NAME: East Cliff Drive Pedestrian Improvements Phase III
APPLICATION: 111134
A.P.N: County Right-of-Way

NEGATIVE DECLARATION MITIGATIONS

1. In order to mitigate potential impacts to cormorants and other nesting birds, prior to site disturbance the project biologist will conduct preconstruction surveys for nesting birds. If active nests are present the biologist will establish buffer zones. The size of which will be determined based upon the species of birds. Work within the buffer zones will only proceed when birds have fledged.

2. In order to mitigate potential impacts due to unstable soils, prior to final approval, the recommendations contained in the geotechnical report, including construction of the wall with deep piers or piles or embedment of the wall into the bedrock platform or below design scour elevations, and proper design of engineered fills, shall be incorporated into the final design to reduce this potential hazard to a less than significant level.

3. In order to mitigate any potential noise-related impacts, the project will be required to include hours of operation for heavy construction machinery, restricting construction activities to after 8:30 am to minimize morning noise disturbance to surrounding residential uses. In addition, the contractor will be required to provide a noise notification sign alerting the public of the duration of the noise disturbance for this portion of the work.

4. In order to ensure adequate emergency and public access, one lane of traffic shall be maintained open. The lane may be temporarily closed for up to 20 minutes at a time as needed with traffic control in place.

County of Santa Cruz

PLANNING DEPARTMENT
701 OCEAN STREET, 4TH FLOOR, SANTA CRUZ, CA 95060
(831) 454-2580 FAX: (831) 454-2131 TDD: (831) 454-2123
KATHLEEN MOLLOY PREVISICH, PLANNING DIRECTOR
www.sccoplanning.com

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) ENVIRONMENTAL REVIEW INITIAL STUDY

Date: September 4, 2012 **Application Number:** 111134

Staff Planner: Sheila McDaniel

I. OVERVIEW AND ENVIRONMENTAL DETERMINATION

APPLICANT: County of Santa Cruz

APN(s): County Right-of-Way, APN 010-321-10 (Port District), 027-011-03, 11, 12, 13, 16 (Twin Lakes State Beach), 027-011-10 (Port District-Harbor Beach)

OWNER: County of Santa Cruz

SUPERVISORAL DISTRICT: 1st and 3rd

PROJECT LOCATION: The project is located within the East Cliff Drive public right-of-way between 5th Avenue and 7th Avenue adjacent to Twin Lakes State Beach, Harbor Beach, and the Santa Cruz Yacht Harbor within the Live Oak Planning area.

SUMMARY PROJECT DESCRIPTION: Proposal to complete roadway and roadside improvements within the East Cliff Drive public right-of-way between 5th and 7th Avenue to include parking and circulation improvements (vehicle, bicycle, and pedestrian) and a bluff protection structure on the south side of the right-of-way. The project includes the removal of a 24 inch Monterey Cypress tree, a 24 inch and a 26 inch Mexican Fan Palm tree, and multiple smaller trees. The project requires a Coastal Development Permit.

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED: All of the following potential environmental impacts are evaluated in this Initial Study. Categories that are marked have been analyzed in greater detail based on project specific information.

- ☒ Geology/Soils
- ☒ Hydrology/Water Supply/Water Quality
- ☒ Biological Resources
- ☐ Agriculture and Forestry Resources
- ☐ Mineral Resources
- ☒ Visual Resources & Aesthetics
- ☐ Cultural Resources
- ☐ Hazards & Hazardous Materials
- ☒ Noise
- ☒ Air Quality
- ☒ Greenhouse Gas Emissions
- ☐ Public Services
- ☒ Recreation
- ☐ Utilities & Service Systems
- ☐ Land Use and Planning
- ☐ Population and Housing

☒ Transportation/Traffic

☒ Mandatory Findings of Significance

DISCRETIONARY APPROVAL(S) BEING CONSIDERED:

☐ General Plan Amendment

☐ Land Division

☐ Rezoning

☐ Development Permit

☒ Coastal Development Permit

☐ Grading Permit

☐ Riparian Exception

☐ Other:

NON-LOCAL APPROVALS

Other agencies that must issue permits or authorizations:

California Coastal Commission Permit for work within the coastal jurisdiction area boundary to the mean high tide line

California State Parks right-of-entry encroachment permits for construction work

Santa Cruz Port District easements for construction on Harbor Beach

DETERMINATION: (To be completed by the lead agency)
On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☒ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

pln05

Matt Johnston

Matthew Johnston
Environmental Coordinator

9/10/2012
Date

II. BACKGROUND INFORMATION

EXISTING SITE CONDITIONS

Parcel Size: N/A, County right-of-way and beach area
Existing Land Use: County right-of-way, Harbor Beach, Twin Lakes State Beach
Vegetation: Area within and adjacent to right-of-way contains eucalyptus trees, cypress trees, palm trees, many smaller trees and shrubs, and groundcover along slopes
Slope in area affected by project: ☒ 0 - 30% ☐ 31 – 100%
Nearby Watercourse: Twin Lakes Beach, Schwan Lake outfall
Distance To: Adjacent to right-of-way

ENVIRONMENTAL RESOURCES AND CONSTRAINTS

Water Supply Watershed: Arana Rodeo
Groundwater Recharge: No
Timber or Mineral: No
Agricultural Resource: No
Biologically Sensitive Habitat: See attached Biotic Report
Fire Hazard: No
Floodplain: Yes
Erosion: Yes
Landslide: No
Liquefaction: Yes
Fault Zone: No
Scenic Corridor: Not mapped as a visual resource area, but generally considered scenic
Historic: No
Archaeology: Not mapped
Noise Constraint: No
Electric Power Lines: Yes
Solar Access: N/A
Solar Orientation: N/A
Hazardous Materials: No
Other:

SERVICES

Fire Protection: Central
School District: N/A
Sewage Disposal: County Sanitation
Drainage District: County Flood Control Zone 5
Project Access: East Cliff Drive Public right-of-way
Water Supply: Santa Cruz Water Department

PLANNING POLICIES

Zone District: PR and R-1-3.5, both to the center of the right-of-way
General Plan: Existing Parks and Recreation, Urban High Residential, both to the center of the right-of-way
Special Designation:

Urban Services Line: ☒ Inside ☐ Outside
Coastal Zone: ☒ Inside ☐ Outside

ENVIRONMENTAL SETTING AND SURROUNDING LAND USES:

The proposed project is located along East Cliff Drive between 5th and 7th Avenue, adjacent to Twin Lakes Beach and Harbor Beach within the Live Oak Planning Area. All references to Twin Lakes State Beach are hereafter considered to include Harbor Beach for the beach areas located between the centerline of 6th Avenue and the Santa Cruz Harbor east jetty.

East Cliff Drive is the main east/west coastal route between Capitola and Santa Cruz and provides two way access for vehicles, pedestrians and bicyclists to and from surrounding residential areas to the Santa Cruz Yacht Harbor and the beaches in the vicinity, including the California State Park Twin Lakes Beach.

