

# CALIFORNIA COASTAL COMMISSION

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# W23a

**3-18-0814 (CAPITOLA JETTY REHABILITATION)**

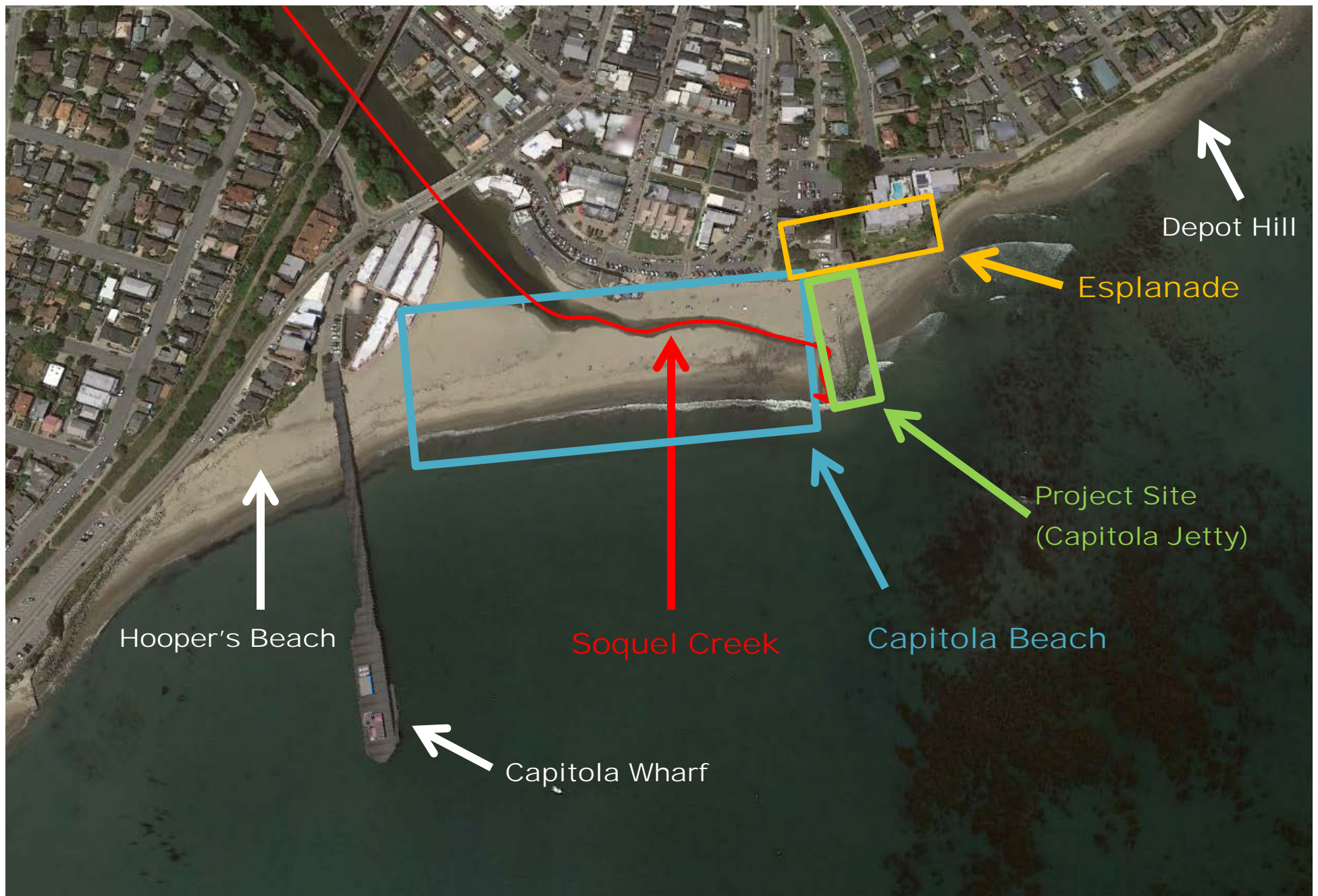
**APRIL 10, 2019 HEARING**

## **EXHIBITS**

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- Exhibit 1 - Aerial Photo of Project Vicinity Map
- Exhibit 2 - City's Coastal Engineering Project Description
- Exhibit 3 - Project Plans
- Exhibit 4 - Project Area Photos
- Exhibit 5 - City's Coastal Engineering Analysis
- Exhibit 6 - City's Sand Transport Study
- Exhibit 7 - Historical Photos

# Aerial Photo of Project Vicinity



## MEMORANDUM

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**To:** Steve Jesberg, P.E., Public Works Director, City of Capitola

**From:** Sam Tooley, P.E.  
Mads Jorgensen, P.E.  
Brad Porter, P.E.

**Date:** October 16, 2018

**Subject:** Capitola Beach Jetty Rehabilitation – Project Description, Revision 1

**M&N Job No.:** 9154-01

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The City of Capitola (City) is proposing to make essential repairs to the rock groin (herein referred to as the 'Jetty') located at the eastern extent of Capitola Beach. The purpose of this memorandum is to provide a description of the project purpose and proposed construction activities and quantities.

The purpose of the Jetty Rehabilitation Project (Project) is to maintain the current public beach and continued viability of the Soquel Creek Lagoon Management Plan. Maintenance includes replacement of the rock protection (armor) that has scattered due to wave action. The displacement of the rock protection has exposed the concrete membrane cutoff wall in the core of the jetty to direct wave attack that could result in damage or failure. The wall provides a continuous membrane to block water passage through the jetty, which is essential to its function. Damage to the wall would result in a much more significant repair event. The proposed project would involve retrieving and replacing the rock material that has scattered from the Jetty and adding the minimum necessary amount of clean rock material. There would be no change in configuration, filled area, or materials. The work will not affect sediment transport patterns around the Jetty and will not impact by-passing of sediment to downcoast shoreline areas.

### Background

The Jetty was originally constructed in 1969 (Figures 1 – 3) to help stabilize the beach and the outlet of Soquel Creek. The construction of the jetties at the Santa Cruz Yacht Harbor in the early 1960's resulted in a disturbance to longshore sediment transport. Capitola Beach was no longer receiving the same quantity of sand, resulting in loss of beach width and presenting a flooding hazard to the City due to waves breaking closer to the shore. The original Jetty was designed by the USACE and constructed as an emergency project to restore the original function of the beach.

Comparing photographs from before and after the construction of the jetties at Santa Cruz, the images show that the beach area decreased by approximately 52% after the construction of the Santa Cruz jetties. Exhibit A shows the approximate shorelines of the beach in 1928<sup>1</sup> and 1967<sup>2</sup>. The beach in the 1928 aerial is approximately 260,000 ft<sup>2</sup>, compared to the beach in the aerial from 1967, which has a footprint of approximately 125,000 ft<sup>2</sup>. Examining aerials from recent

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<sup>1</sup> <https://www.californiacoastline.org/cgi-bin/captionlist.cgi?searchstr=capitola>

<sup>2</sup> U.S. Army corps of Engineers. Addendum, City of Capitola, Beach Erosion Study, Santa Cruz County, California; Detailed Project Report. Nov. 1971.

years with the Capitola Jetty in place, the summer and winter beaches are within 10% of the 1928 beach footprint. The summer beach has an approximate footprint of 275,000 ft<sup>2</sup> and the winter beach has an approximate footprint of 235,000 ft<sup>2</sup>. As documented in the USACE Addendum to the City of Capitola Beach Erosion Study (1971), the Capitola Jetty is continuing to function as intended.

Exhibit B shows the approximate 1928 and 1976 shoreline at Depot Hill on a present day aerial. The image shows there is little variation between the 1967 and present day shoreline. Exhibit C shows only the 1928 shoreline on the present day aerial, where erosion has occurred on the northwestern end but accretion is shown on the southeastern end.

The core of the Jetty is constructed of rock riprap with a median stone size of 200 lbs (minimum = 5 lbs and maximum = 600 lbs). On top of the riprap core sits a 1' concrete membrane wall which serves to retain sand from longshore sediment transport from west to east. The wall is protected by armor rock having a median rock size of 2.5 tons (minimum = 2 ton and maximum = 3 ton) which serves as protection against direct wave action.

Based on the topographic survey conducted in May 2018, some of the jetty rock has been scattered from its original position. The width of the current Jetty's trunk is approximately 70 feet at its widest point and 45 feet at its narrowest point. The trunk of the Jetty is approximately 175 feet long with an average elevation between +9.0 and +10.2 feet MLLW (average height between 9 and 10 feet). The head of the Jetty is approximately 40 feet long at a 10:1 slope. Since the initial construction of the Jetty, the head of the Jetty has settled approximately 1.5 feet, whereas the trunk has stayed at approximately the same elevation. However, the rock surrounding the wall has sloughed down the slope and exposed approximately 1-2 feet of wall. Since the continued displacement of rock on the jetty will compromise the stability of the wall, repairs are needed to prevent further exposure of the wall to wave action.

### **Rock Volume**

Based on the sections shown in the As-Built Drawings, it is anticipated that approximately 3,300 CY of rock was used to construct the jetty. It is estimated that approximately 380 CY (12%) will be needed to restore the jetty to its original configuration (note the initial estimate of 900 CY to reconfigure the jetty has decreased to 380 CY after final design). Of that 380 CY, some of the material will be rocks that have been displaced from the jetty and some of the rock will be new, imported rock. Approximately 240 CY (7%) of rock will either be placed or replaced below the USACE delineated Jurisdictional High Tide Line (HTL) and 170 CY (5%) of rock will be placed or replaced below the USACE delineated Jurisdictional Mean High Water Line (MHW). The remaining quantity of rock (140 CY – 4%) to be placed or replaced is located outside of the intertidal zone.

### **Rock Size**

A 50-year return period wave event was chosen as the design storm. To determine whether the current size of the rock is sufficient to protect against the 50-year return period storm, an analysis of extreme wave conditions was conducted by analyzing the NOAA operated NDBC wave buoy located offshore in Monterey Bay. The 50-year return period wave height was then adjusted for shallow water conditions as would be experienced at the toe of the jetty. Sea level rise (SLR) of up to 2 feet was also applied to the design water level. The analysis showed that the 2.5 ton rock presently on the jetty is slightly undersized. Therefore, it is recommended that any imported armor material be 3 ton rock.

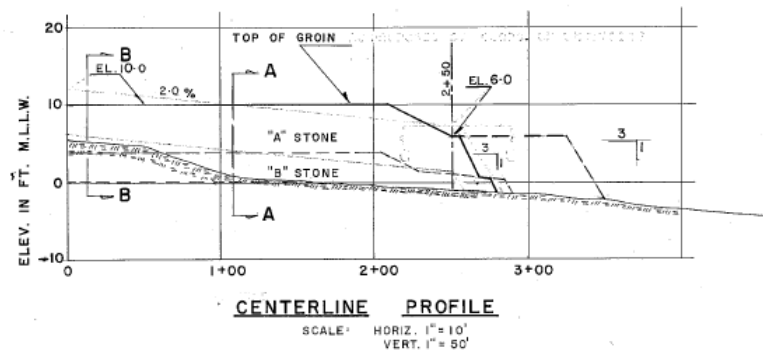


Figure 1: Elevation View of Jetty (Original Design)

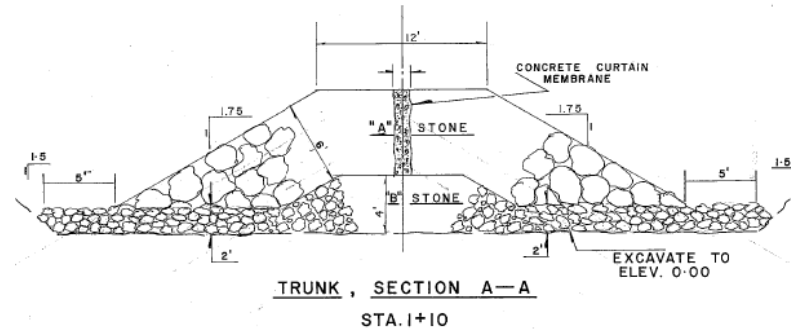


Figure 2: Section View at Seaward End (Original Design)

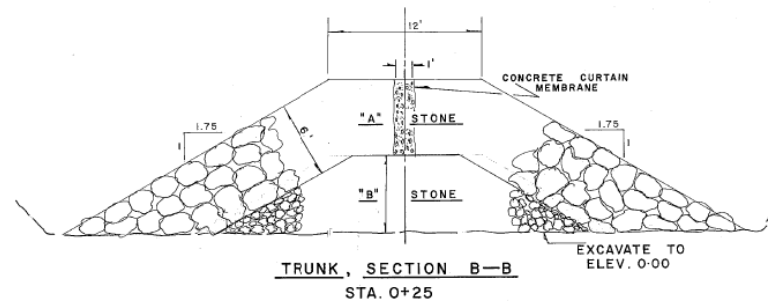


Figure 3: Section View at Landward End (Original Design)

