental Scientist State Parks - (949) 324-9130
Todd Lewis, State Parks, District Superintendent
Rich Haydon, State Parks, Sector Superintendent
Kim Garvey, Moffatt & Nichol, Coastal Engineer
Brett Sanders, Ph.D., UC Irvine, Professor of Engineering
Jo Schubert, Ph.D., UC Irvine, Postdoctoral researcher
Travis Huxman, Ph.D., UC Irvine, Professor of Ecology
Ben Freeston, Surfline, Data Scientist
Mandy Sackett, Surfrider Foundation, California Policy Coordinator
Jim Wynne, San Onofre Surfing Club, In-coming President
Kenny Shue, Hawaiian Surf Club
Bob Mignogna, San Onofre Parks Foundation, Founding President
Steve Long, San Onofre Parks Foundation, Founder and Board Advisor

Time	Item
10:00AM	Introductions
10:10AM	Overview of monitoring requirements, goals, and objectives (Riley)
10:20AM	Overview of current monitoring methods (Riley, Brett, Ben)
10:40AM	Group discussion
11:40AM	Wrap up w/ action items

Appendix B. Stakeholder Meeting Agenda for Surf Beach Shoreline Monitoring (August 30, 2019).

2nd Stakeholder Meeting Agenda for Surf Beach Shoreline Monitoring
August 30, 2019
10AM-12PM
District Training Room
3030 Avenida del Presidente
San Clemente, CA 92672-4433

Invitees/Attendees
Riley Pratt, Ph.D., Sr. Environmental Scientist State Parks - (949) 324-9130
Todd Lewis, State Parks, District Superintendent
Rich Haydon, State Parks, Sector Superintendent
Aaron Holloway, Moffatt & Nichol, Coastal Engineer
Brett Sanders, Ph.D., UC Irvine, Professor of Engineering
Jo Schubert, Ph.D., UC Irvine, Postdoctoral researcher
Travis Huxman, Ph.D., UC Irvine, Professor of Ecology
Ben Freeston, Surfline, Data Scientist
Mandy Sackett, Surfrider Foundation, California Policy Coordinator
Tom Bistline, San Onofre Surfing Club, Past President
Kenny Shue, Hawaiian Surf Club
Bob Mignogna, San Onofre Parks Foundation, Founding President
Steve Long, San Onofre Parks Foundation, Founder and Board Advisor

Time	Item
10:00AM	Introductions
10:10AM	Brief overview of 1st meeting (Riley)
10:20AM	Discussion of monitoring thresholds & shoreline management alternatives identified in long-term hazard management report
11:40AM	Wrap up w/ action items