This section of East Cliff Drive is a 60 foot to approximately 110 foot wide public right-of-way. Three streets intersect East Cliff Drive: 5th Avenue (one way), 6th Avenue and Assembly Avenue. 7Th Avenue intersects East Cliff Drive from the northeast. East Cliff Drive provides the only access to most residential properties adjoining the right-of-way. 6th Avenue and Assembly Avenue are two way streets, but are signed as "do not enter" from East Cliff Drive due to traffic circulation impacts to the neighborhood.

Roadway improvements on East Cliff Drive do not currently occupy the full right-of-way, with much of the right-of-way undeveloped. The right-of-way is constrained by steep slopes on the north side that extend upward and alongside residential properties, though a portion of the northern edge of the right-of-way toward 5th Avenue is at grade level. On the south side of the street there is a steep slope adjacent to and downward toward Twin Lakes Beach from the roadway. Driveways and private property improvements, such as landscaping, extend into the right-of-way and up to the edge of the roadway improvements, occupying the bulk of un-utilized right-of-way.

Parking and Circulation

East Cliff Drive is currently developed with two travel lanes and a narrow shoulder with informal parking along the north and south side of the street. Parked vehicles straddle the roadway shoulder and beach. Sidewalk and bicycle lanes are not provided and pedestrians and bicyclists share the roadway and shoulder with vehicles, which is not the most desirable situation.

Parking configuration varies between perpendicular, diagonal, and parallel style parking. On the north side of the street, vehicles generally park diagonally, though vehicles park perpendicularly at times. On the south side of the roadway vehicles generally park diagonally between the traffic circle and approximately Assembly Avenue. There are times when vehicles, especially recreational vehicles, parallel park along the south shoulder, which results in fewer diagonal or perpendicular parking spaces. Between approximately Assembly Avenue and the curve of East Cliff Drive vehicles generally parallel park due to steeper slopes adjacent to the Twin Lakes Beach restroom. Parking is restricted between 10 pm to 6 am.

As a result of variable parking conditions, the number of existing parking spaces along the beach fluctuates. Parking has been estimated between 20 and 30 spaces.

Existing Vegetation

There are many trees located within and adjacent to the public right-of-way in the project development area. An arborist report prepared by Nigel Belton, dated August 4, 2009, updated March 4, 2010, and July 30, 2012 document the location, species and size of all trees (Attachment 12). The most recent report provides a location map. There are a total of 26 existing trees and shrubs within close proximity to the improvements.

Larger tree species, equal to or greater than 20 inches in diameter, include three Blue Gum Eucalyptus trees (50 inch, 48 inch, and 42 inch diameter at breast height, dbh) located on the south side of East Cliff Drive across from 7th Avenue on State Park Property. There is an 84 inch dbh Monterey Cypress tree located on the boundary of the Carroll property at 2691 East Cliff Drive just south of the intersection of 7th Avenue and East Cliff Drive. There is a 20 inch, a 24 inch, and a 26 inch dbh Mexican Fan Palm located in front of the Wessbecher and Rivoir residence at 2601and 2615 East Cliff Drive located on the north side of East Cliff Drive east of 6th Avenue. There are two Monterey Cypress trees (a 24 inch, and a 48 inch dbh size) located on the north side of East Cliff Drive in close proximity to 6th Avenue and in front of the Wessbecher residence. A number of smaller trees and shrubs are scattered along the north side of East Cliff Drive around the 48 inch Monterey Cypress tree located adjacent to 6th Avenue and Assembly Avenue and in front of the Wessbecher property. There are also a number of smaller trees and shrubs on the north side of East Cliff Drive between 5th and 6th Avenue that fill the undeveloped right-of-way area between the existing roadway and residential properties. Ice plant covers portions of the beach on the south side, mostly along the slope adjacent to Twin Lakes Beach restroom.

Drainage

Existing drainage along the East Cliff Drive right-of-way generally drains along four drainage basins. Surface flows from 5th Avenue drain toward East Cliff Drive and west toward the harbor. Drainage flows between 6th Avenue and Assembly Avenue drain toward the east to an existing drainage culvert on the north side of the street that directs flows under East Cliff Drive to an outfall at Twin Lakes Beach. 7th Avenue flows drain in two directions, east along East Cliff Drive toward an existing 15 inch drainage pipe to an outlet at Twin Lakes Beach and across the street to an existing catch basin located on the south side of the roadway intersection.

PROJECT BACKGROUND

This roadway improvement project was originally proposed by the Public Works Department and Redevelopment Agency (prior to the elimination of the Redevelopment Agency) to improve pedestrian and bicycle access and safety, and formalize parking within the right-of-way where improvements are limited or not provided. Initially, the

pln056

Redevelopment Agency held community meetings for the Twin Lakes beachfront improvement project proposed on East Cliff Drive between 5th Avenue and 12th Avenue. Due to the complexity of the overall project, considerable community input, and ultimately a lack of community consensus on the beachfront portion of the project, the Agency divided the beachfront improvement project into three separate improvement projects, phases, if you will, so each segment could address the specific issues related to each and the Agency could provide additional community meetings as necessary. This resulted in the Lake and 5th Avenue improvement project (Phase 1), East Cliff Drive improvement project from 9th Avenue to 12th Avenue (Phase 2), and East Cliff Drive Improvement project from 5th Avenue to 9th avenue (Phase 3).

Phase 1, the Lake and 5th Avenue improvement project, was completed in 2003. Prior to construction of the Phase 2, 9th to 12th Avenue, the project funding was cut by the Redevelopment Agency in anticipation of the elimination of the Redevelopment Agency by the State of California. The project has been put on-hold unless funding becomes available in the future.

For Phase 3, between 5th Avenue to 9th Avenue, the Redevelopment Agency held three community meetings on September 27, 2007, January 10, 2008, and on May 1, 2008, where a consensus was achieved regarding roadway design alternatives. The Route Concept Plan was submitted to the Board of Supervisors and approved August 12, 2008 (Attachment 19). However, as a result of elimination of the Redevelopment Agency, construction funding was reduced by the Redevelopment Agency and the project scope has been revised from 5th Avenue to 7th Avenue instead of 5th to 9th Avenue as originally proposed.

DETAILED PROJECT DESCRIPTION:

The proposed project improvements are located within the East Cliff Drive public right-of-way, with exception of a construction area encroachment within the California State Parks property on Twin Lakes Beach and on Harbor Beach for construction of the bluff stabilization protection structure.

Right-of-way Improvements

On the south side of the street proposed improvements include the construction of a shoreline bluff protection structure from the 5th Avenue traffic circle to the vicinity of the Twin Lakes Beach restroom building location located south of 7th Avenue. Curb, gutter, and a six foot to approximately ten foot (in places) meandering sidewalk is proposed along the south side of the street. Fourteen diagonal parking spaces (including one handicapped space) and three parallel parking spaces are proposed on the south side. An accessible pathway is proposed from the traffic circle to Harbor Beach. A pedestrian stairway access to Twin Lakes Beach is proposed adjacent to the Twin Lakes Beach restroom.