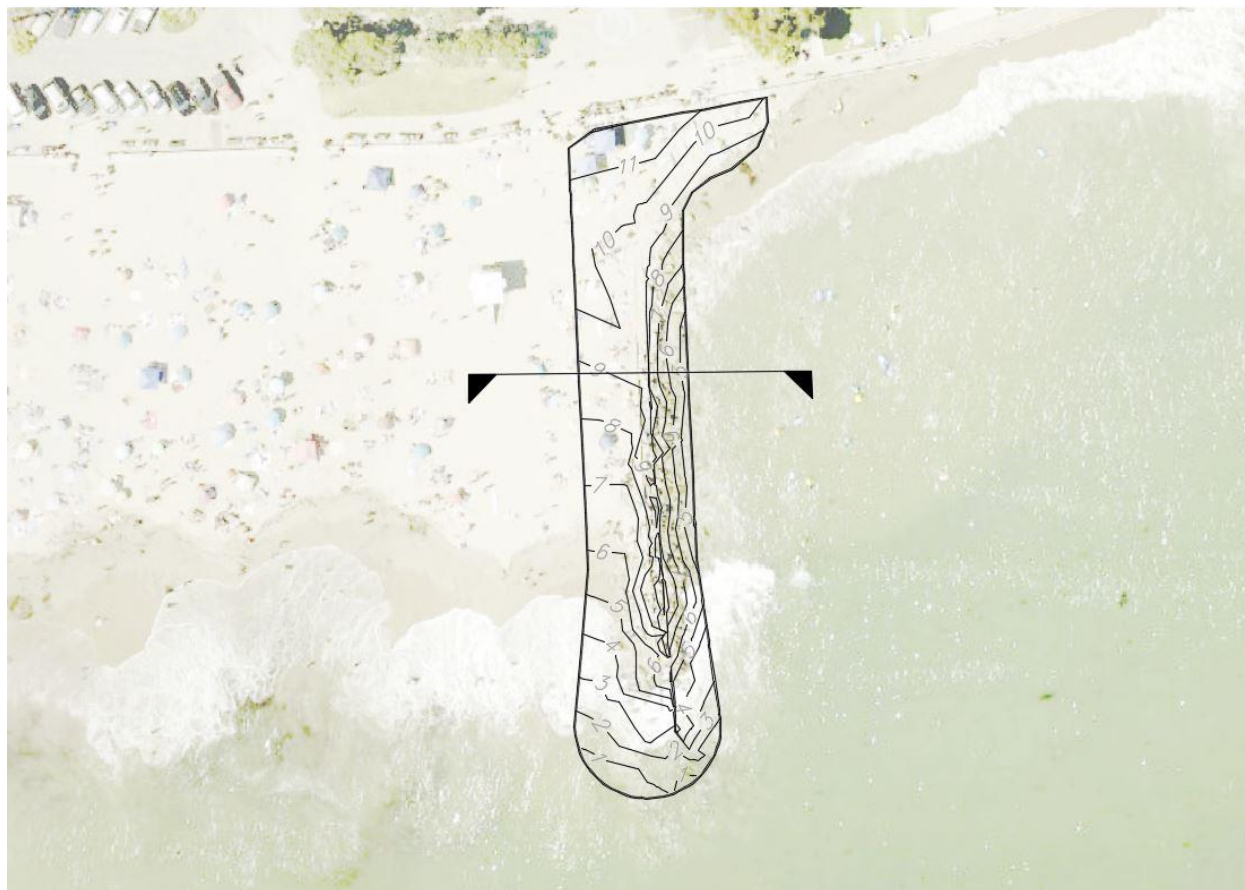


Figure 4: Existing Elevations (feet MLLW) from topographic Survey in May 2018

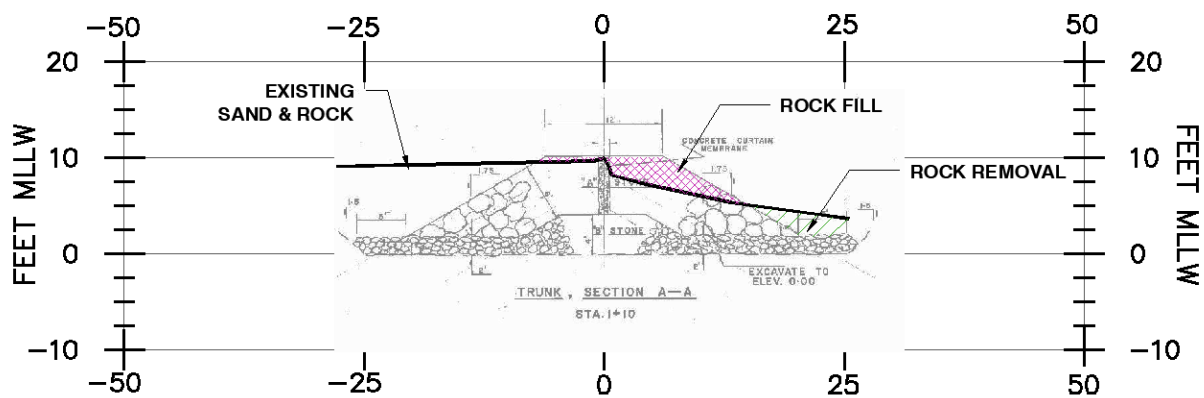


Figure 5: Typical Jetty Section









**GENERAL NOTES**

1. ELEVATIONS SHOWN ARE IN FEET REFERENCED TO MEAN LOWER LOW WATER.
2. DEMOLITION OF EXISTING FEATURES SHALL BE LIMITED TO THE ITEMS SHOWN ON THE PLANS AND DESCRIBED IN THE SPECIFICATIONS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO REPAIR AND/OR REPLACE EXISTING FEATURES TO REMAIN THAT ARE DAMAGED BY THE CONTRACTOR.
3. CONTACT THE CITY IMMEDIATELY UPON FINDING ANY FIELD CONDITIONS THAT CONFLICT WITH THE INFORMATION ON THESE DRAWINGS. ALL FIELD ADJUSTMENTS MUST BE APPROVED BY THE CITY BEFORE CONSTRUCTION OF SAID ADJUSTMENTS. FAILURE TO DO SO WILL RESULT IN THE CONTRACTOR ASSUMING FULL RESPONSIBILITY FOR ANY REQUIRED REVISIONS OR FIELD MODIFICATIONS, AS DIRECTED BY THE CITY, AT NO ADDITIONAL COST.
4. PROVIDE CONSTRUCTION SITE SECURITY FOR THE DURATION OF THE CONTRACT PERIOD AND AS SPECIFIED.
5. FURNISH, INSTALL AND MAINTAIN ALL WARNING SIGNS AND DEVICES NECESSARY TO SAFEGUARD THE GENERAL PUBLIC AND THE WORK, AND PROVIDE PROPER AND SAFE ROUTING OF VEHICULAR AND PEDESTRIAN TRAFFIC DURING THE PERFORMANCE OF THE WORK. THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND SHALL NOT BE LIMITED TO WORKING HOURS.
6. KEEP THE PROJECT SITE IN A NEAT AND ORDERLY CONDITION, FREE OF RUBBISH AND DEBRIS, AT ALL TIMES.
7. ALL WORK SHOWN SHALL BE NEW UNLESS OTHERWISE NOTED.

**PROJECT WORK**

- A. FLUME**
1. PURPOSE OF THE PROJECT IS TO STOP LEAKAGE IN THE FLUME AND THE RESULTING SAND MIGRATION BELOW THE FLUME THAT CAUSE SINKHOLES AND COLLAPSE IN THE BEACH.
  2. CONSTRUCT WATERPROOFING (FIBERGLASS LINER) ALONG THE ENTIRE LENGTH.
  3. CONSTRUCT CUTOFF WALLS BELOW THE FLUME IN THE BEACH SAND.
  4. REPAIR CONCRETE ABRASION ON THE LOWER FLUME.
  5. SEE DRAWINGS C-110 TO C-116.
- B. FIBERGLASS LINER WET-LAYUP**
1. THE PURPOSE OF THE FIBERGLASS LINER IS TO PROVIDE A STRONG WATERTIGHT SURFACE TO PREVENT LEAKAGE IN THE FLUME.
  2. THE FIBERGLASS LINER REHABILITATION SYSTEM SHALL BE QUAKEWRAP OR APPROVED EQUIVALENT.
  3. FIBERGLASS FABRIC SHALL BE QUAKEWRAP VB2610G OR APPROVED EQUAL HIGH-STRENGTH BIXIAL FABRIC.
  4. FABRIC SHALL BE IMPREGNATED WITH A TWO COMPONENT, HIGH STRENGTH, AND LOW VISCOSITY STRUCTURAL EPOXY, QUAKEBOND J300SR OR APPROVED EQUAL, TO THOROUGHLY AND UNIFORMLY SATURATE THE FABRIC.
  5. ALL IRREGULARITIES, UNEVENNESS, AND SHARP PROTRUSIONS IN THE SURFACE PROFILE SHALL BE GROUND AWAY TO A SMOOTH SURFACE WITH CSP 3/CSP 2 SURFACE PROFILE USING HAND TOOLS. VOIDS OR DEPRESSIONS WITH DIAMETERS LARGER THAN 1 1/2 IN. OR DEPTHS GREATER THAN 1/8 IN., WHEN MEASURED FROM A 12-IN. STRAIGHT EDGE PLACED ON THE SURFACE, SHALL BE FILLED. ANY EXPOSED STEEL REINFORCEMENT SHALL BE CLEANED WITH A WIRE BRUSH.
  6. ALL INTERIOR CRACKS IN THE SURFACE OF CONCRETE OR THE SUBSTRATE THAT ARE WIDER THAN 0.010 IN. AND ALL EXTERIOR CRACKS WIDER THAN 0.006 IN. SHALL BE FILLED USING PRESSURE INJECTION OF EPOXY ACCORDING TO ACI 224R-01 AND 224.1R-07. THE FIBERGLASS LINER SHALL BE INSTALLED NO EARLIER THAN 12 HOURS AFTER CRACK INJECTION.
  7. AFTER SURFACE GRINDING, ANY UNEVENNESS IN THE SURFACE SHALL BE FILLED AND SMOOTHED OVER BY USING PUTTY MADE OF EPOXY RESIN MORTAR OR POLYMER CEMENT MORTAR.
  8. SUBSTRATE CONCRETE AND FINISHED SURFACE OF CONCRETE SHALL BE CLEANED PRIOR TO APPLICATION OF THE FIBERGLASS AND ALLOWED TO DRY FULLY.
  9. ALL RESIN COMPONENTS, INCLUDING THE MAIN AGENT AND HARDENER, SHALL BE MIXED AS SPECIFIED BY THE MANUFACTURER UNTIL THOROUGH MIXING WITH UNIFORM COLOR AND CONSISTENCY IS ACHIEVED. RESINS SHALL NOT BE DILUTED WITH ANY ORGANIC SOLVENTS SUCH AS A THINNER.
  10. APPLY TWO COATS OF PRIMER ON THE CONCRETE SURFACE TO PENETRATE OPEN PORES, QUAKEBOND 220UR OR EQUIVALENT. THE PUTTY SHALL BE APPLIED AS SOON AS THE PRIMER BECOMES TACK FREE OR IS NOT STICKY TO THE FINGERS. THE PUTTY SHALL BE APPLIED WITHIN 7 DAYS AFTER PRIMER APPLICATION.
  11. THE FABRIC SHALL BE UNIFORMLY SATURATED. THE FABRIC SHALL BE CUT TO THE LENGTH AND BE INSTALLED IN PLACE AND GENTLY PRESSED ONTO THE WET PUTTY. ANY ENTRAPPED AIR BETWEEN THE FIBER SHEET AND THE CONCRETE SURFACE SHALL BE RELEASED OR ROLLED ACROSS THE SHEET IN THE DIRECTION PARALLEL TO THE

- FIBERS WHILE ALLOWING THE RESIN TO IMPREGNATE THE FIBERS AND ACHIEVE INTIMATE CONTACT WITH THE SUBSTRATE. ROLLING PERPENDICULAR TO THE FIBER DIRECTION IS NOT ALLOWED.
12. ELASTOMERIC INTERNAL JOINT SEALS (WEKO OR APPROVED EQUIVALENT) CAN BE USED AT THE TERMINATION POINTS WITH THE APPROPRIATE DETAILS INCLUDED IN THE DRAWING SET.
  13. THE FIBERGLASS LINER SYSTEM SHALL BE ALLOWED TO CURE FOR 72 HOURS. FIELD MODIFICATION OF RESIN CHEMISTRY FOR RAPID CURING IS NOT ALLOWED.
  14. AFTER AT LEAST 24 HOURS FOR THE INITIAL CURING OF THE RESIN, A VISUAL INSPECTION OF THE SURFACE WILL BE PERFORMED FOR ANY SWELLING, BUBBLES, VOIDS, OR DELAMINATION.
- C. JETTY**
1. PURPOSE OF THE PROJECT IS TO RECONSTRUCT JETTY TO THE ORIGINAL CROSS SECTION.
  2. IMPORT ROCK AND REPOSITION EXISTING DISPLACED ROCK AS NEEDED TO RESTORE SECTION.
  3. SEE DRAWINGS C-120, C-121.

**CONSTRUCTION BEST MANAGEMENT PRACTICES**

1. PRIOR TO THE START OF CONSTRUCTION AND IN ACCORDANCE WITH THE PROJECT TIMELINE, A SERVICE-APPROVED FISHERY BIOLOGIST WILL SURVEY THE LAGOON AND FLUME ENTRANCE FOR TIDEWATER GOBY, STEELHEAD, AND COHO SALMON THAT WOULD BECOME EXPOSED, REMOVED, OR IMPACTED IN ANY WAY DUE TO PLANNED ACTIVITY. THE FISHERY BIOLOGIST WILL HAVE THE AUTHORITY TO HALT OR DELAY CONSTRUCTION ACTIVITIES IF SUCH ACTIVITIES ARE RESULTING IN UNINTENDED OR UNANTICIPATED IMPACTS TO SPECIAL STATUS AND MSA-MANAGED SPECIES AND THEIR HABITAT (NMFS 2013; USFWS 2013; D.W. ALLEY & ASSOCIATES 2004).
2. A SERVICE-APPROVED FISHERY BIOLOGIST WILL LEAD AN ON-SITE ENVIRONMENTAL TRAINING FOR WORK CREWS PRIOR TO THE START OF THE PROPOSED PROJECT TO PROTECT SURROUNDING BIOLOGICAL RESOURCES. ANY NEW CREW MEMBERS BROUGHT ONTO THE JOB PRIOR TO PROJECT COMMENCEMENT MUST UNDERGO THE ENVIRONMENTAL TRAINING BEFORE STARTING WORK ON THE PROJECT.
3. A SERVICE-APPROVED FISHERY BIOLOGIST WILL BE PRESENT TO MONITOR DURING ALL CONSTRUCTION ACTIVITIES THAT HAVE THE POTENTIAL TO AFFECT FISH HABITAT IN THE LAGOON/ESTUARY. THIS INCLUDES, BUT IS NOT LIMITED TO, ANY BERM MANIPULATION ACTIVITIES ASSOCIATED WITH THE CONSTRUCTION OF A CONTINGENCY BYPASS, FLUME CLEARING ACTIVITIES WHEN FISH MAY BE PRESENT, UP UNTIL THE SUCCESSFUL SWITCH OF FLUME USE DURING THE CLOSED LAGOON PHASE TO FULL ESTUARY USE.
4. IF THE CONTINGENCY BYPASS IS INSTITUTED, A SERVICE-APPROVED FISHERY BIOLOGIST WILL SEINE THE VICINITY OF THE LAGOON PERIPHERY TO BE IMPACTED BY CONSTRUCTION ACTIVITIES TO REMOVE ALL STEELHEAD AND TIDEWATER GOBIES FROM THE AREA, FOLLOWED BY INSTALLATION OF A BLOCK NET TO PREVENT FISH FROM RE-ENTERING THE IMPACT ZONE. THE BLOCK NET WILL REMAIN UNTIL THE CONSTRUCTION AREA IS ISOLATED BY EXCLUSIONARY WALLS OF SANDBAGS OR OTHER INSERT MATERIAL.
5. THE SERVICE-APPROVED FISHERY BIOLOGIST WILL BE PRESENT TO RESCUE ANY FISH REMAINING IN ISOLATED AREAS AS AREAS ARE ACTIVELY DEWATERED FOR CONSTRUCTION PURPOSES OR FLUME ISOLATION.
6. MONITORING OF LAGOON WATER QUALITY (I.E. TEMPERATURE, DISSOLVED OXYGEN, TURBIDITY) SHALL BE CONDUCTED BY A SERVICE-APPROVED FISHERY BIOLOGIST IF THE CONTINGENCY BYPASS IS INSTALLED PRIOR TO THE NATURAL FACILITATED BREACHING OF THE BERM. IF THE SAND BERM HAS BEEN BREACHED PRIOR TO THE ONSET OF FLUME REPAIR AND THE FLUME IS COMPLETELY ISOLATED FROM STREAMFLOW AND TIDAL INFLOW, THEN NO WATER QUALITY MONITORING WILL BE NECESSARY.
7. THE CONTRACTOR IMPLEMENTING THE PROPOSED PROJECT SHALL EXERCISE EVERY REASONABLE PRECAUTION AND BMPs TO PROTECT SPECIAL STATUS AND MSA-MANAGED SPECIES AND THEIR HABITATS FROM CONSTRUCTION BY-PRODUCTS AND POLLUTANTS SUCH AS CONSTRUCTION DEBRIS, CHEMICALS, FUEL, HYDRAULIC FLUID, FRESH CEMENT, SAW-DUST, OR OTHER DELETERIOUS MATERIALS.
8. A SPILL PLAN AND APPROPRIATE SPILL CONTROL AND CLEAN-UP MATERIALS (E.G., OIL ABSORBENT PADS) SHALL BE RETAINED ON SITE IN CASE A FUEL SPILLOCCURS. ALL CONSTRUCTION VEHICLES AND EQUIPMENT SHALL BE INSPECTED BEFORE THEY ARE MOVED TO THE PROJECT SITE, AND SHALL NOT BE MOVED TO THE SITE IF LEAKING FLUIDS THAT COULD RESULT IN SPILLS OF TOXIC MATERIALS. ALL CONSTRUCTION VEHICLES AND EQUIPMENT USED ON SITE SHALL BE WELL MAINTAINED AND CHECKED DAILY FOR FUEL, OIL, AND HYDRAULIC FLUID LEAKS OR OTHER PROBLEMS THAT COULD RESULT IN SPILLS OF TOXIC MATERIALS.
9. VEHICLE STAGING, CLEANING, MAINTENANCE, REFUELING, AND FUEL STORAGE SHALL TAKE PLACE IN A VEHICLE STAGING AREA PLACED 100 FEET OR MORE FROM SOQUEL CREEK AND LAGOON AND THE MHWL. THE FUELING AREA WILL BE DOUBLE LINED. DAILY MONITORING WILL OCCUR TO ENSURE THERE ARE NO LEAKS. OIL ABSORBING PADS, DRIP PANS, OR SIMILAR DEVICES WILL BE PLACED BENEATH THE EQUIPMENT WHEN WORKING IN WATERS OR STAGED OVERNIGHT TO CATCH ANY LEAKAGE.
10. ONCE FLUME MAINTENANCE CONSTRUCTION ACTIVITIES ARE COMPLETE, ALL TEMPORARY CONSTRUCTION-RELATED EQUIPMENT AND MATERIALS SHALL BE REMOVED FROM THE SITE.

11. DURING CONSTRUCTION, ALL TRASH WITHIN THE WORK SITE MUST BE PROPERLY CONTAINED AS TO NOT LEAVE THE WORK SITE OR AFFECT BIOLOGICAL RESOURCES IN ANY WAY.
12. A SUMMARY OF THE OBSERVED ACTIONS ASSOCIATED WITH THE FLUME REHABILITATION SHALL BE INCORPORATED INTO A POST-CONSTRUCTION REPORT PROVIDED TO THE NATIONAL MARINE FISHERIES SERVICE (NMFS) FOLLOWING THE COMPLETION OF PROJECT ACTIVITIES.
13. ALL CONSTRUCTION MATERIALS AND EQUIPMENT PLACED ON THE BEACH DURING DAYLIGHT CONSTRUCTION HOURS SHALL BE STORED BEYOND THE REACH OF TIDAL WATERS. THE ONLY OTHER EXCEPTIONS SHALL BE FOR EROSION AND SEDIMENT CONTROLS AND/OR CONSTRUCTION AREA BOUNDARY FENCING WHERE SUCH CONTROLS AND/OR FENCING ARE PLACED AS CLOSE TO THE TOE OF THE SEAWALL/RETVEMENT AS POSSIBLE, AND ARE MINIMIZED IN THEIR EXTENT.
14. CONSTRUCTION (INCLUDING BUT NOT LIMITED TO CONSTRUCTION ACTIVITIES, AND MATERIALS AND/OR EQUIPMENT STORAGE) IS PROHIBITED OUTSIDE OF THE DEFINED CONSTRUCTION, STAGING, AND STORAGE AREAS.
15. EQUIPMENT WASHING SHALL NOT TAKE PLACE ON THE BEACH; REFUELING AND/OR SERVICING OF EQUIPMENT SHALL BE ALLOWED ONLY AT DESIGNATED LOCATION AS NOTED ON THE PLAN. APPROPRIATE BEST MANAGEMENT PRACTICES SHALL BE USED TO ENSURE THAT NO SPILLS OF PETROLEUM PRODUCTS OR OTHER CHEMICALS TAKE PLACE DURING THESE ACTIVITIES.
16. THE CONSTRUCTION SITE SHALL MAINTAIN GOOD CONSTRUCTION SITE HOUSEKEEPING CONTROLS AND PROCEDURES (E.G., CLEAN UP ALL LEAKS, DRIPS, AND OTHER SPILLS IMMEDIATELY; KEEP MATERIALS COVERED AND OUT OF THE RAIN, INCLUDING COVERING EXPOSED PILES OF SOIL AND WASTES; DISPOSE OF ALL WASTES PROPERLY, PLACE TRASH RECEPTACLES ON SITE FOR THAT PURPOSE, AND COVER OPEN TRASH RECEPTACLES DURING WET WEATHER; REMOVE ALL CONSTRUCTION DEBRIS FROM THE BEACH; ETC.).
17. THE PERMITTEE SHALL NOTIFY PLANNING STAFF OF THE COASTAL COMMISSION'S CENTRAL COAST DISTRICT OFFICE AT LEAST THREE WORKING DAYS IN ADVANCE OF COMMENCEMENT OF CONSTRUCTION OR MAINTENANCE ACTIVITIES, AND IMMEDIATELY UPON COMPLETION OF CONSTRUCTION OR MAINTENANCE ACTIVITIES.

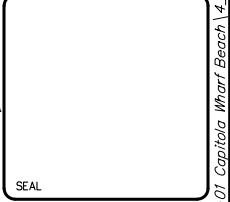


Rev.	Date	Description	Mark

**CAPITOLA BEACH JETTY REHABILITATION**  
**GENERAL NOTES 1 OF 2**

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Designed by: BP Dwn by: CD, D.M, ST Reviewed by: JJ	Submitted by: BRAD PORTER, P.E., MOFFATT & NICHOLOTT

2185 N. CALIFORNIA BLVD.  
 SUITE 500  
 WALNUT CREEK, CA 94596



Sheet Reference No.  
**G-002**  
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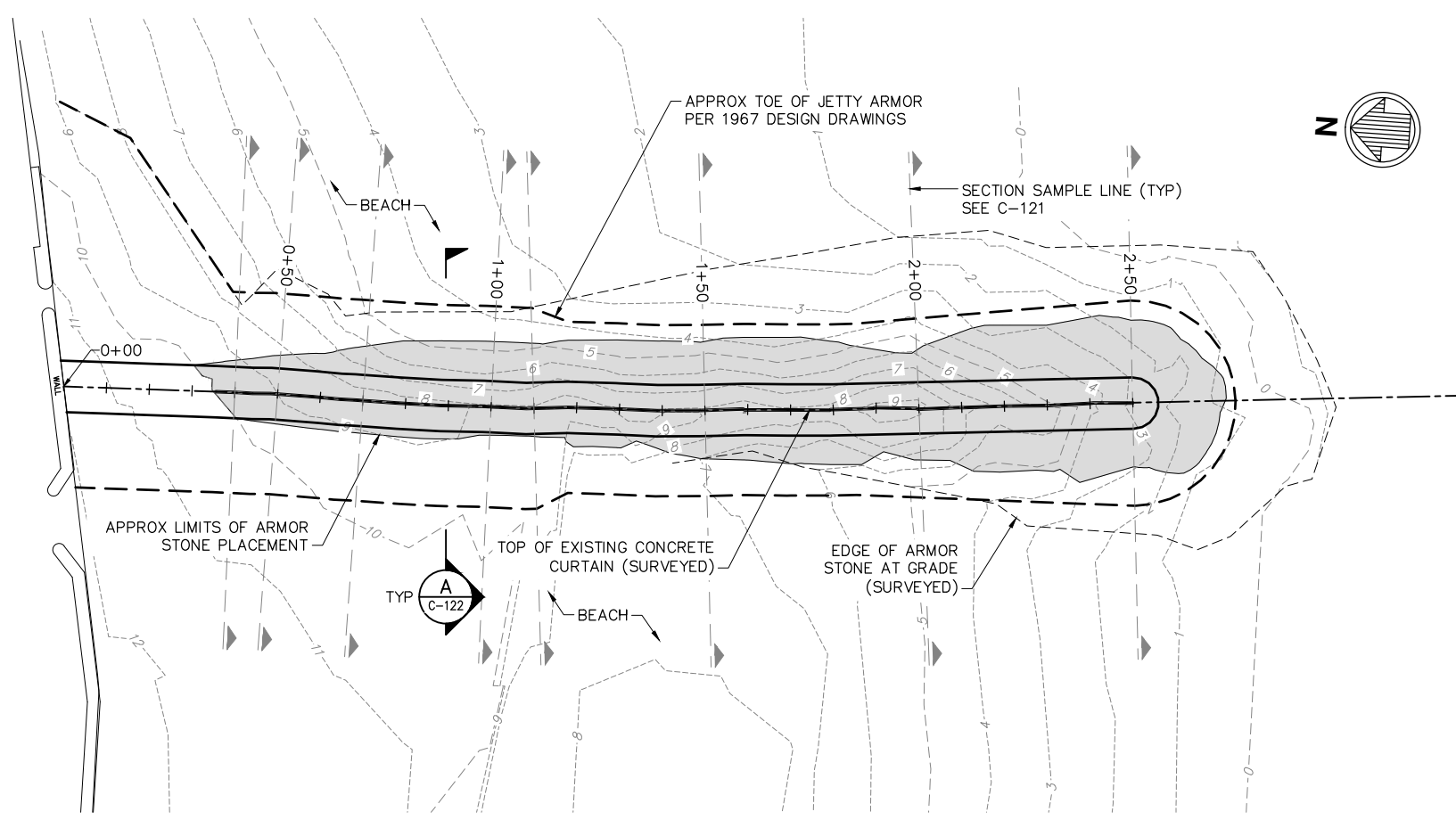
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**ISSUED: 10 OCT 2018**  
**NOT TO BE USED FOR CONSTRUCTION**

**Exhibit 3**  
**3-18-0814**  
**Page 2 of 7**

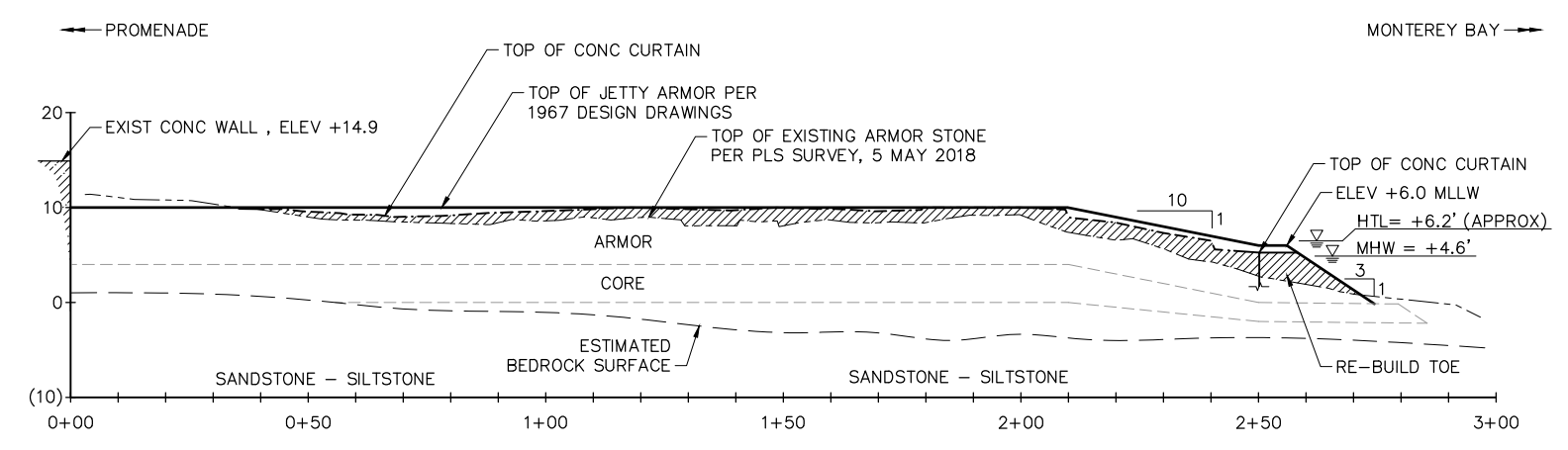
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PLAN  
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PROFILE  
SCALE: 1" = 20'

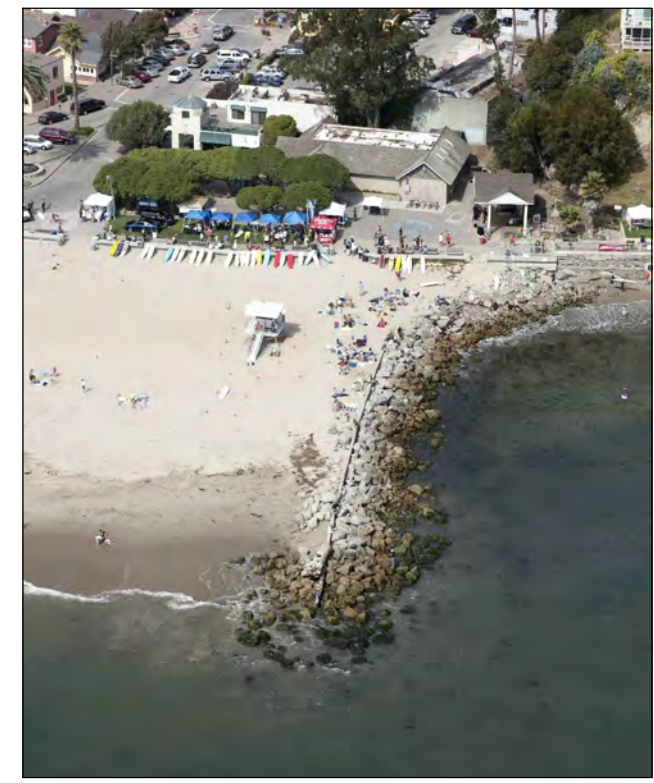


PHOTO 1—JETTY PRE—PROJECT (EXISTING)  
SCALE: NTS

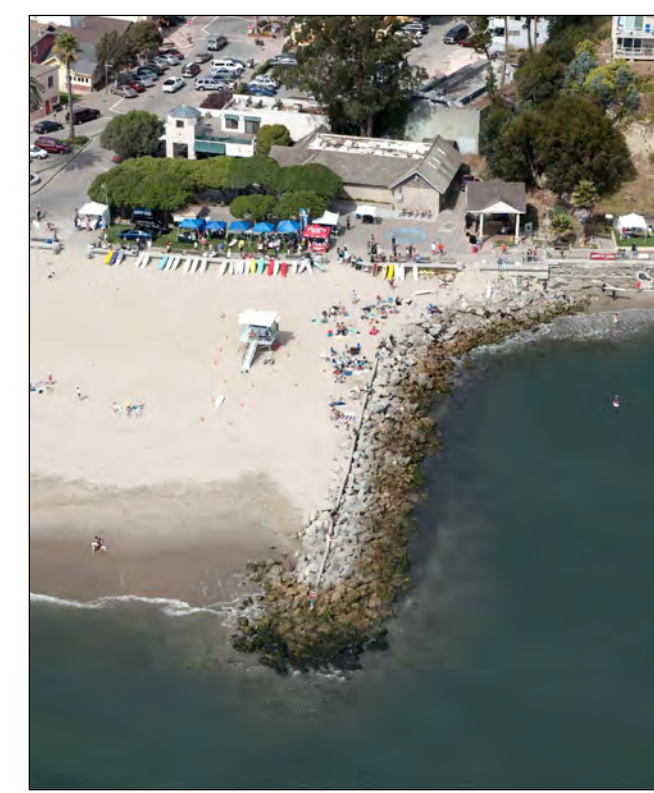
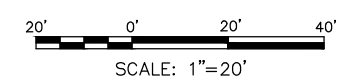


PHOTO 2—JETTY POST— PROJECT (PHOTO RENDITION)  
SCALE: NTS



**100% FOR REVIEW**  
ISSUED: 10 OCT 2018  
NOT TO BE USED FOR CONSTRUCTION



Work	Description	Date	Appr.

**CAPITOLA BEACH FLUME AND JETTY REHABILITATION**

**JETTY PLAN AND PROFILE**

Designed by: BP	Checked by: VF, DAM, ST	Date: 10/10/2018	Revision: -
Dwn by: VF, DAM, ST	Submitted by: BRAD PORCER, P.E. MOFFATT & NICHOL	M&N Project No: 9154-01	Drawing Scale: Plot scale: 1" (0 SHEET)
Reviewed by:		Drawing code:	

2185 N. CALIFORNIA BLVD.  
SUITE 500  
WALNUT CREEK, CA 94596

SEAL

Sheet Reference No.  
**C-120**  
INDEX: 11 OF 13



Mark	Description	Date	Appr.