On the north side of the street roadway improvements include curb, gutter, and an informal decomposed granite pathway between 5th and 6th Avenue and a 4 foot

sidewalk between 6th and Assembly Avenue. Curb cuts are proposed at existing residential driveways. Pedestrian crosswalks are proposed across 6th Avenue and across East Cliff Drive at 6th Avenue, across Assembly Avenue, and at the 7th Avenue and East Cliff Drive intersection. A three foot retaining wall is proposed behind the sidewalk east of 6th Avenue to address grade issues at the corner and to protect an existing Monterey Cypress tree. Four diagonal parking spaces are proposed on the north side of the street between 5th and 6th Avenue and two motorcycle spaces are proposed to the east of Assembly Avenue.

Drainage

The proposed drainage improvements include the installation of curb and gutter along the entire length of the roadway project, which will direct existing run-off to existing or proposed drainage facilities. The project includes the removal and replacement of an existing 15 inch drainage pipe located on the south side of East Cliff Drive that outfalls to Twin Lakes Beach, opposite the intersection of 7th Avenue and East Cliff Drive. Four additional drainage inlets and associated water quality treatment units are proposed on the north side of East Cliff Drive, east and west of 6th Avenue, and on the south side of East Cliff Drive across from 6th Avenue. Finally, an 18 inch water quality treatment unit is proposed on each side of two existing drainage catch basins located on the north and south side of East Cliff Drive. These improvements are proposed to re-route and improve water quality of existing flows before they runoff into Twin Lakes Beach, Harbor Beach, and Monterey Bay.

Grading

Overall project grading includes approximately 1158 cubic yards of cut and 2338 cubic yards of fill, which was determined by analysis of proposed versus existing road surface elevation. The volumes do not include asphalt and base rock removal, replacement of the existing roadway surface, or over-excavation and re-compaction of roadway materials. Plans show approximately 10,260 cubic yards excavation, of which 80 to 90 percent is beach sand, required for construction of bluff stabilization structure. This volume is proposed to be stock piled alongside the construction zone until it can be put back in place at the base of the structure.

A grading permit is not required for this project as Public Works Projects are exempt where the proposed work does not impact a mapped resource of hazardous or critical concern. No mapped resource has been identified at this location. Winter grading is proposed for this project due to biotic constraints and public access requirements of the State Parks Department.

Tree Removal/Protection

Of the 26 trees and shrubs within the project area, project plans call for preservation of 10 existing trees, which include most of the largest trees and a few small trees. Plans call for removal of 11 smaller trees and shrubs. Plans call for removal and replacement

pln956

of two existing trees, a 24 and a 26 inch dbh Mexican Fan Palms and one 24 inch Monterey Cypress tree, on a 3 to 1 basis. Replacement trees are proposed to be 15 gallon size. Plans also call for removal and relocation of two palm trees within the public right-of-way, one with two stems approximately 16 inches and 17 inches dbh and another 13.5 inch dbh size.

Landscaping and Site Amenities

The plans provide native perennials and grasses within all right-of-way areas that are un-utilized for parking, circulation, walkways, or driveways. Seat-wall islands located within the meandering walkway also provide native plantings. Seven New Zealand Christmas trees are proposed on the north side of the street and two Monterey Cypress trees are proposed on the south side of the street in proximity to the Twin Lakes Beach restroom.

III. ENVIRONMENTAL REVIEW CHECKLIST

A. GEOLOGY AND SOILS

Would the project:

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
A. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☒	☐
B. Strong seismic ground shaking?	☐	☐	☒	☐
C. Seismic-related ground failure, including liquefaction?	☐	☐	☒	☐
D. Landslides?	☐	☐	☒	☐

Discussion (A through D):

The project site is located outside of the limits of the State Alquist-Priolo Special Studies Zone (County of Santa Cruz GIS Mapping, California Division of Mines and Geology, 2001). However, this project is located in a seismically active region of northern California, as the October 17, 1989 earthquake amply demonstrated, and is relatively close to the San Andreas Fault. The Working Group on California Earthquake Probabilities[1] estimates that Northern California has a 30-year probability of 93% for the occurrence of an M≥6.7 earthquake, and a 15% probability of an M≥7.5 earthquake. The nearby San Andreas Fault by itself has a 30-year probability of 21% of generating an M≥6.7 earthquake. Very strong ground shaking is likely to occur at the site during the anticipated lifetime of the project and, therefore, proper grading, structural and foundation design is imperative. In addition to the San Andreas, other nearby fault systems capable of producing intense seismic shaking on this property include the San Gregorio, Zayante, Sargent, Hayward, Butano, and Calaveras faults,

[1] Working Group on California Earthquake Probabilities - Historic California Earthquake Catalog, 2007 Working Group on California Earthquake Probabilities, 2008, The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2): U.S. Geological Survey Open-File Report 2007-1437 and California Geological Survey Special Report 203 [http://pubs.usgs.gov/of/2007/1437/].

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

and the Monterey and Corralitos fault complexes.

Rogers E. Johnson prepared a geologic investigation, dated October 16, 1995 and an updated report, dated June 4, 2009 (Attachment 3). Haro, Kasunich and Associates prepared a geotechnical investigation, dated June 5, 2009 and an updated report, dated August 27, 2009 (Attachment 4). These reports have been reviewed and accepted by the Environmental Planning Section of the Planning Department (Attachment 5). The reports conclude that fault rupture would not be a potential threat to the proposed development, and that seismic shaking and liquefaction can be managed by constructing the wall with deep piers or piles, or embedment of the wall into the bedrock platform or below design scour elevations, and by following the recommendations in the geologic and geotechnical reports referenced above.

2. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☒	☐	☐

Discussion: The reports cited above concluded that there is a potential risk from liquefaction, shaking, settlement and scour of beach deposits by wave action that may result in wall failure as a result of the project. As recommended by the geotechnical engineer in the Geotechnical Review of Conceptual Project Plans, dated February 23, 2012 (Attachment 6) and the project engineering geologist in the Revised Preliminary Plan Review, dated February 21, 2012 (Attachment 7), additional subsurface exploration is recommended to be conducted along the entire seawall alignment of the project to determine depths to bedrock for project structural engineering design and construction planning to ensure that this potential risk is minimized.

The County Public Works Design Criteria require that all retaining walls adjacent to County right-of-way be designed in accordance with the California Building Code (CBC). The CBC has provisions that require structures to be designed to resist liquefaction and lateral spreading. The further geotechnical work that will be done as part of the construction design phase of the project will address these issues. Prior to construction the recommendations contained in the geotechnical report, including construction of the wall with deep piers or piles or embedment of the wall into the bedrock platform or below design scour elevations, and proper design of engineered fills, shall be incorporated into the final design plans to reduce this potential hazard to a less than significant level.

pln054

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
3. Develop land with a slope exceeding 30%?	☐	☐	☒	☐

Discussion: There are slopes that exceed 30% on the property on the south side of East Cliff Drive. However, proposed improvements will reinforce the slope and be designed to increase stability for the road and pedestrian improvements.

4. Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐

Discussion: An excavation and stockpile plan has been provided showing the volume and location of proposed stockpiles. In addition, an erosion control plan has been provided that includes provisions for protecting the stockpiled material and for disturbed areas to be planted with ground cover at the completion of the project. The existing site conditions include fill placed over a pre-existing coastal edge. The proposed project repair will mitigate increased coastal erosion which occurs due to the interception and dispersal of littoral sands by the harbor improvements (i.e. the jetties).

5. Be located on expansive soil, as defined in Section 1802.3.2 of the California Building Code (2007), creating substantial risks to life or property?	☐	☐	☐	☒

Discussion: There is no indication that the development site is subject to substantial risk caused by expansive soils.

6. Place sewage disposal systems in areas dependent upon soils incapable of adequately supporting the use of septic tanks, leach fields, or alternative waste water disposal systems where sewers are not available?	☐	☐	☒	☐

Discussion: No septic systems are required or proposed by the project. The project is a road improvement project.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
7. Result in coastal cliff erosion?	☐	☐	☒	☐

Discussion: The proposed project is for a coastal protection structure to reinforce the existing cliff overlooking Twin Lakes Beach and Harbor Beach and stabilize the roadway and pedestrian improvements. The project will not result in coastal cliff erosion as the wall will be designed to resist erosion as recommended by the project coastal engineer, engineering geologist and soils engineer. The proposed project will reduce existing erosion through stabilization of the cliff, drainage control, landscaping, and maintenance.

The sea wall has also been designed to dissipate wave energy, and will be aligned to follow the form of the existing coast line. At the ends, the wall will be tied into the harbor seawalls on the west and the existing bluff to the east. The project civil engineers have reviewed the design of the sea wall and have determined that in its proposed configuration the design will reduce coastal erosion without producing significant adverse reflection or refraction of waves.

B. HYDROLOGY, WATER SUPPLY, AND WATER QUALITY

Would the project:

1. Place development within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☒	☐

Discussion: According to the Federal Emergency Management Agency (FEMA) National Flood Insurance Rate Map, dated March 2, 2006, a portion of the project site lies within the special flood hazard area. Still water levels (SWLs) and total water levels (TWLs) were developed for the project area in an analysis prepared by Halcrow, Inc, dated August 1, 2011 (Attachment 8). The analysis, acceptable by FEMA standards (Attachment 9), states that the proposed improvements will not negatively impact existing adjacent properties and structures.

2. Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☒	☐

Discussion: According to the Federal Emergency Management Agency (FEMA) National Flood Insurance Rate Map, dated March 2, 2006, a portion of the project site lies within a 100-year flood hazard area. The proposed improvements are next to Twin Lakes Beach and will not impede flow or modify the geometry of the roadway in such a manner that redirects flood flows. In addition, the analysis by Halcrow, Inc. referenced in item 1 above states that the proposed improvements will not negatively impact

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

existing adjacent properties and structures. A plan review letter from Halcrow, Inc. has been provided, stating that the plans are consistent with the report's recommendations (Attachment 10).

3.	Be inundated by a seiche, tsunami, or mudflow?	☐	☐	☒	☐

Discussion: The proposed project is for a coastal protection structure to reinforce the existing cliff overlooking Twin Lakes Beach and Harbor Beach and stabilize the roadway and pedestrian improvements. There is a possibility that the proposed improvements would be inundated by a tsunami, however, the proposed improvements will not increase nor exacerbate this possibility. Rather, the coastal protection structure will provide better protection from a tsunami for the roadway and existing structures beyond it.

4.	Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☐	☐	☒

Discussion: The project does not require ground water and is not located in a mapped groundwater recharge area.

5.	Substantially degrade a public or private water supply? (Including the contribution of urban contaminants, nutrient enrichments, or other agricultural chemicals or seawater intrusion).	☐	☐	☐	☒

Discussion: The project would not discharge runoff either directly or indirectly into a public or private water supply.

6.	Degrade septic system functioning?	☐	☐	☐	☒

Discussion: There is no indication that existing septic systems in the vicinity would be affected by the project.

7.	Substantially alter the existing drainage pattern of the site or area,	☐	☐	☒	☐

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding, on- or off-site?

Discussion: Although the proposed project is located adjacent to the outfall of Schwan Lake, a coastal lagoon, the proposed project would not alter the existing overall drainage pattern of the site. The Department of Public Works Drainage Section staff has reviewed and approved the drainage calculations dated July 19, 2011 and November 22, 2011 (Attachment 11) and the proposed drainage plan included in the project plans. Public Works drainage comments are attached (Attachment 18).

8.	Create or contribute runoff water which would exceed the capacity of existing or planned storm water drainage systems, or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
9.	Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☒	☐

Discussion: The project is not located within proximity to a levee or dam.

10.	Otherwise substantially degrade water quality?	☐	☐	☒	☐

Discussion: The project includes the addition of water quality treatment units alongside two existing inlets along East Cliff Drive and the addition of water quality treatment units at each of the four proposed inlets in the vicinity of 6th Avenue. Public Works drainage comments (Attachment 18) note that the 18th inch square water quality treatment inlets are too small for maintenance by County maintenance. Plans will be conditioned to ensure that inlet size complies with the minimum standard to ensure that water quality may be maintained and significant impacts do not occur.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

C. BIOLOGICAL RESOURCES

Would the project:

1.	Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game, or U.S. Fish and Wildlife Service?	☐	☒	☐	☐

Discussion: A Biotic Report was prepared for this project by John Gilchrist and Brian Mori, dated January 29, 2010 (Attachment 16). This report has been reviewed and accepted by Matt Johnston, County Planning Department (Attachment 15). The biotic assessment identifies potential impacts to nesting birds, and recommends preconstruction surveys and buffer zones should active nests be present in the work area. In order to ensure impacts are less than significant, prior to site disturbance the project biologist will conduct preconstruction surveys for nesting birds. If active nests are present the biologist will establish buffer zones. The size of which will be determined based upon the species of birds. Work within the buffer zones will only proceed when birds have fledged.

2.	Have a substantial adverse effect on any riparian habitat or sensitive natural community identified in local or regional plans, policies, regulations (e.g., wetland, native grassland, special forests, intertidal zone, etc.) or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐

Discussion: No sensitive habitat has been identified within the project disturbance area. See attached Biotic Report, prepared for this project by John Gilchrist and Brian Mori, dated January 29, 2010 (Attachment 16).

3.	Interfere substantially with the movement of any native resident or migratory fish or wildlife species, or with established native resident or migratory wildlife corridors, or impede the use of native or migratory wildlife nursery sites?	☐	☐	☒	☐

Discussion: See C-1 for discussion.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
4. Produce nighttime lighting that would substantially illuminate wildlife habitats?	☐	☐	☒	☐

Discussion: The development area is adjacent to a small grove of eucalyptus trees, which are noted in the Biotic Report (Attachment 16) under C-1 to provide nesting habitat for a variety of nesting birds, including cormorants. The right-of-way development area is adjacent to residential development and existing power poles that generate nighttime lighting. The project does not propose additional street lighting and the will not adversely affect nesting habitat contained within the existing eucalyptus trees. The eucalyptus trees will be preserved by the project.

5. Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☒	☐

Discussion: Although the project site is within the vicinity of Schwan Lake, the project development improvements will not directly impact this wetland.

6. Conflict with any local policies or ordinances protecting biological resources (such as the Sensitive Habitat Ordinance, Riparian and Wetland Protection Ordinance, and the Significant Tree Protection Ordinance)?	☐	☐	☒	☐

Discussion: Pursuant to the County's significant tree protection ordinance, projects that involve removal of trees greater than 20 inches in diameter in the urban services line require a significant tree removal permit unless the tree removal is an exempt activity under 16.34.090. Any tree removal done pursuant to a valid discretionary permit approval authorized pursuant to Chapter 13.20 (Coastal Zone Permit), such as the proposed project, is exempt from the significant tree protection ordinance.

Pursuant to County Code Section 13.20.130, developers are encouraged to minimize removal of trees greater than six inches in diameter, with the exception of where circumstances require their removal for development of a building site. This would include tree removal required for development of public improvements within a public right-of-way.

An arborist report, prepared by Nigel Belton, dated August 4, 2009 and updated March

pln054

Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

24, 2010 and July 30, 2012 (Attachment 12) identifies the number of trees, species, size, location, health, and viability for relocation. A location map with photo documentation of the trees is included in the report for clarity.

The plans identify 26 trees and shrubs within the project area, most of which are located on the north side of East Cliff Drive between 5th and Assembly.

The project plans call for preservation of 10 existing trees, which will not be impacted by the project construction.

Plans call for removal and relocation of two palm trees within the public right-of-way, as recommended by the arborist, one with two stems approximately 16 inches dbh and 17 inch dbh and another at 13.5 inch dbh size tree. These trees are proposed to be relocated to the north side of East Cliff Drive, with one on the east and one on the west side of 6th Avenue.

Plans call for removal of 11 smaller trees and shrubs located within the improvement area. These are comprised of mostly non-native species between two inches in diameter at breast height (dbh) to nine inches dbh. Species include palm, yucca, lilac, banana, and juniper.

Plans calls for removal of three large trees, a 24 and a 26 inch dbh non-native Mexican Fan Palm and one 24 inch native Monterey Cypress tree within the roadway improvement area. In order to reduce impacts of removed trees, plans propose replacement of these three removed trees with nine 15 gallon size trees within the public right-of-way.

To compensate for the loss of trees within the right-of-way, seven New Zealand Christmas trees are proposed on the north side of the right-of-way between 6th and Assembly Avenue, and two native Monterey Cypress trees are proposed on the south side of the right-of-way located adjacent to the Twin Lakes restroom along the slope.

Subsequent to submittal of the revised project plans and in response to staff concerns about the potential for the proposed New Zealand Christmas tree species to damage the existing or proposed improvements, the applicant agreed to revise the species with a native species suitable to the location. Final tree selection shall be consistent with the Urban Forestry Master Plan street tree list and shall be reviewed and approved by staff prior to construction. Therefore, a mitigation measure is not required.

Notwithstanding the above determination that the removal of this 24 inch tree would not be a potentially significant impact, due to public comment, two alternative design options were considered as a means to evaluate the feasibility of retention of the 24 inch native Monterey Cypress tree, the largest and healthiest native tree required to be removed. See Tree Relocation Feasibility Report, prepared by Monarch Consulting LLC, dated August 31, 2012 (Attachment 13) for evaluation of these alternatives.

Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

One option would be to redesign the project to retain the tree in its existing location. The other option would be to relocate the tree.

Retention of the tree would require shifting the roadway improvements (sidewalk, bike lane and one travel lane), onto the beach by as much as 13 to 20 feet so that the recommended 13 foot minimum separation could be provided between the trunk and edge of pavement. This is a significant redesign that would no longer strictly follow the natural contours of the coast or be located fully within the right-of-way. The redesigned improvements would be located substantially south of the existing right-of-way and on the beach. This would significantly narrow the beach area available to the public, compromise the scenic integrity of the open beach, and potentially affect the location of the Port District dredge line, and operation of the Port District's yacht harbor dredging, sand removal, and deposition onto Harbor Beach and Twin Lakes Beach. This option is considered to result in greater impacts to the environment than removal of the 24 inch tree and is thus undesirable as a design option.

Staff also considered placing the sidewalk behind the 24 inch dbh Monterey Cypress tree toward the Wessbecher property, but this option would require additional retaining walls due to topographic differences between the proposed roadway, tree, and walkway. This grade difference appears to require a sidewalk slope in excess of the maximum two percent slope allowed for accessibility. This option would also provide insufficient area between the trunk and edge of improvements based on tree protection requirements and is therefore not considered a feasible option.

The tree relocation option was thoroughly evaluated by the Tree Relocation Feasibility Report, prepared by Richard Gessner of Monarch Consulting Arborists, dated August 30, 2012 (Attachment 13). It evaluates the viability of relocating the 24 inch Monterey Cypress tree proposed for removal. This analysis was requested by the Planning Department in order to address community correspondence (Attachment 20) given the large size, health, and structure of the tree.

It determined that the 24 inch dbh Monterey Cypress tree would be suitable for relocation given the age, health, structure, and viability for survival. The most feasible transplant location would be approximately 35 to 40 feet to the northwest, in the location of the existing mature 48 inch dbh Monterey Cypress tree located on the east side of 6th Avenue adjacent to the Wessbecher property. This 48 inch tree is in poor health and has poor structure and is described to have a "low suitability for preservation" by the arborist report (Attachment 12) and would be a good location for the 24 inch Monterey Cypress tree. However, given the size and maturity of the tree, project plans propose to retain the 48 inch tree. Tree protection measures consistent with the arborist report would be employed during construction to ensure the maximum tree protection. In addition, a tree transplant cost estimate prepared by Environmental Designs, undated (Exhibit 14), to relocate the existing 24 inch Monterey Cypress tree to this spot is approximately $98,000. This is considered an excessive and unreasonable expense when the proposed replacement species will grow to equal the

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

height of the removed tree; especially when there is no guarantee that the relocated tree will survive.

On balance, removal of this tree and others within the roadway improvement area of the public right-of-way is in greater conformance with the coastal design criteria and provides greater environmental protection than redesigning to protect it and relocating improvements onto the beach. While the coastal design criteria encourage retention of trees over six inches in height, this section specifically allows for tree removal where necessary to facilitate permitted development such as the proposed roadway and roadside improvements in a public right of way. As currently designed, the shoreline protection structure will provide protection of existing improvements by locating improvements almost entirely within the public right-of-way, following the natural shoreline, except where necessary to tie into the purisima bedrock below natural sand grade. A redesigned project to protect this tree and others along the north side would result in more significant environmental impacts to the shoreline and be in greater conflict with shoreline protection policies.

Given limited right-of-way area available for roadway and roadside improvements, it is understood that tree removal cannot be completely avoided, but the project design retains and relocates the largest trees, where feasible and consistent with the recommendations of the arborist reports. Where infeasible to protect or relocate existing trees, the project includes replacement trees for removed species.