**CAPITOLA BEACH  
FLUME AND JETTY  
REHABILITATION**

**JETTY CROSS SECTIONS**

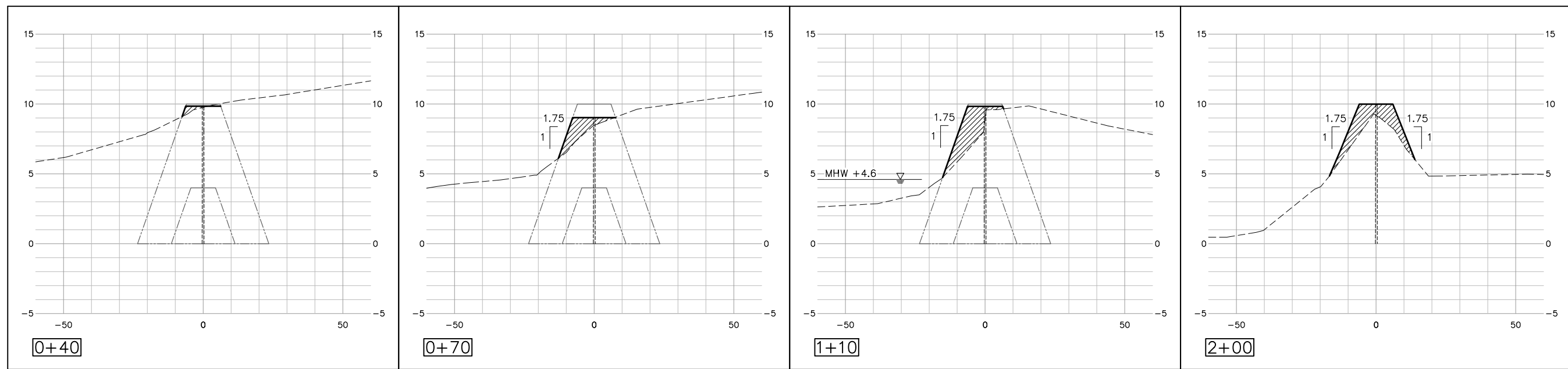
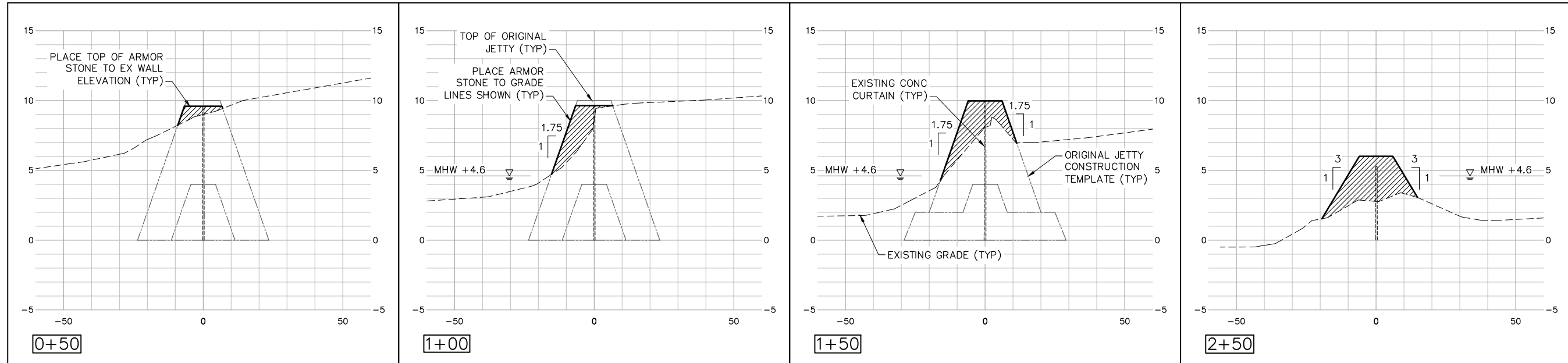
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			-	10/10/2018
			M&N Project No.:	9154-01
			Drawing code:	
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2185 N. CALIFORNIA BLVD.  
SUITE 500  
WALNUT CREEK, CA 94596

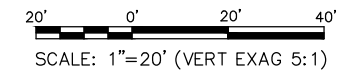
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**C-121**  
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**Exhibit 3  
3-18-0814  
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**100% FOR REVIEW  
ISSUED: 10 OCT 2018  
NOT TO BE USED FOR CONSTRUCTION**



# Jetty Facing the Ocean



# Eastern Side of the Jetty

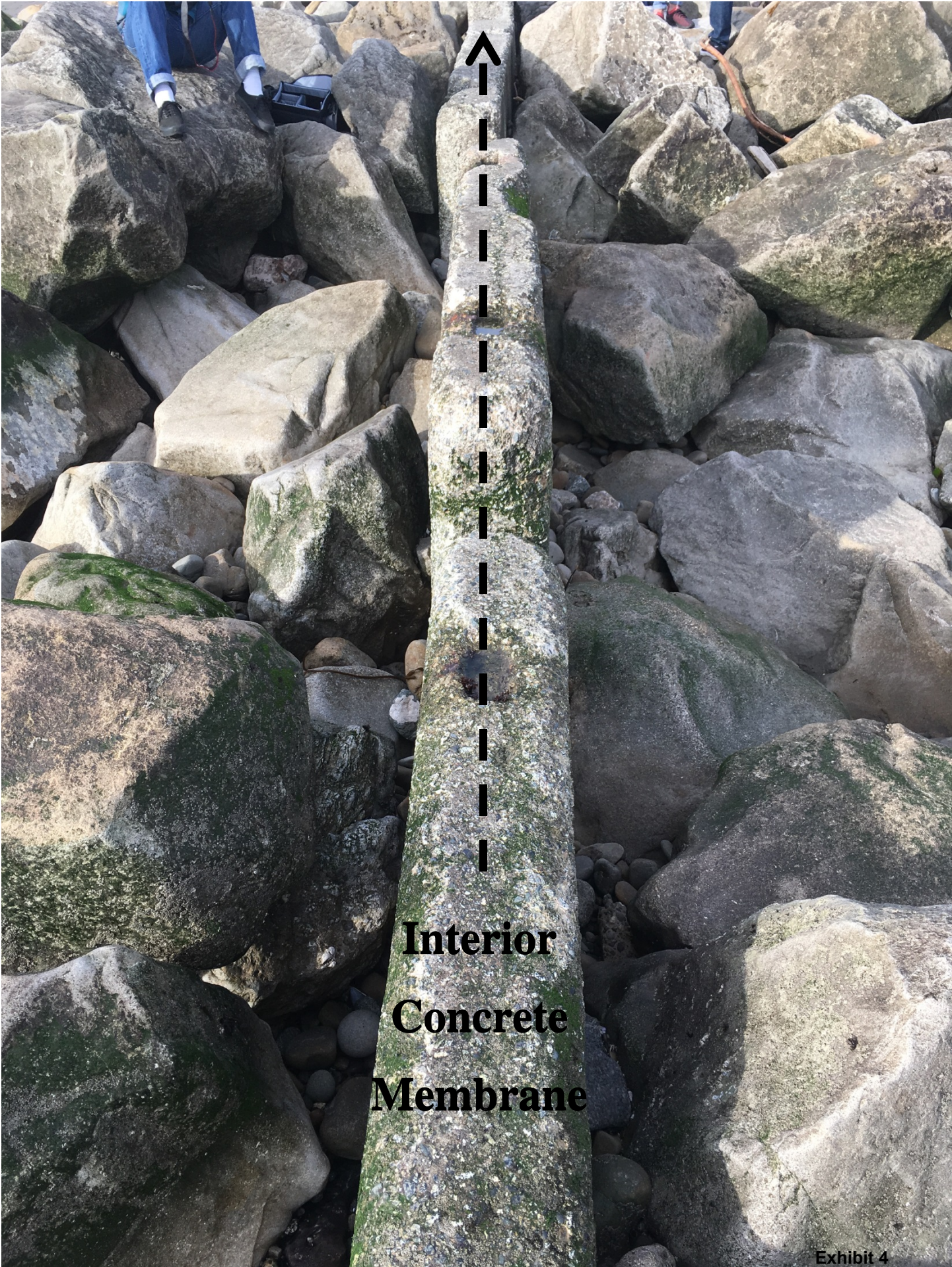


# Jetty Facing the Esplanade



# Toe of the Jetty





**Interior  
Concrete  
Membrane**

## MEMORANDUM

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To: Steve Jesberg, P.E., Public Works Director, City of Capitola

From: Sam Tooley, P.E.  
Mads Jorgensen, P.E.  
Brad Porter, P.E.

Date: November 12, 2018

Subject: Capitola Beach Jetty Rehabilitation – Coastal Engineering Analysis

M&N Job No.: 9154-01

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The City of Capitola (City) is proposing to make essential repairs to the rock groin (herein referred to as the 'Jetty') located at the eastern extent of Capitola Beach. The proposed maintenance project is intended to maintain the current public beach and continued viability of the Soquel Creek Lagoon Management Plan. This memorandum describes the site conditions and coastal processes at Capitola Beach.

Capitola Beach is located at the mouth of Soquel Creek where it flows into Monterey Bay. The beach is a seasonal feature, building up and closing the outlet of Soquel Creek to create Soquel Creek Lagoon during the summer and breaching and narrowing due to high flows in Soquel Creek and increased wave action during the winter. The beach consists of sand overlaying sandstone-siltstone at an approximate elevation of +1 feet MLLW at the back of the beach and -5 feet MLLW at the seaward extent of the summer beach. Based on measurements taken by the USACE directly after the construction of the Jetty, the beach berm can vary in elevation by 4 feet and the beach width can vary by more than 100 feet between summer and winter conditions.

### **History**

In the 1930's, the City of Capitola decided to address the threat of flooding from Soquel Creek associated with flow backing up when the mouth was closed. A boxed culvert ('Flume') was installed to allow flow to reach Monterey Bay during the summer.

With the construction of the jetties at the Santa Cruz Harbor in 1963, the disruption in longshore sediment transport from west to east resulted in less sand being deposited on the beach at Capitola. This disruption delayed the closure of Soquel Creek and resulted in a narrower beach, restricting public access significantly. The lack of beach at Capitola also presented a major flooding threat from storm surge, waves and swell. Figure 2 shows the narrow beach that enabled wave runup to reach buildings along Soquel Creek.

Between 1966 and 1967, the USACE performed an alternatives analysis to address the problem of beach erosion at Capitola. The result of the analysis was a recommendation to construct a 300 foot groin at the eastern extent of the Capitola Beach paired with a 20,000 cubic yard beach nourishment. A 250 foot groin was constructed (slightly shorter than the USACE proposed). After construction was completed in 1970, the project was monitored to determine performance of the system. Figure 1 and Figure 2 show aerials of Capitola beach before and after the construction

of the jetties at the Santa Cruz Harbor, respectively. Both Figure 1 and Figure 2 are before the construction of the Capitola Jetty.

Review of available aerial photographs has shown that the Jetty is still functioning as designed. The summer beach typically builds out to the extent of the Jetty within weeks or, in some instances within days. In winter conditions, when the Lagoon is open, the Jetty helps stabilize the mouth of Soquel Creek and capture some sediment traveling with the Creek flow. This additional sediment deposit helps protect the Capitola Esplanade from flooding during storm events.



*Figure 1: Aerial of Capitola Beach in 1928 (source: californiacoastline.org)*



*Figure 2: Aerial of Capitola Beach in 1967 after construction of Jetties at Santa Cruz and Prior to Construction of Capitola Jetty (source: USACE 1971)*

## **Project Need**

The purpose of this project is to replace the rock that has been dislodged off of the Jetty, causing exposure of the interior concrete wall. The City of Capitola recognizes that without the protection of the rock, the wall experiences direct wave attack that can compromise its stability and can lead to failure. If failure of the wall were to occur, this would result in a larger scale repair event in the future.

Additionally, rock scattered on the beach is posing a hazard to visitors to the beach. It also decreases the amount of available area for public access. The project intends to retrieve the rock on the beach and place it back onto the Jetty so as to protect the wall from wave exposure. Additionally, rocks at the toe of the structure have scattered along the beach. This toe will be rebuilt using rocks in close proximity to the Jetty that have not yet been buried as well as importing new rock. The rocks below the water level that are buried will be left where they are to minimize disturbance of the natural habitat. For areas where the armor rock has been displaced and the underlying layer of rock has been washed out, new underlying rock will be placed before the armor stones are returned to the Jetty. Figure 3 shows areas of repair on the Jetty.



*Figure 3: Proposed Repairs to Jetty*

There will be no impact to sediment transport due to the repairs. Only the minimum amount of rock that is needed to protect the wall will be placed onto the Jetty. The elevation of the rock replaced will not exceed the top elevation of the wall. Therefore, there will be no visual impacts compared to the current structure. The dimensions of the Jetty (length and width) will remain the

same as the originally constructed Jetty, namely, 250 feet long and 50 feet wide. This repair work should decrease the current footprint of the Jetty.

### **Coastal Processes**

The Jetty is exposed to both extreme water levels, wind-waves, and Pacific swell. The following subsections discuss these coastal processes and how they affect the Jetty.

#### **Water Levels**

The National Oceanic and Atmospheric Administration (NOAA) operates tidal and meteorological station 9413450 at Monterey Harbor. Located approximately 25 miles from Capitola Beach. For areas in close proximity to each other on the open coast, there is typically little spatial variation in water levels between the two sites. Therefore, the station at Monterey Harbor will produce water level measurements similar to those expected at Capitola. Vertical datums at the station are presented in Table 1.

*Table 1: Water Level Datums at Monterey Harbor*

<b>Datum</b>		<b>Elevation (feet) NAVD88</b>
Highest Observed Water Level (01/27/1983)	HOWL	+11.40
Highest Astronomical Tide	HAT	+7.18
Mean Higher High Water	MHHW	+5.48
Mean High Water	MHW	+4.78
Mean Tide Level	MTL	+3.01
Mean Sea Level	MSL	+2.97
Diurnal Tide Level	DTL	+2.81
Mean Low Water	MLW	+1.23
Mean Lower Low Water	MLLW	+0.14
North American Vertical Datum of 1988	NAVD88	0.00
Lowest Astronomical Tide	LAT	-1.77
Lowest Observed Water Level (01/11/2009)	LOWL	-2.28

The station began verifying hourly water level measurements in 1973. An extreme value analysis was conducted on the 45-year hourly record to determine the return-period water levels, shown in Table 2.

*Table 2: Extreme Water Levels at Monterey Harbor*

<b>Annual Exceedance Probability</b>	<b>Recurrence Interval</b>	<b>Elevation (feet NAVD88)</b>
1%	100 years	+8.22
10%	10 years	+7.73
50%	2 years	+7.30
99%	1 year	+6.87

Annual Exceedance Probability	Recurrence Interval	Elevation (feet NAVD88)
99%	1 year	-0.02
50%	2 years	-1.26
10%	10 years	-1.98
1%	100 years	-2.21

Based on the analysis, the 100-year return period water level (1% annual chance water level) of +8.2 feet NAVD88 almost reaches the Jetty elevation of +10 feet NAVD88. The highest water level ever recorded at Monterey Harbor of +11.40 feet NAVD88 exceeded the highest elevation of the Jetty and likely submerged Capitola Beach.

### Wind Data

Capitola is exposed to both wind waves and Pacific swell. Waves are generated when wind blows over the surface of the water. The size of the wave is dependent on the speed and duration of the wind and the fetch, or distance over which the wind blows. The wave heights and wave periods increase with wind speed, duration, and fetch. Wave direction is in the same general direction as the wind direction.

Data from the NOAA operated meteorological station 9413450 was analyzed to define the wave climate at Capitola. As with the water levels at Monterey Harbor, there is no significant variation in wind conditions for neighboring sites as long as the topography of the region is similar. Therefore, wind conditions at Capitola can be reasonably estimated using the wind measurements at Monterey Harbor. Wind speed and direction was measured at this station in six-minute intervals beginning in 2009. The wind rose is presented in Figure 5.

Winds from the Northwest, North, and Northeast will not generate waves at Capitola Beach. Additionally, Capitola Beach is sheltered from significant wind-wave action from the west by the headland located at Pleasure Point. Winds blowing from the East, Southeast, and South have limited fetch over which to generate large waves. Therefore, the greatest wind-induced wave heights will occur from winds blowing from the Southwest, which occur approximately 24% of the time and only exceed 12 knots approximately 1% of the time.

### Waves

Waves experienced at Monterey Bay can be attributed to local wind-waves, as discussed in the previous paragraph, northwest wind-waves, north Pacific swell, and southern hemisphere swell (*Storlazzi and Wingfield, 2005*), as shown in Figure 4.

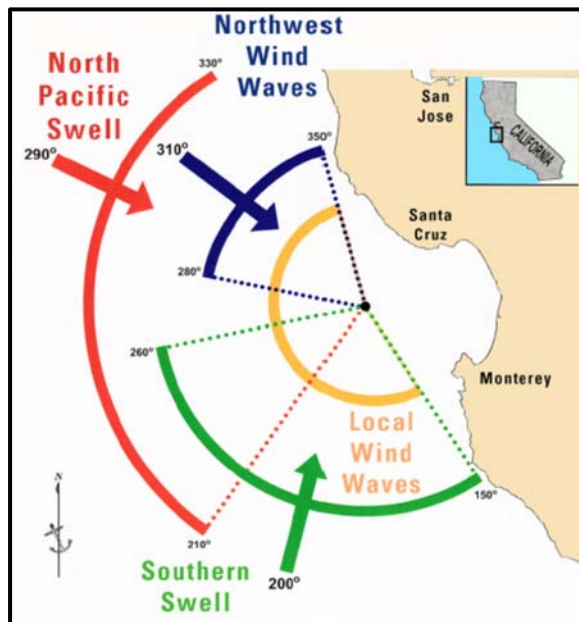
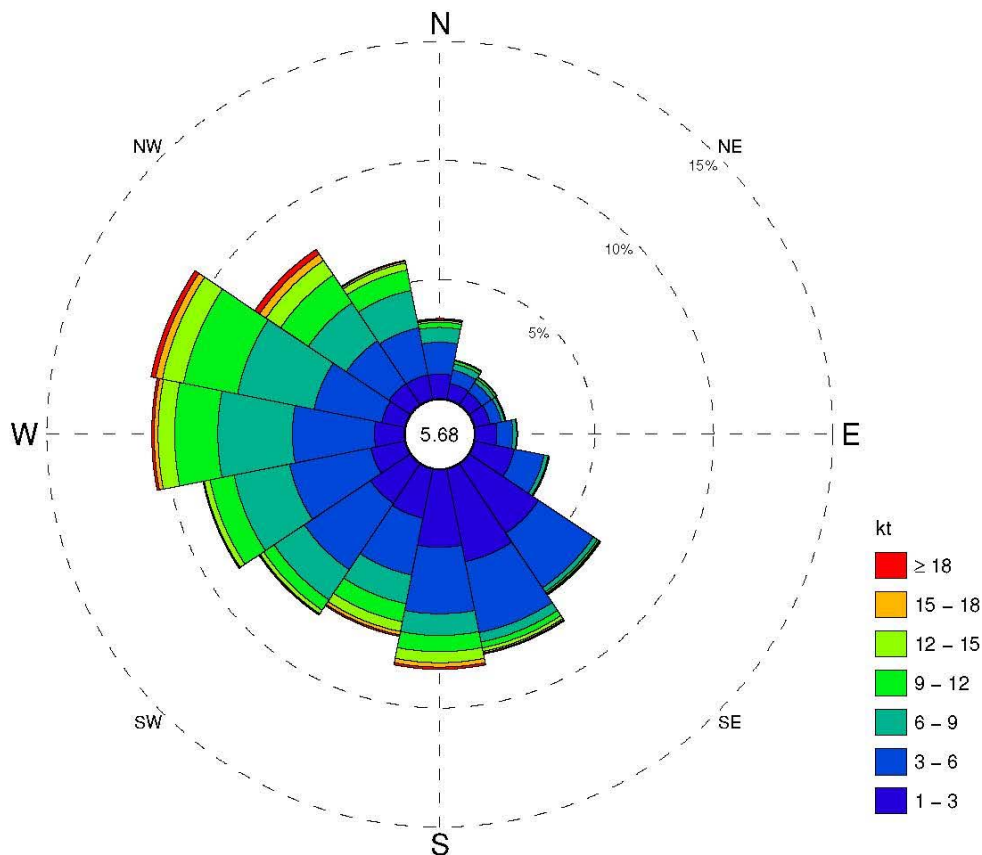


Figure 4: Wave Exposure at Monterey Bay based on Offshore Buoy Data (Hapke et al. 2006)

Wind Speed (Annual)  
Station 9413450 – Monterey, CA  
Period 10–Nov–2009 to 27–Apr–2018



Direction FROM is shown  
Center value indicates calms below 1 kt  
Total observations 635822, calms 36144

Percentage of Occurrence

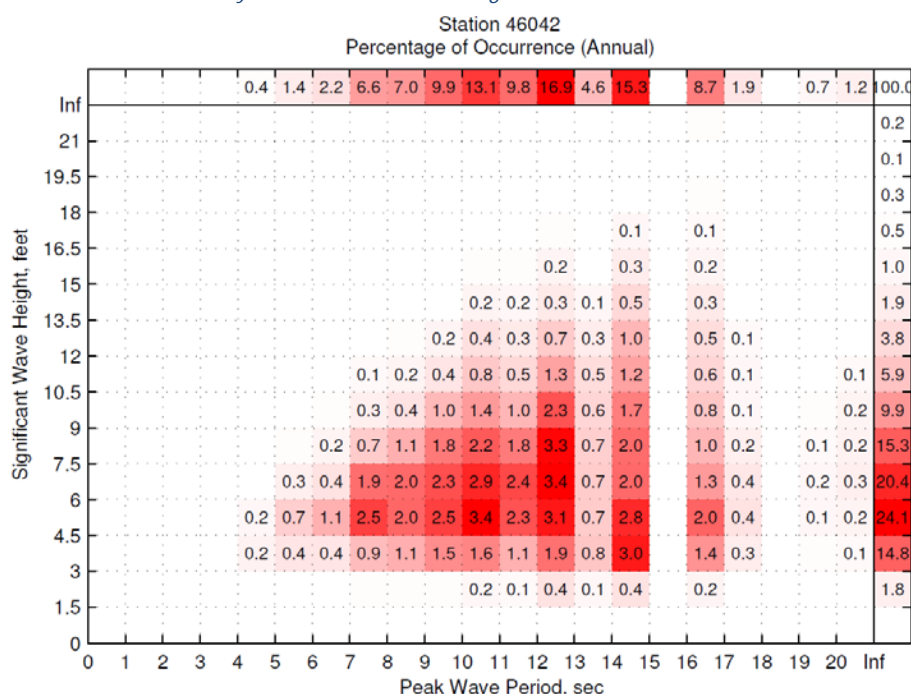
Total	3.36	1.68	1.40	1.33	1.76	3.20	6.62	7.92	8.37	7.16	7.63	8.63	10.60	10.86	7.84	5.96	94.32
18													0.10	0.19	0.24		0.89
15									0.19	0.14			0.17	0.29	0.32		1.42
12								0.15	0.46	0.42	0.18	0.25	0.70	0.90	0.74	0.30	4.31
9	0.21	0.12						0.25	0.68	0.77	0.52	1.03	1.81	2.31	1.40	0.87	10.27
6	0.62	0.27	0.18	0.15	0.16	0.17	0.20	0.40	0.91	1.23	1.53	2.38	3.13	3.28	1.92	1.60	18.13
3	1.34	0.58	0.48	0.48	0.67	1.27	2.76	3.04	2.79	2.44	3.34	3.48	3.45	2.89	2.16	2.02	33.20
1	1.03	0.66	0.62	0.66	0.90	1.69	3.49	3.95	3.25	2.09	2.00	1.44	1.24	0.99	1.06	1.04	26.10
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total

Figure 5: Wind Rose and Percent Occurrence Table for Wind Speed and Direction at Monterey Harbor

Northwest wind waves will not have a significant impact on Capitola Beach due to the shielding of the headland at Pleasure Point. Both north Pacific swell and southern hemisphere swell, in conjunction with locally generated wind-waves, can result in wave action at Capitola. North Pacific swell is generated by mid-latitude cyclonic storms in combination with cold fronts in the North Pacific. Southern swell is generated by winter storms in the southern hemisphere and is dominant in the summer.

Offshore wave measurements are available at the National Data Buoy Center Station 46042, located approximately 27 miles west of the Monterey Bay coastline. Wave measurements are composed of both swell and wind-wave components superimposed on each other. Longer period waves are generally representative of swell conditions and shorter period waves represent wind-waves. Table 3 gives the joint probability of wave height and wave period at Station 46042.

Table 3: Joint Probability Distribution of Wave Height and Wave Period at NDBC Station 46042



The offshore significant wave height measurements at Station 46042 is presented in Figure 6. An extreme value analysis on the wave heights was performed to determine the recurrence intervals of waves. The return-period offshore wave heights are presented in Table 4.

Table 4: Extreme Offshore Wave Events

Annual Exceedance Probability	Recurrence Interval	Significant Wave Height (feet)
1%	100 years	+35.9
2%	50 years	+34.3
10%	10 years	+30.4
50%	2 years	+25.6
99%	1 year	+22.8



As waves travel onshore, the local bathymetry affects both the wave height and direction of the propagating wave. Therefore, waves at the offshore Station 46042 are not representative of the waves experienced at Capitola Beach. Wave heights at the Jetty will be limited by the water depth in front of the structure and the period of the wave. For example, assuming a wave period of 12 seconds occurring during a Mean High Water event, the extreme wave heights presented in Table 4 would correspond to the following wave heights at the toe of the Jetty:

*Table 5: Transformed Wave Heights at the Toe of the Jetty*

Annual Exceedance Probability	Recurrence Interval	Significant Wave Height (feet)
1%	100 years	+6.5
2%	50 years	+6.4
10%	10 years	+6.2
50%	2 years	+5.9
99%	1 year	+5.7

### Sea Level Rise

The Ocean Protection Council (OPC, 2018) maintains guidance on Sea Level Rise (SLR) for the coast of California. The guidance considers two different SLR scenarios: a low emission scenario considering a decrease in green gas emissions, and a high emission scenario. Table 6 provides the OPC probabilistic projections for the height of sea-level rise at Monterey for the years 2050 and 2100.

*Table 6: SLR Projections at Monterey Harbor*

Year	Emission Scenario	Median	Likely Range	1-in-20 chance	1-in-200 chance
		50% probability SLR meets or exceeds...	66% probability SLR is between...	5% probability SLR meets or exceeds...	0.5% probability SLR meets or exceeds...
2050	High	0.8	0.5 - 1.1	1.3	1.9
2100	Low	1.5	0.9 - 2.3	3.1	5.5
2100	High	2.3	1.5 - 3.3	4.3	6.9

The rock size currently on the Jetty would protect against the 100-year return period wave height (1% annual chance wave event) for SLR up to 1.5 feet.

## **Alternatives Analysis**

Four alternatives were evaluated for the protection of the Jetty interior concrete wall. A description of the proposed alternatives and a comparison of each alternative based on cost, construction feasibility, project performance, and environmental impacts are provided in the following discussion.

Though considered, a living shoreline solution incorporating submerged aquatic vegetation (SAV) such as reef balls or wetland creation was not analyzed because the wave climate along Capitola Beach is considered too severe to support this type of habitat. Additionally, any type of supertidal vegetation, such as dune plantings, would limit public access to the beach and would be difficult to implement in the sensitive environment created by the Soquel Creek, Lagoon, and Bay interface. Therefore, these options were not carried forward as alternatives.

### *Alternative 1: No Project*

This alternative examines not performing any maintenance repairs to the Jetty. This alternative will have no immediate cost implications, no immediate construction or environmental impacts and the Jetty will continue to function as intended. However, as wave action continues to dislodge the rock, damage to the concrete wall could result. If the wall is damaged, the Jetty will no longer capture sand as effectively. Repairs to the wall and surrounding rock will be necessary in order for the continued operation of the Jetty. This will be a significant repair effort that will involve reconstructing the wall by pouring cast-in-place concrete in areas below the high tide line. Construction cost will be an order of magnitude greater than if the minor repairs are performed today. Construction below the waterline would be unavoidable, resulting in a more complex construction methodology, long construction duration, and significant environmental impacts in relation to performing repairs on the Jetty today.

If the Jetty wall is allowed to fail and no repairs performed on the Jetty, essentially allowing the Jetty to stop capturing sand and stabilizing the mouth of Soquel Creek, the beach will likely reach a footprint similar to the 1967 footprint shown in Figure 2. A smaller beach width will result in decreased public access, increased frequency of flooding, and loss of habitat if there is not sufficient sand to close Soquel Creek. These impacts will become more hazardous with future SLR conditions.

Additionally, rocks from the Jetty have scattered onto the beach. The presence of these rocks decreases the amount of beach available for public use. If no project is implemented to retrieve these rocks and if more rocks become dislodged and scattered on the beach, this will further decrease access and could pose a hazard to the public.

### *Alternative 2: Beach Nourishment (No Repairs to Jetty)*

A soft engineering solution to protecting the jetty wall is to perform a beach nourishment project. Nourishing the beach adjacent to the Jetty will protect the wall from exposure to wave action on the western side of the Jetty. Aerial photographs of the Jetty show that the majority of the displaced rock has occurred on west side of the Jetty. A beach nourishment project would decrease the vulnerability of the wall on the west side with little to no protection of the wall on the east side of the Jetty. However, this will delay the potential for wall failure only as long as the sand is present.

Depending on the quantity of sand and the transport of the sand from its original location, this alternative could present one to two orders of magnitude greater construction costs than the preferred alternative of replacing the missing rocks on the Jetty. Additionally, this alternative would only present a temporary solution as the wall would be exposed annually again once the sand was carried away by longshore or cross-shore sediment transport. Construction of this alternative would involve closing off the entire beach from public access for the length of construction. Berms would have to be constructed along the coastline and Soquel Creek so that sand is not discharged into these bodies of water. Sand can either be trucked from an upland source or pumped as a slurry (mixture of 15% sand and 85% water) to the site. This project would have to be repeated once the sand has moved away from Capitola Beach and the Jetty wall is exposed again. The cumulative environmental impacts of these maintenance projects have the potential to be significant to the sensitive habitat of Soquel Creek.

The advantage of this alternative is that it will add sand into the Monterey Bay sediment budget. If the sand is transported away from Capitola, it may nourish the beaches downcoast. This could add protection for the areas along Monterey Bay that are experiencing coastal erosion and help offset the effects of SLR.

#### *Alternative 3: Wave Attenuators*

Offshore wave attenuators are considered as an alternative because they would decrease the wave energy reaching Capitola Beach. A decrease in wave energy would result in less sand moving offshore or downcoast due to cross-shore and longshore sediment transport. Therefore, Capitola Beach would maintain a wider beach that can serve as protection against wave action and flooding. The decrease in wave energy would also result in smaller waves impacting the Jetty and lessen the risk of damage to the exposed portions of the wall.

Wave attenuators could come in the form of 'hard' engineering structures such as rock or rubble mound breakwaters or 'soft' engineering solutions such as oyster reefs. Either option would likely result in an order of magnitude cost increase over the preferred alternative of repairing the existing Jetty. This alternative would fundamentally modify the wave climate and displace the large surfing community at Capitola Beach.

Construction for this alternative would involve all in-water work. Material would have to be barged to the site and offloaded from equipment staged on floats. The large footprint of this alternative would likely result in larger environmental impacts than the preferred alternative of repairing the Jetty. The construction of a rock breakwater or an oyster reef would provide environmental benefits by creating habitat, however, those benefits would need to be weighed against the impacts resulting in project implementation.

#### *Alternative 4: Repairs to Existing Jetty (Preferred Alternative)*

The preferred alternative for the project is to repair the Jetty by retrieving rock scattered near the structure and placing it back onto the Jetty. The existing rock would be supplemented with a small quantity of new rock to fill the gaps in areas where the rock has been dislodged but is not near the Jetty. The rock will be retrieved during low tide events and returned to the Jetty using an excavator bucket or rock grapple. The estimated construction cost of this option is approximately \$400,000 which is an order of magnitude less than the other options discussed in this alternatives analysis. Additionally, environmental impacts would be minimal since they would only occur during the few days of construction and have no long-term impacts. The Jetty

would continue to perform as it has before and the hazard to the wall would be significantly reduced. There would be no impact to the surfing community.

Table 7 presents the alternatives comparison summarized using a low, medium, or high influence on the comparison criteria.

### **Recommendations**

Based on the alternatives analysis performed, the most feasible and least impactful project alternative for the protection of the Jetty wall is Alternative 4: Repairs to Existing Jetty.