Plans call for replacement of larger trees, those greater than 20 inches in diameter, on a three to one ratio, which has been a ratio encouraged by the Planning Department in the past. However, the tree replacement ratio is not an ordinance standard. Typically, trees subject to the significant tree ordinance are recommended to be replaced on a three to one ratio where feasible, and trees subject to the coastal zone protection requirements are recommended to be replaced on a 1 to 1 ratio where feasible. The context and nature of the project site guide the appropriate replacement ratio. In this case, the applicant's proposed nine replacement trees is on the high side and thus the impact on biological resources is not considered a potentially significant impact. No mitigation is required.

7.	Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☒

Discussion: The proposed project would not conflict with the provisions of any adopted Habitat Conservation Plan Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan. Therefore, no impact would occur.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

D. AGRICULTURE AND FOREST RESOURCES

In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment Project; and forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Board. Would the project:

1.	Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒

Discussion: The project site does not contain any lands designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency. In addition, the project does not contain Farmland of Local Importance. Therefore, no Prime Farmland, Unique Farmland, Farmland of Statewide or Farmland of Local Importance would be converted to a non-agricultural use. No impact would occur from project implementation.

2.	Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒

Discussion: The project site is a public right-of-way, which is not considered to be an agricultural zone. Additionally, the project site's land is not under a Williamson Act Contract. Therefore, the project does not conflict with existing zoning for agricultural use, or a Williamson Act Contract. No impact is anticipated.

3.	Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code Section 12220(g)), timberland (as defined by Public Resources Code Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104(g))?	☐	☐	☐	☒

Discussion: The project is not adjacent to land designated as Timber Resource.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
4. Result in the loss of forest land or conversion of forest land to non-forest use?	☐	☐	☐	☒

Discussion: No forest land occurs on the project site or in the immediate vicinity. No impact is anticipated.

5. Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use?	☐	☐	☐	☒

Discussion: The project site and surrounding area is located within an urban area and does not contain any lands designated as Prime Farmland, Unique Farmland, Farmland of Statewide Importance or Farmland of Local Importance as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency. Therefore, no Prime Farmland, Unique Farmland, Farmland of Statewide, or Farmland of Local Importance would be converted to a non-agricultural use. Therefore, no impacts are anticipated.

E. MINERAL RESOURCES

Would the project:

1. Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒

Discussion: The site does not contain any known mineral resources that would be of value to the region and the residents of the state. Therefore, no impact is anticipated from project implementation.

2. Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒

Discussion: The project site is located within a public right-of-way, which is not considered to be an Extractive Use Zone (M-3) nor does it have a Land Use Designation with a Quarry Designation Overlay (Q) (County of Santa Cruz 1994). Therefore, no potentially significant loss of availability of a known mineral resource of locally important mineral resource recovery (extraction) site delineated on a local general plan, specific plan or other land use plan would occur as a result of this project.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
F. VISUAL RESOURCES AND AESTHETICS Would the project:				
1. Have an adverse effect on a scenic vista?	☐	☐	☒	☐
Discussion: See item 3 below.				
2. Substantially damage scenic resources, within a designated scenic corridor or public view shed area including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☒	☐
Discussion: See item 3 below.				
3. Substantially degrade the existing visual character or quality of the site and its surroundings, including substantial change in topography or ground surface relief features, and/or development on a ridgeline?	☐	☐	☒	☐

Discussion: Although the project is not mapped within a protected scenic resource area, as identified and mapped in the General Plan, the project is located along the coast and provides views of the surrounding ocean, coastal bluff, Twin Lakes State Beach, Harbor Beach, and Schwan Lagoon by pedestrians and vehicle occupants. While County visual resource protection regulations only apply to public view sheds, coastal protection ordinances require that improvements within the coastal zone be designed to be visually compatible and integrated with the area, to minimize site disturbance, and to retain all mature trees over 6 inches in diameter where feasible. Project improvements are proposed within the East Cliff Drive right-of-way and within very small portions of Twin Lakes State Beach and Harbor Beach. The proposed improvements will provide enhanced public views of the lake and ocean, which is a beneficial impact of the project.

The project includes a bluff stabilization structure along the south side of the right-of-way that follows the natural topography of the coastal bluff and mimics the natural character of the bedrock. Visual simulations provided by the applicant show the appearance of the bluff stabilization structure upon construction. The proposed improvements provide neutral earth tone materials and colors intended to blend the improvements with the surroundings. No significant visual impacts are anticipated by the proposed bluff stabilization structure.

The project includes the removal of a 24 inch Monterey Cypress, a 24 and a 26 inch Palm tree, and removal of multiple smaller trees scattered on the north side of the roadway, and recommended pruning of Eucalyptus trees. The plans provide nine 15

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

gallon replacement trees, seven of which are in the vicinity of the majority of removed Monterey Cypress, Palm trees, and smaller trees located on the north side of the street. The proposed replacement species will compensate for the loss of trees and will improve the visual character of the existing street front. The replacement of removed trees along the north side of the street will result in minor changes to the existing visual environment as the replacements will not be located in the exact location of existing trees. However, they are in the general location of most of the removed species and will therefore not result in a significant aesthetic impact to the environment.

4.	Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☒	☐

Discussion: The project does not propose additional light poles or include additional lighting on existing street poles and will therefore not adversely affect day or nighttime views in the area.

G. CULTURAL RESOURCES

Would the project:

1.	Cause a substantial adverse change in the significance of a historical resource as defined in CEQA Guidelines Section 15064.5?	☐	☐	☐	☒

Discussion: There are no existing structures within the right-of-way. Therefore the project would not affect a historical resource.

2.	Cause a substantial adverse change in the significance of an archaeological resource pursuant to CEQA Guidelines Section 15064.5?	☐	☐	☒	☐

Discussion: No archeological resources have been identified in the project area. Pursuant to County Code Section 16.40.040, if at any time in the preparation for or process of excavating or otherwise disturbing the ground, any human remains of any age, or any artifact or other evidence of a Native American cultural site which reasonably appears to exceed 100 years of age are discovered, the responsible persons shall immediately cease and desist from all further site excavation and comply with the notification procedures given in County Code Chapter 16.40.040.

3.	Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☒	☐

Discussion: Pursuant to Section 16.40.040 of the Santa Cruz County Code, if at any time during site preparation, excavation, or other ground disturbance associated with

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

this project, human remains are discovered, the responsible persons shall immediately cease and desist from all further site excavation and notify the sheriff-coroner and the Planning Director. If the coroner determines that the remains are not of recent origin, a full archeological report shall be prepared and representatives of the local Native California Indian group shall be contacted. Disturbance shall not resume until the significance of the archeological resource is determined and appropriate mitigations to preserve the resource on the site are established.

4.	Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☒	☐

Discussion: None have been identified on site.

H. HAZARDS AND HAZARDOUS MATERIALS

Would the project:

1.	Create a significant hazard to the public or the environment as a result of the routine transport, use or disposal of hazardous materials?	☐	☐	☐	☒

Discussion: The project does not involve the transport or use of hazardous materials.

2.	Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☐	☒

Discussion: See Item H.1, above.

3.	Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒

Discussion: See Item H.1, above.