Table 7: Comparison of Alternatives

No.	Description	Construction Feasibility	Economic Considerations	Environmental Impacts	Project Performance	Design Life
1	No Project	<b>Low</b> – No construction in the short-term; may need a large-scale project in the future.	<b>Low</b> - No construction costs in the short-term; may need a high cost project in the future.	<b>Low</b> - No impacts in the short-term; impacts would result from larger project in the future.	<b>High</b> – The Jetty will continue to perform in current condition.	<b>Low</b> – The Jetty has deteriorated which will likely accelerate.
2	Beach Nourishment	<b>High</b> – Project would involve beach closure, beach reconfiguration, complex construction methodology.	<b>High</b> – Project costs would be in millions or tens of millions of dollars.	<b>High</b> – Impacts to existing habitat would occur; however, new types of habitat would also develop.	<b>Medium</b> – The wall would be protected the duration the sand is present and exposed once the sand is washed away.	<b>Low</b> – Beach nourishment would be required on a seasonal basis.
3	Wave Attenuators	<b>Medium</b> – Project would not involve beach closure or reconfiguration. Heavy equipment would be necessary.	<b>High</b> – Project costs would be in millions or tens of millions of dollars.	<b>High</b> – Impacts to existing habitat would occur; however, new types of habitat would also develop.	<b>High</b> – Decreased wave energy will allow Jetty to perform as intended and less sand to be washed away from beach.	<b>High</b> – Project would be robust and constructed of durable materials.
4	Repairs to Jetty	<b>Low</b> – Construction will not require beach closure except in close proximity to the Jetty during the offseason. Heavy equipment will only be necessary for a few days.	<b>Low</b> – Project estimate of \$400,000 with a design life of +50 years.	<b>Low</b> – Impacts minimal and temporary; habitat will be the same post-construction as pre-construction.	<b>High</b> – The Jetty will continue to perform as intended for +50 years.	<b>High</b> – The Jetty has been in use since 1969 (49 years) and once repaired is expected to perform similarly.

## **References**

OPC (2018). *State of California Sea-Level Rise Guidance*. California natural resources agency, California Ocean Protection Council, 2018.

USGS (2006). *National Assessment of Shoreline Change, Part 3: Historical Shoreline Change and Associated Coastal Land Loss Along Sandy Shorelines of the California Coast*. Open-File Report 2006-1219. Cheryl J. Hapke, David Reid, Bruce M. Richmond, Peter Ruggiero and Jeff List. U.S. Department of the Interior, U.S. Geological Survey.

## MEMORANDUM

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To: Steve Jesberg, P.E., Public Works Director, City of Capitola

From: Sam Tooley, P.E.  
Mads Jorgensen, P.E.  
Brad Porter, P.E.

Date: October 16, 2018

Subject: Capitola Beach Jetty Rehabilitation – Sand Transport Study, Revision 1

M&N Job No.: 9154-01

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### Executive Summary

This memo evaluates sand transport at Capitola as part of the planned repair of the existing jetty. The proposed maintenance project is intended to maintain the current public beach and continued viability of the Soquel Creek Lagoon Management Plan. The study concludes that repair of the deteriorated jetty will not impact sand transport as the crest elevation, profile, and extent of the jetty are not altered by the repair work.

The Santa Cruz Littoral Cell represents a closed system of sediment movement, having its northern limit at Pillar Point and terminating at the Monterey submarine canyon. On the Pacific Coast, the net longshore littoral transport is southward, and eastward into Monterey Bay.

Sand transport at Capitola is primarily a function of wave action and wave-induced longshore currents. Contributions to the system include sand transported downcoast resulting from bluff erosion, dredge material bypassed at the Santa Cruz Harbor, and sediments from the San Lorenzo River and Soquel Creek. The beach profile at Capitola varies seasonally, transitioning between a wider beach in the summer months and a narrower beach in the winter months, see Figure 7.

The study concludes that the beach at Capitola is in dynamic equilibrium with its seasonal environment and repair of the jetty will have no impact on sand transport and will not affect sand supply to downcoast areas.

**Revision 1:** The material revision to the previous document was the reduction of the top-of-rock elevation for the proposed replacement rock. The previous proposal included building rock back to the original design elevation. This proposal reduces that elevation, and now proposes to build rock no higher than the currently existing concrete membrane, as shown in Figure 2, below. As the proposed repair project results in no change to the existing crest elevation, profile, and extent of the jetty, the study concludes there will be no impact to sand transport

## Introduction

The purpose of this memo is to evaluate sand transport at Capitola in connection with a project to restore the Capitola Wharf and rehabilitate the lagoon outlet box culvert and jetty. Figure 1 shows an aerial view of the existing wharf and beach. The beach is retained by a rock jetty at the eastern end of the beach. Outflow from Soquel Creek results in formation of a lagoon at the back beach, which breaches periodically.

The City of Capitola manages the lagoon at the mouth of Soquel Creek via a concrete box culvert and construction of a sandbar in the early summer months. The box culvert enables drainage of excess inflow to the lagoon, which extends the period of lagoon formation and prevents premature breaching, while enabling outmigration of smolts. The sand bar is typically constructed around Memorial Day to enhance summer beach use and support lagoon formation (CRSMP, 2015). Breaching of the lagoon occurs in the winter months, enabling salmonid upstream migration, which typically goes on from December to May.



*Figure 1: Aerial view of Capitola Wharf and Beach.*

## Background

The Capitola Wharf was constructed in 1857 during the Gold Rush era. The portion of the beach east of the wharf is the Capitola City Beach. The smaller beach west of the wharf is named Hooper Beach.

The jetties constructed for the Santa Cruz Harbor in 1963 initially trapped large volumes of sand that would otherwise have nourished the shoreline downcoast to Capitola. The sand deficiency led to accelerated cliff erosion, depleted Capitola Beach, and waves eventually undercut building foundations along the waterfront and exposed a storm sewer outfall. The jetty was constructed in 1969 to retain sand and replenish the beach. The current Jetty Profile including existing concrete membrane wall, and the proposed region of restoration are shown in Figure 2.

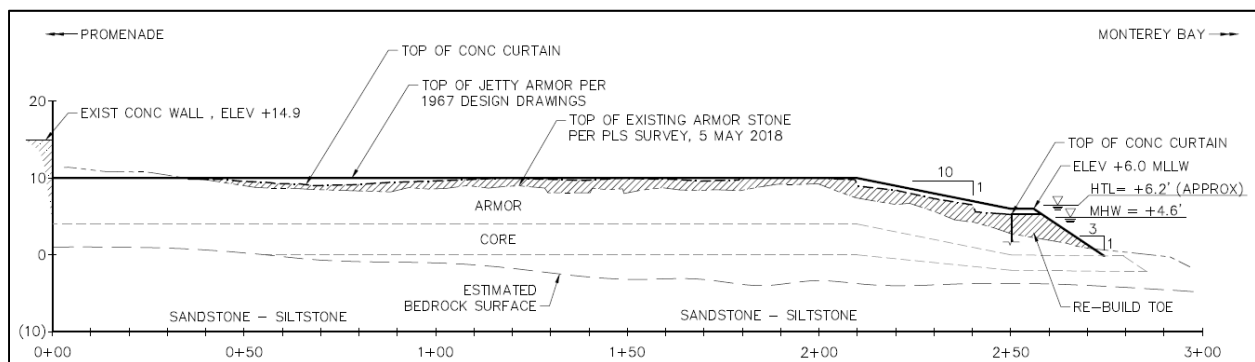


Figure 2. Jetty Profile

## Sand Transport

Sand transport at Capitola is governed by the regional setting of Monterey Bay on the Pacific Coast (Figure 3). Capitola is located within the Santa Cruz Littoral Cell, which represents a self-contained system of sediment movement. Sediment movement is driven by wave action which produces a longshore coastal current.

The Littoral cell begins at Pillar Point in Half Moon Bay and ends at the Monterey Submarine Canyon offshore of Moss Landing. On the Pacific Coast the net longshore littoral transport is southward (downcoast), turning eastward into Monterey Bay. The net sand transport direction is indicated with yellow arrows in Figure 3. Sources of sediment originating from major streams are indicated by orange arrows.

Sand transport at Capitola is detailed in Figure 4. Input to the sand transport balance includes longshore littoral transport (from the west), sediment from eroding cliffs, and sediment from the San Lorenzo River and Soquel Creek. Loss of sediment occurs due to the longshore littoral transport (to the east), ultimately drawn offshore and lost to the Soquel Submarine Canyon and Monterey Submarine Canyon, (IMS, 2006).



Figure 3: Santa Cruz Littoral Cell.

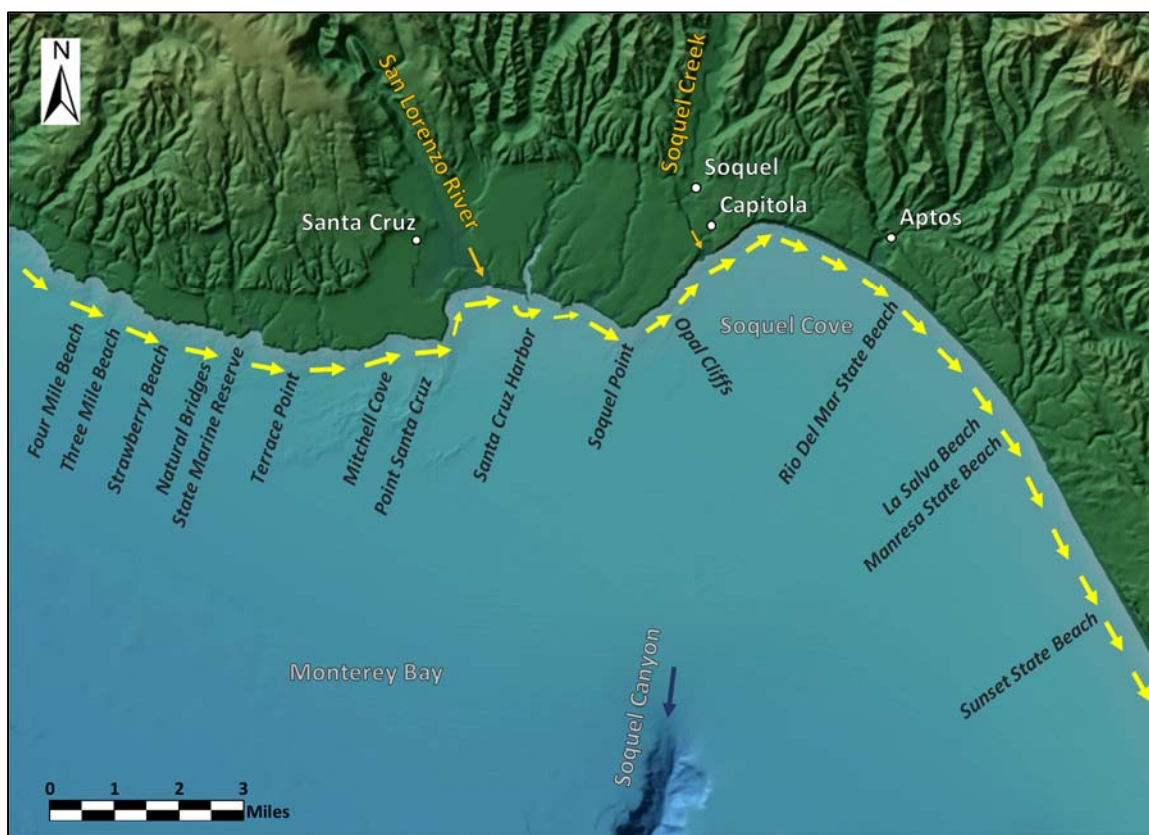


Figure 4: Santa Cruz Littoral Cell at Capitola.

## Wave Climate

Wave action is the main driver of longshore littoral transport. Monterey Bay is exposed to North Pacific swells throughout the year and periodically to Southern Hemisphere swells (Figure 5). Swells are waves originating from distant storms in the Pacific Ocean and are characterized by long wave periods, typically ranging from 8 to 16 seconds.

Southern Hemisphere swell waves arrive from southerly to southwesterly directions. Swell waves from the North Pacific Basin arrive from southwesterly to northwesterly directions. Wave heights can range from 2 to 30 feet, with the larger swells occurring from October to May. During El Niño-Southern Oscillation (ENSO) events, winter storms track farther south than they do in normal (non-ENSO) years, thereby impacting Capitola more frequently and with waves of larger heights. Monterey Bay is also exposed to open water wind-waves generated by local storms.

The National Buoy Data Center (NBDC) maintains a wave buoy offshore of Monterey Bay, which is indicated by the yellow diamond in Figure 5. Table 1 provides statistics summarizing the distribution of significant wave heights by direction, and Table 2 shows the relationship between significant wave heights and peak wave periods. Waves are the primary driver of longshore littoral transport.

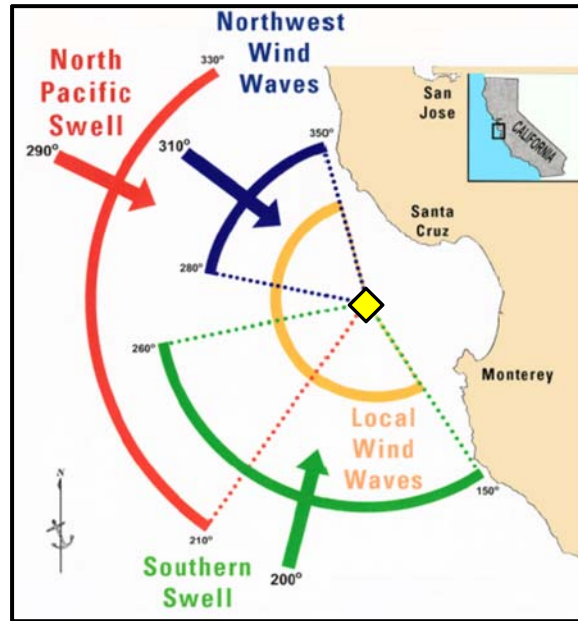


Figure 5: Wave exposure at Monterey Bay (USGS, 2006).

Table 1: Distribution of significant wave heights by direction.

H <sub>s</sub> (ft)		Waves From Direction (°N)											Total
From	To	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	
0	2	-	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	0.04%
2	4	0.0%	0.1%	1.3%	1.7%	0.8%	0.5%	1.3%	2.3%	2.1%	0.1%	-	10.33%
4	6	0.0%	0.2%	1.7%	1.8%	0.8%	0.8%	3.5%	8.7%	12.3%	0.5%	0.0%	30.24%
6	8	0.0%	0.1%	0.4%	0.3%	0.1%	0.3%	3.0%	9.5%	12.3%	0.5%	-	26.53%
8	10	-	0.1%	0.2%	0.1%	0.1%	0.2%	1.8%	7.0%	6.8%	0.2%	0.0%	16.29%
10	12	-	0.1%	0.1%	0.0%	0.0%	0.1%	0.9%	3.9%	3.4%	0.0%	-	8.70%
12	14	-	0.1%	0.1%	0.0%	0.0%	0.1%	0.5%	2.0%	1.7%	0.0%	-	4.52%
14	16	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.9%	0.7%	0.0%	-	1.97%
16	18	-	0.0%	0.0%	0.0%	-	0.0%	0.1%	0.4%	0.3%	0.0%	-	0.81%
18	20	-	0.0%	0.0%	-	0.0%	0.0%	0.0%	0.1%	0.1%	-	-	0.28%
20	22	-	-	0.0%	0.0%	-	0.0%	0.1%	0.1%	0.0%	-	-	0.18%
22	24	-	-	0.0%	-	-	0.0%	0.0%	0.0%	0.0%	-	-	0.07%
24	26	-	-	-	-	-	0.0%	0.0%	0.0%	-	-	-	0.03%
26	28	-	-	-	-	-	-	0.0%	0.0%	-	-	-	0.01%
28	30	-	-	-	-	-	-	0.0%	-	-	-	-	0.00%
Total		0.0%	0.7%	3.8%	3.9%	1.9%	2.1%	11.5%	35.0%	39.7%	1.4%	0.0%	100.0%

Table 2: Distribution of Significant wave heights and peak wave periods.

Significant Wave Height (ft)		Peak Wave Period (seconds)															Total
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
From	To	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
0	2	-	-	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	-	-	-	-	-	-	0.0%
2	4	-	0.0%	0.9%	2.5%	3.0%	2.4%	1.0%	0.4%	0.1%	0.0%	-	-	-	-	-	10.3%
4	6	-	-	1.3%	8.1%	9.2%	7.0%	3.0%	1.1%	0.5%	0.1%	0.0%	-	-	-	-	30.2%
6	8	-	-	0.0%	4.2%	8.7%	6.8%	3.9%	1.7%	0.7%	0.3%	0.1%	0.0%	-	-	-	26.5%
8	10	-	-	-	0.5%	4.8%	4.5%	3.2%	1.8%	1.0%	0.4%	0.1%	0.0%	0.0%	-	-	16.3%
10	12	-	-	-	0.0%	1.5%	2.6%	2.0%	1.4%	0.7%	0.3%	0.2%	0.0%	0.0%	-	-	8.7%
12	14	-	-	-	-	0.3%	1.3%	1.1%	0.9%	0.5%	0.3%	0.1%	0.0%	0.0%	-	-	4.5%
14	16	-	-	-	-	0.0%	0.4%	0.5%	0.4%	0.3%	0.2%	0.0%	0.0%	0.0%	0.0%	-	2.0%
16	18	-	-	-	-	0.0%	0.1%	0.2%	0.2%	0.2%	0.1%	0.0%	0.0%	0.0%	-	-	0.8%
18	20	-	-	-	-	-	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	-	-	0.3%
20	22	-	-	-	-	-	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	-	-	0.2%
22	24	-	-	-	-	-	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	0.1%
24	26	-	-	-	-	-	-	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	-	0.0%
26	28	-	-	-	-	-	-	-	-	0.0%	0.0%	0.0%	0.0%	-	-	-	0.0%
28	30	-	-	-	-	-	-	-	-	-	0.0%	0.0%	-	-	-	-	0.0%
Total		-	0.0%	2.3%	15.4%	27.6%	25.1%	15.0%	7.9%	4.1%	1.9%	0.6%	0.2%	0.0%	0.0%	-	100.0%

### Longshore Littoral Transport

Longshore transport of sand occurs when waves arrive at an angle to the shoreline. The steeper the angle, the larger the amount of material transported downcoast. Figure 6 illustrates the process of longshore sediment transport due to waves arriving at an angle to the beach. The runup and downrush of individual waves makes sand on the beach move in a sawtooth pattern. Wave-breaking produces a longshore current in the surf zone which transports sediments suspended in the water and along the bottom.

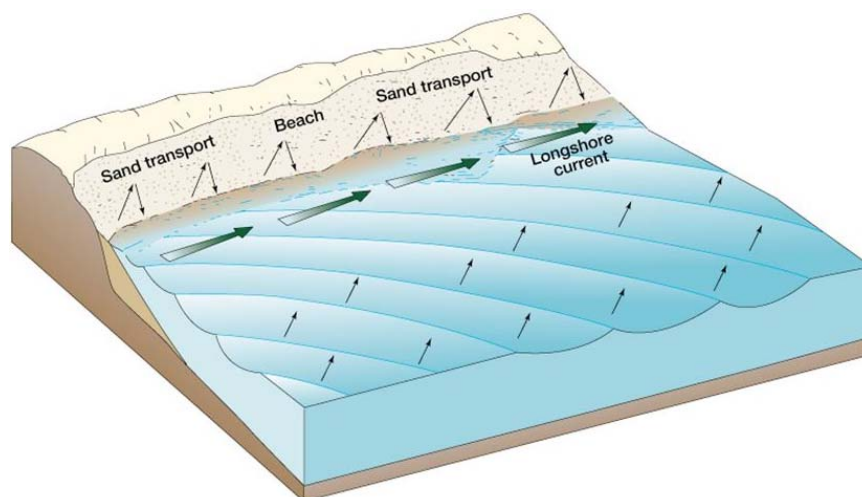


Figure 6: Wave-induced longshore littoral transport.

At Santa Cruz west of Capitola, sand is transported southeastward along the shore and past the Santa Cruz Harbor as littoral drift (Figure 4). A portion of the sand deposits within the harbor entrance channel. *USACE (1992)* cites several studies which developed estimates of longshore sediment transport rates at Santa Cruz. Estimates range from 300,000 to 500,000 cubic yards per year. Dredging at the Santa Cruz Harbor entrance averages 200,000 to 300,000 cubic yards per year. The dredge material is placed (bypassed) to the beaches east of the harbor jetties, where it provides a sand resource for beach replenishment of the shoreline further east, including Capitola.

## Fluvial Sources

The primary sediment input to the littoral cell upcoast of Capitola from fluvial sources is from the San Lorenzo River and from Soquel Creek. Stream discharge data is summarized in Table 3.

The drainage area for the San Lorenzo River is 136.0 square miles. Sediment contribution from the river is 89,000 CY per year, *Slagel et al (2006)*. The drainage area for Soquel Creek is 42.8 square miles and the sediment yield approximately 33,000 CY per year (*BH, 2003*). The downstream portions of the Soquel Creek watershed are gently sloping. Further upstream, the terrain becomes steeply sloping, and the primary source of sediment is from large, natural, deep-seated landslides in soil and colluvium (weathered bedrock). Landslides are commonly triggered by rainfall and seismic activity (*SCCRCD, 2003*).

Table 3: Stream discharge.

Recurrence Interval (years)	Discharge (cfs)	
	Soquel Creek	San Lorenzo River
500	24,300	70,100
100	17,500	50,600
50	14,700	42,300
10	8,310	23,700

## Coastal Cliff Erosion

Capitola is situated on marine terrace consisting of a series of wave-cut platforms produced due to seismic uplift. The geologic formations consist of siltstone and sandstone with outcrops of severely weathered, soft, light grayish-brown sandstone in coastal bluff areas.

Bedrock exposed in coastal cliffs is relatively erosion-resistant, and significant erosional events are limited to storm-wave activity that also erodes the overlying unconsolidated marine-terrace sediments.

Long-term erosion rates for the Opal Cliffs (*USGS, 2017*) are on the order of 0.3 to 1.3 feet per year. Bluff erosion can be related to the occurrence of high tide levels coincident with wave action, El Niño events, precipitation, and seismic events. Bluff failures are therefore episodic and irregular, and short term localized bluff retreat can therefore be significantly larger than the average long-term trend.

### Jetty Performance

Figure 7 shows beach profiles on the upcoast side of the jetty obtained from coastal LiDAR surveys conducted between 1997 and 2016. The figure also shows the crest elevation of the original jetty in blue and the crest elevation of rock along the existing jetty in black, which shows that the structure has deteriorated somewhat since its construction.

The figure shows that the jetty crest elevation at around +10 feet NAVD88 is generally in line with the beach elevations. The data shows that in some years, the beach profile can build up to elevations above the crest of the jetty (1997 Fall). However, the beach profiles are generally in line with the crest of the jetty. Bypassing of sand to the shoreline downcoast of the jetty takes place at the back beach (left in the figure, approximately from 0-50 feet). Sand transport in this area is wind-driven. Bypassing of sand also occurs around the offshore end of the jetty. This is indicated by the fact that the beach profiles extend beyond the toe of the jetty (to the right in the figure, around 280 feet). Sand transport in this area is wave and current driven. An example of this mode of sand bypassing can be seen in Figure 1, evidenced by the sediment plumes along the beach drifting around the end of the jetty. Figure 1 also shows the buildup of sand over the crest of the jetty at the back beach.

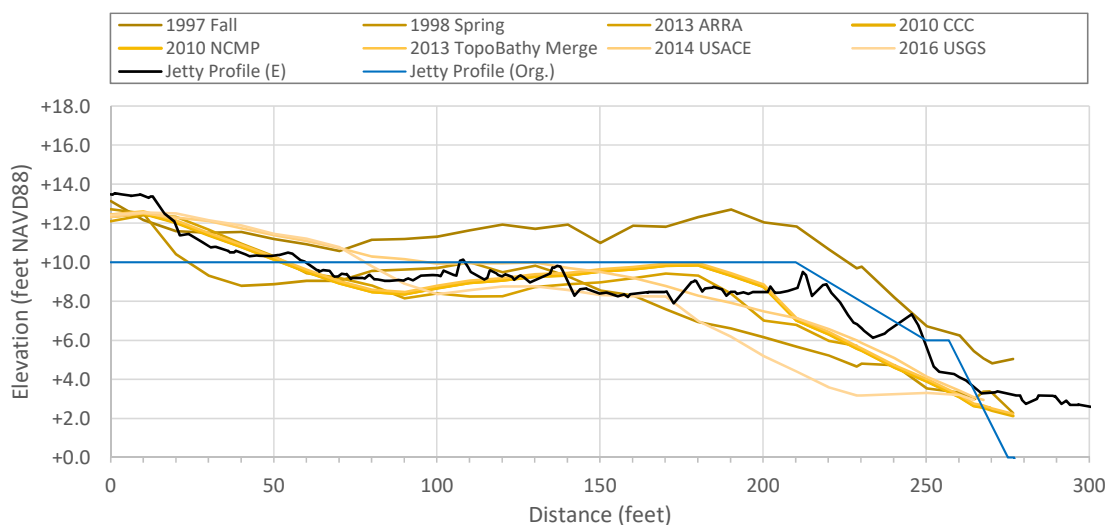


Figure 7: Comparison of beach profiles with jetty elevation.

### Sand Transport Balance

Table 4 provides a summary of the relative quantities of sediment movement within the Santa Cruz Littoral Cell at Capitola based on the data presented in the preceding sections. It should be noted that the sediment transport rates are intended for order-of-magnitude comparison only. A true sand budget would account for all sources and losses of sand within the entire Santa Cruz Littoral cell. The data shown in Table 4 are limited to the vicinity of Capitola.

The following observations can be made:

- The annual average longshore littoral transport is an order of magnitude greater than the typical summer/winter beach variation at Capitola.
- Soquel Creek and the San Lorenzo River contribute up to 40% of sand transported alongshore.
- The contribution of sand due to bluff recession is about 1% of the total on average.

*Table 4: Order-of-magnitude comparison of sediment movement.*

<b>Sediment Source/Location</b>	<b>Sediment Transport Rate (CY/year)</b>
Longshore littoral transport <sup>1)</sup>	200,000 to 300,000
San Lorenzo River <sup>2)</sup>	89,000
Soquel Creek <sup>2)</sup>	33,000
Bluff recession <sup>3)</sup>	2,700
Capitola Beach variation (summer/winter) <sup>4)</sup>	Δ 22,000
Addl. sand volume retained by repaired jetty <sup>5)</sup>	n/a

<sup>1)</sup> Ref. section on Longshore Littoral Transport.

<sup>2)</sup> Ref. section on Fluvial Sources.

<sup>3)</sup> Ref. section on Cliff Erosion, assuming an average recession rate of 0.6 feet/year, average bluff height of 50 feet and extent of 7,500 feet with 30% sand retained.

<sup>4)</sup> Ref. section on Jetty Performance, Figure 7. Cross-sectional area between higher and lower beach profiles and beach extent of 1,000 feet.

<sup>5)</sup> The planned project will not change the elevation, profile or extent of the jetty.

**Repair of the jetty will not impact sand transport as the crest elevation, profile, and extent of the jetty are not altered by the repair work.** Areas downcoast of the Jetty will therefore continue to receive the same amount of sediment that is currently by-passing the jetty.

### Sea Level Rise

A sandy shoreline represents a highly dynamic environment. The beach responds to the seasonal variation of the wave climate, and also to individual storm events. The wave exposure over the winter months tends to draw sand offshore, which results in a narrower beach. The wave climate over the summer brings sand back to the shore which widens the beach.

An increase in the water level heightens the potential for waves to erode the shoreline. Accelerated erosion is therefore often tied to storm events occurring on high tides and storm surge, and in El Niño years which produce a general rise of the ocean level.

In response to sea level rise, a sandy shoreline will maintain a dynamic equilibrium around the mean water level and the shoreline will therefore migrate inland. If sediment supply is limited the transition may result in accelerated shoreline recession. If there is a sufficient sediment supply, the response of the shoreline to sea level rise will be less apparent.

At Capitola, where there is an ample supply of sediment, it should be expected that the beach face will tend to rise as sea level increases. However, a significant increase in sea level would also mean that more sand would bypass over the crest of the jetty. It is therefore conceivable that the crest elevation of the jetty would need to be raised at some point in the future as an element of adaptation to sea level rise.

As sea levels increase, it is expected that the width of the beach will decrease, especially during winter conditions. Currently, Capitola experiences seasonal flooding during the winter when the beach is narrowest. Sea level rise will only exasperate the flooding problem. In the near-term it is expected that the jetty system will continue to minimize the frequency and scale of flood events. In the long-term, adaptation may be required to continue to protect Capitola from flooding. Beach nourishment could be a short-term solution to increasing water levels. However, it is important to note that beach nourishment is only effective if the jetty is functional. Not performing the repairs to the jetty in the near term will cause the wall to be exposed to increased wave action that accompanies sea level rise. Therefore, a future beach nourishment project should only be considered once repairs to the jetty have been made.

## Conclusions

The jetty serves to retain the beach at Capitola, and its continued deterioration will result in gradual loss of beach, and eventually increased erosion as waves impinge on the low bluff in the area. Repair of the jetty will not affect the longshore transport of sand and will not impact sand supply to downcoast areas.