4.	Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

Discussion: The project site is not included on the list of hazardous sites in Santa Cruz County compiled pursuant to the specified code.

5.	For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒

Discussion: No airport is located within close proximity to the site.

6.	For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒

Discussion: See H. 5 above.

7.	Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☒

Discussion: The proposed road widening, pedestrian sidewalk, improved bicycle lanes and diagonal parking areas will not impair emergency response or emergency evacuation and may have a beneficial impact for pedestrian evacuation.

8.	Expose people to electro-magnetic fields associated with electrical transmission lines?	☐	☐	☒	☐

Discussion: The project proposes to relocate existing electric poles. However, no new electrical transmissions lines are proposed as part of this project. This would result in a less than significant impact.

9.	Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☒	☐

Discussion: The project design incorporates all applicable fire safety code requirements and includes two additional fire hydrants in the final design plans as required by the local fire agency.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

I. TRANSPORTATION/TRAFFIC

Would the project:

1.	Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?	☐	☐	☒	☐

Discussion: The proposed project does not conflict with an applicable plan, ordinance or any policies regarding traffic circulation as the proposed improvements are intended to improve existing traffic safety and circulation and not expected to generate significant additional traffic or traffic impacts, including bicycle traffic or traffic safety, as a result of roadway improvements. Proposed improvements will result in greater compliance with the arterial street improvement standards consistent with the Public Works Design Criteria, which require two travel lanes, sidewalk on both sides of the street, and bicycle lanes, and improve traffic and pedestrian safety. See comments of Jack Sorhiakoff, Department of Public Works Traffic Engineering, dated June 14, 2006 and August 31, 2012 (Attachment 22). These comments are incorporated here.

2.	Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒

Discussion: There are no impacts to air traffic.

3.	Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☒	☐

Discussion: The proposed project provides improvements within the East Cliff Drive right-of-way between 5th Avenue and 7th Avenue that address the lack of road and roadside improvements. The roadway currently has two travel lanes and a narrow shoulder on the south side that provides informal and irregular parking that fluctuates between diagonal parking, perpendicular parking, and parallel parking. Parked vehicles must straddle the limited shoulder and beach. The north side shoulder is significantly

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

wider than on the south in places and vehicles park diagonally and perpendicularly there as well. The current roadway design results in vehicles, pedestrians and bicyclists sharing the road and shoulder.

The project proposes to provide two travel lanes, two bicycle lanes, a four foot walkway on the north side of the street where feasible, an approximately six to ten foot sidewalk on the south side, pedestrian crosswalks, diagonal parking, accessible access to the beach, landscaping, and drainage improvements.

In order to reduce conflicts between road users, the improvements are designed to County Design Criteria standards. They are an improvement to the existing roadway design and provide greater traffic safety and will create a beneficial impact. The proposed improvements will improve traffic safety to all users because sidewalk and bicycle lanes will be provided. See comments of Jack Sorhiakoff, Department of Public Works, dated June 14, 2006 and August 31, 2012 (Attachment 22) with regard to traffic safety. These comments are incorporated here.

4.	Result in inadequate emergency access?	☐	☒	☐	☐

Discussion: It is anticipated that one lane of traffic would be temporarily closed during hours of construction operations. Public Works standard procedure requires the contractor to implement a traffic control and local detour plan to the Public Works Department for written approval a minimum of 5 days prior to construction. Full closure of the road would interfere with emergency access. In order to mitigate impacts to emergency access, one lane of traffic is required to remain open at all times so that fire trucks, ambulances and other emergency vehicles will not be blocked from using the road at any time. Implementation of these construction practices will ensure that emergency access and/or traffic circulation impacts are less than significant.

5.	Cause an increase in parking demand which cannot be accommodated by existing parking facilities?	☐	☐	☒	☐

Discussion: The project is not subject to parking requirements since it is a pedestrian, bicycle, and roadway improvement project that will not create new uses that generate additional parking needs.

Roadway improvements are proposed along East Cliff Drive between 5th and 7th Avenue. This area currently provides informal parking along the shoulder of the roadway, with vehicles occasionally parking mostly on the beach, due to limited, developed right-of-way area. Roadway improvements will improve traffic, circulation, public safety, and maximize parking where feasible.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
6. Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities?	☐	☐	☒	☐

Discussion: Figure 3-6 of the Circulation Element of the County General Plan identifies East Cliff Drive as an arterial street. The Circulation Element requires roadways to be developed meeting the County Design Criteria. The standard for urban arterial streets establishes a minimum of two 12 foot travel lanes, two five (5) foot bicycle lanes, and six foot sidewalk on either side. A six to ten foot pedestrian pathway is provided on the south side, which provides improved public access along the coast. Sidewalks are limited to four foot sections on the north side where feasible and appropriate due to topographic challenges.

Parking alongside the roadway provides existing public access to the coast. The General Plan and Local Coastal Program policies require both traffic safety as well as protection of coastal access for visitor serving recreation uses of Twin Lakes Beach. The proposed project, on balance, meets the objectives of the General Plan and County Design Criteria to provide improved traffic safety while also improving public parking for access to the coast and recreational uses.

See Item 3 above for additional discussion regarding vehicle, bicycle, and pedestrian safety.

The proposed project is in conformance with the General Plan Bikeway System objectives and policies in that bicycle lanes are identified on East Cliff Drive by the County Bicycle Plan and are provided in the project design. The proposed project is consistent with the Recreation System Development policies 3.8.7, 3.8.9, and 3.8.11 in that the project proposes bicycles lanes for access to the beach recreation area, "utilizes the available right-of-way where possible", and provides pathways for public enjoyment and scenic vistas where feasible.

The proposed arterial street improvement project for this segment of East Cliff Drive has been designed to conform to the County Design Criteria by provision of two travel lanes, two bicycle lanes, and sidewalk within the county right-of-way. See comments from Jack Sorhiakoff, Department of Public Works, dated June 14, 2006 and August 31, 2012, (Attachment 22). These comments are incorporated here.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
7. Exceed, either individually (the project alone) or cumulatively (the project combined with other development), a level of service standard established by the County General Plan for designated intersections, roads or highways?	☐	☐	☒	☐

Discussion: See response I-1 above.

J. NOISE

Would the project result in:

1. A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒

Discussion: The project will not create a permanent incremental increase in the existing noise environment as the project is a roadway improvement project and does not involve on-going noisy operations.

2. Exposure of persons to or generation of excessive ground borne vibration or ground borne noise levels?	☐	☒	☐	☐

Discussion: Project construction involves saw cutting of pavement, which is a temporary noise impact that will disturb pedestrians and surrounding residential uses. In order to mitigate for this noise impact, the project includes a mitigation measure requiring hours of operation restricting these saw cutting construction activities to after 8:30 am to minimize morning noise disturbance. In addition, the contractor will be required to provide a noise notification sign alerting the public of the duration of the noise disturbance for this portion of the work. These measures will reduce the potential impacts to pedestrians and surrounding residential uses to less than significant.