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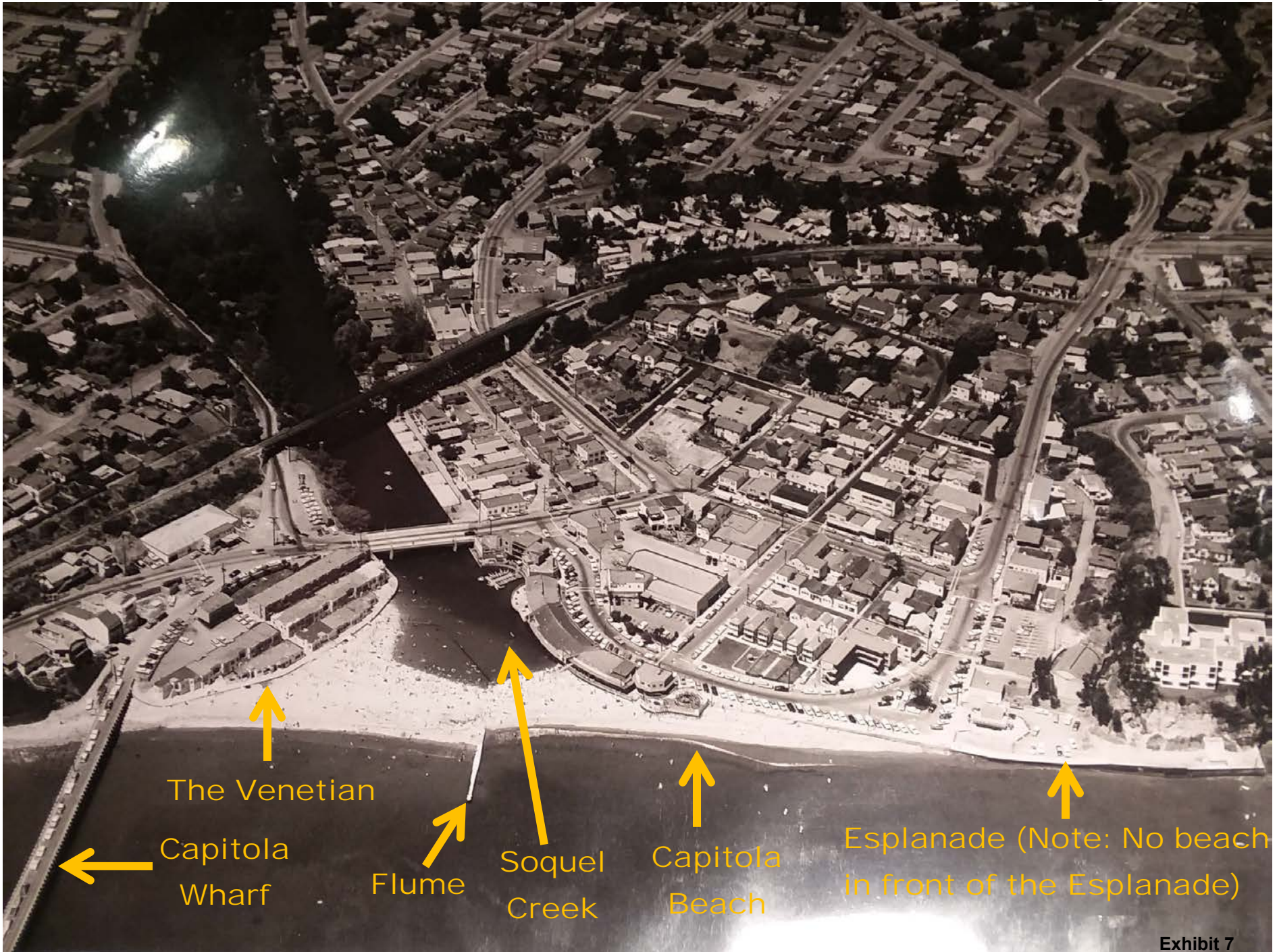
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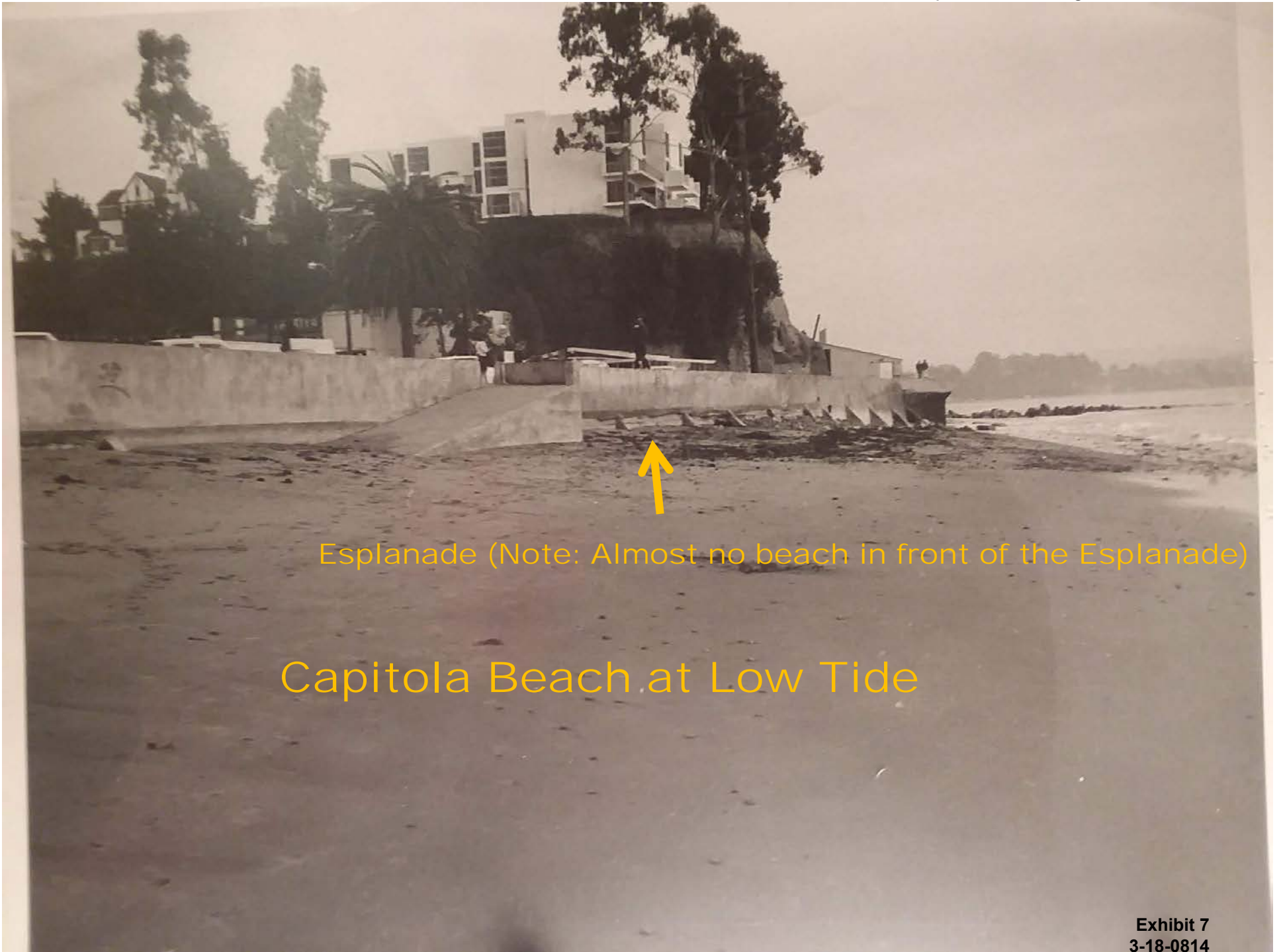
Capitola 1960's

Post-Construction of the Santa Cruz Yacht Harbor Jetties and Pre-Capitola Jetty Construction



Capitola 1960's

Post-Construction of the Santa Cruz Yacht Harbor Jetties and Pre-Capitola Jetty Construction

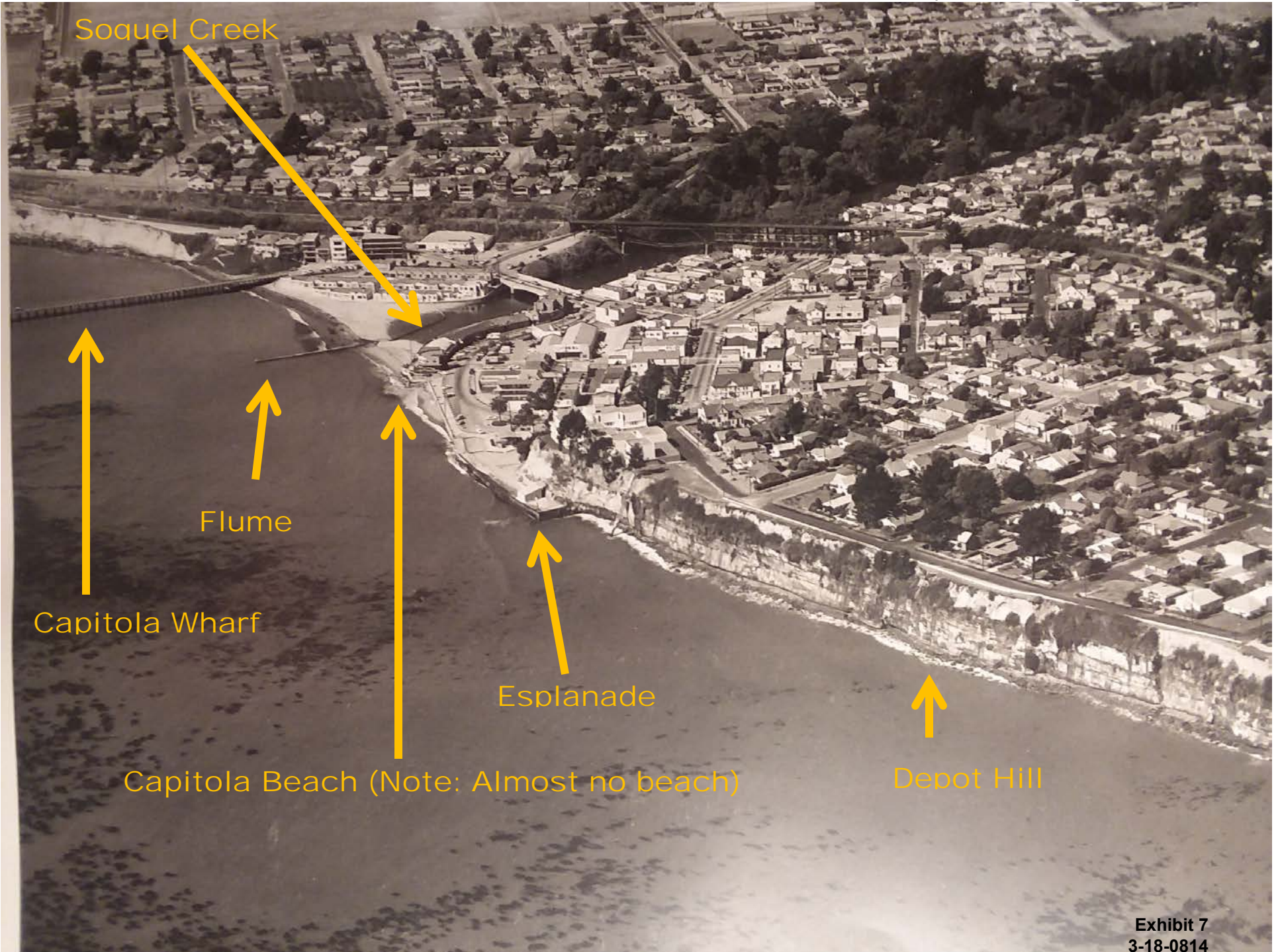


Esplanade (Note: Almost no beach in front of the Esplanade)

Capitola Beach at Low Tide

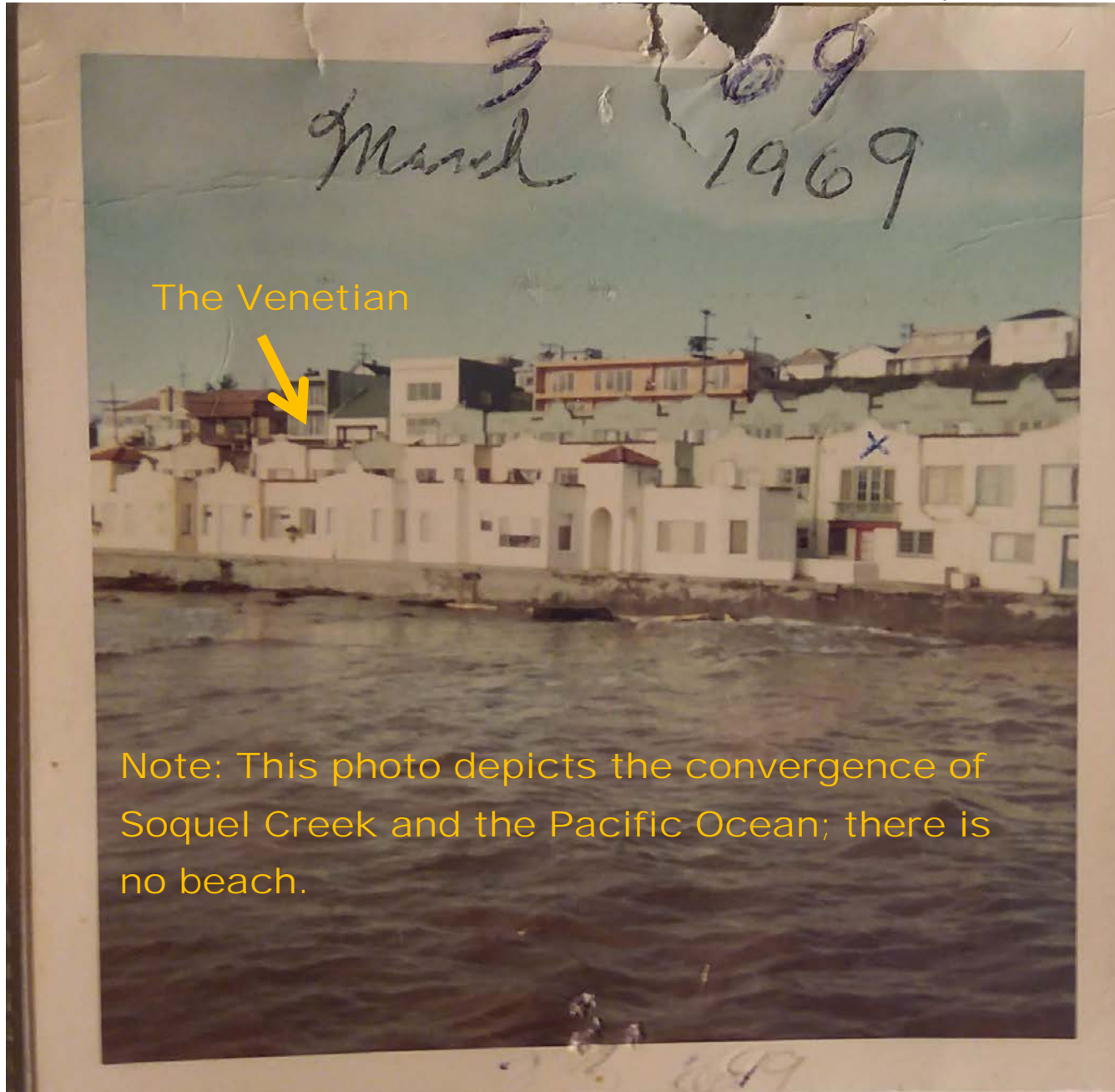
# Capitola 1960's

## Post-Construction of the Santa Cruz Yacht Harbor Jetties and Pre-Capitola Jetty Construction



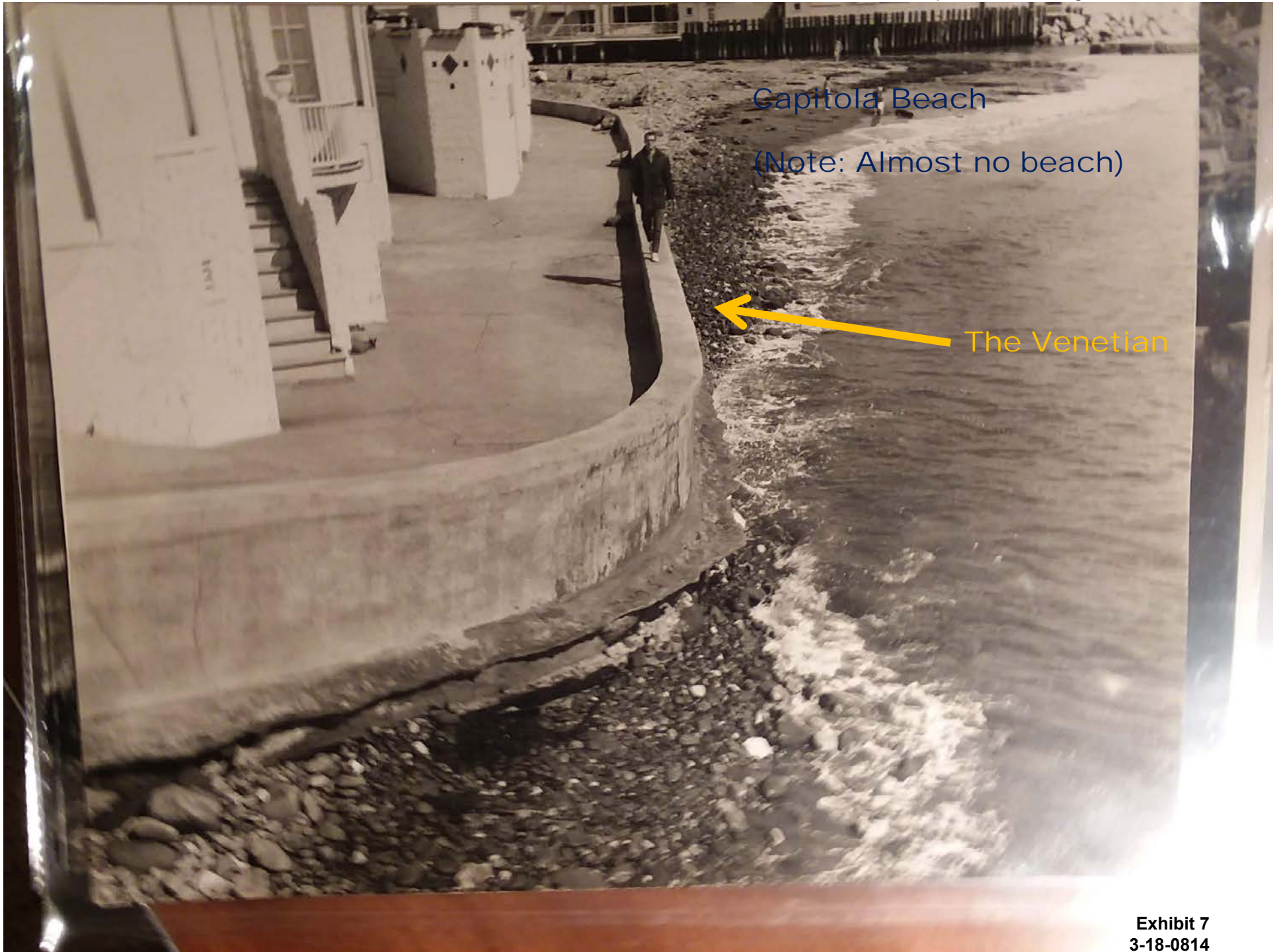
Capitola 1960's

Post-Construction of the Santa Cruz Yacht Harbor Jetties and Pre-Capitola Jetty Construction



Capitola 1960's

Post-Construction of the Santa Cruz Yacht Harbor Jetties and Pre-Capitola Jetty Construction



Capitola Beach

(Note: Almost no beach)

The Venetian

# Capitola 1960's

## Post-Construction of the Santa Cruz Yacht Harbor Jetties and Pre-Capitola Jetty Construction