3. Exposure of persons to or generation of noise levels in excess of standards established in the General Plan or noise ordinance, or applicable standards of other agencies?	☐	☒	☐	☐

Discussion: See item J.2 above.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
4. A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐

Discussion: Noise generated during construction would increase the ambient noise levels for adjoining areas. Construction would be temporary, however, and given the limited duration of this impact it is considered to be less than significant.

5. For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒

Discussion: The project is not located within an airport land use plan area.

6. For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒

Discussion: The project is not located within an airport land use plan area.

K. AIR QUALITY

Where available, the significance criteria established by the Monterey Bay Unified Air Pollution Control District (MBUAPCD) may be relied upon to make the following determinations. Would the project:

1. Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☒	☐

Discussion: The North Central Coast Air Basin does not meet State standards for ozone and particulate matter (PM_{10}). Therefore, the regional pollutants of concern that would be emitted by the project are ozone precursors (Volatile Organic Compounds [VOCs] and nitrogen oxides [NO_x]), and dust.

The project will not result in any long term increases in pollutants because the project is intended as a roadway and pedestrian improvement project and is not expected to generate additional traffic that might result in new emissions of VOCs or NO_x pollutants and therefore there will not be a significant contribution to an existing air quality violation.

plm05.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

Project construction may result in a short-term, localized decrease in air quality due to generation of dust. However, standard dust control best management practices, such as periodic watering, are required to be implemented during construction to reduce impacts to a less than significant level. This is regulated by the Regional Air Quality Control Board Permit required prior to construction. Thus, no mitigation measures are required.

2.	Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐

Discussion: The project will not conflict with or obstruct implementation of the regional air quality plan. See K-1 above and P.1.

3.	Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☐	☐	☒	☐

Discussion: See K1 above.

4.	Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐

Discussion: See K1 above.

5.	Create objectionable odors affecting a substantial number of people?	☐	☐	☒	☐

Discussion: The on-going operation does not involve objectionable odors.

L. GREENHOUSE GAS EMISSIONS

Would the project:

1.	Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	☐	☐	☒	☐

Discussion: The proposed project, like all development, would be responsible for an incremental increase in green house gas emissions by usage of fossil fuels during the site grading and construction. At this time, Santa Cruz County is in the process of developing a Climate Action Plan (CAP) intended to establish specific emission reduction goals and necessary actions to reduce greenhouse gas levels to pre-1990 levels as required under AB 32 legislation. Until the CAP is completed, there are no specific standards or criteria to apply to this project. All project construction equipment

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

would be required to comply with the Regional Air Quality Control Board emissions requirements for construction equipment. As a result, impacts associated with the temporary increase in green house gas emissions are expected to be less than significant.

2.	Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	☐	☐	☒	☐

Discussion: See the discussion under L-1 above. No impacts are anticipated.

M. PUBLIC SERVICES

Would the project:

1.	Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:				
	a. Fire protection?	☐	☐	☐	☒
	b. Police protection?	☐	☐	☐	☒
	c. Schools?	☐	☐	☐	☒
	d. Parks or other recreational activities?	☐	☐	☐	☒
	e. Other public facilities; including the maintenance of roads?	☐	☐	☒	☐

Discussion (a through e): The project will potentially result in the need for new or physically altered improvements on Port District's Harbor Beach to replace and/or restore Port District facilities currently located in areas proposed for bluff stabilization and pedestrian walkways. The proposed project proposes to provide pedestrian improvements at the traffic circle that will connect with and coincide with the existing

pln056

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

Harbor Beach improvements recently constructed by the Port District. Temporary disruption of the existing improvements will occur during construction. Both temporary construction impacts and proposed alterations for bluff stabilization and pedestrian improvements alongside the right-of-way within Harbor Beach are expected to be less than significant. The improvements will result in improved access and circulation to the Twin Lakes Beach and Harbor Beach and improved fire and police protection as a result of improved roadway standards. See correspondence from the Santa Cruz Port District (Attachment 20), dated May 15, 2012 and July 31st, 2012.

N. RECREATION

Would the project:

1.	Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☒	☐

Discussion: The project is a roadway and roadside improvement project that addresses the need for improved parking, pedestrian, and bicycle access to existing coastal recreational uses at Twin Lakes Beach and the Harbor. The project will address needed public safety improvements and deteriorated public facilities, which is a beneficial impact.

2.	Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☐	☐	☐	☒

Discussion: The project is a roadway and roadside improvement project that addresses the need for improved parking, pedestrian and bicycle access to existing coastal recreational uses at Twin Lakes Beach and the Harbor. The project will address needed public safety improvements and deteriorated public facilities, which is a beneficial impact.

O. UTILITIES AND SERVICE SYSTEMS

Would the project:

1.	Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☒	☐

Discussion: Drainage reports prepared by rrmdesigngroup, dated July 19, 2011 and November 22, 2011 (Attachment 11) provides additional drainage inlets and siltation

pln056

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact

traps intended to improve the quality of the water treatment provided to existing run-off. The project does not result in an appreciable increase in run-off. Department of Public Works drainage staff has reviewed the drainage information and have determined that downstream storm facilities are adequate to handle the small increase in drainage associated with the project (Attachment 18).

2.	Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒

Discussion: The project does not involve or require connection to an existing municipal water supply because the project is a road improvement project. Per the attached project plans, municipal water lines will not be affected as a result of project construction.

The project does not require municipal sewer service. Per the Sanitation District comments (Attachment 18), the plans have been reviewed and approved as proposed.

3.	Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒

Discussion: The project will not result in any wastewater flows.

4.	Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒

Discussion: The project does not involve or require water supplies since it is a road improvement project.

5.	Result in determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒

Discussion: The project is a road improvement project and does not involve wastewater use.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
6. Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐

Discussion: Per the Grading Report, prepared by rrmdesigngroup, dated July 19, 2011 (Attachment 17), the project requires grading of 1158 cubic yards of cut and 2338 cubic yards of fill, with an overall 1180 cubic yards of fill. Any required off-haul is required to be taken to the County landfill, which currently has adequate capacity for the project's disposal requirements.

A grading permit is not required for this project as Public Works projects are exempt where the proposed work does not impact a mapped resource of hazardous or critical concern. No mapped resource has been identified at this location. See Biotic Report (Attachment 16).

7. Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐

Discussion: Adequate capacity exists for any required off-haul.

P. LAND USE AND PLANNING

Would the project:

1. Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☒	☐

Discussion: The Port's District's dredging operations, including some of the structures required for dredging operations, are governed by a coastal permit issued by the California Coastal Commission. The District and County staff have been reviewing the project construction process to minimize the impacts of the project construction on the District's permitted activities. The Port District submitted written correspondence, dated, May 15, 2012 and July 31st, 2012 (Attachment 20) providing their support of the proposed project noting that it does not appear that the proposed project will interfere with their coastal permit or air quality permit requirements. However, they have requested that a construction easement be obtained prior to construction. This is a standard requirement for projects involving off-site construction activities. Therefore, a mitigation measure is not required.

	Potentially Significant Impact	Less than Significant with Mitigation Incorporated	Less than Significant Impact	No Impact
2. Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒

Discussion: The project is not located within a habitat conservation plan or natural community conservation plan area.

3. Physically divide an established community?	☐	☐	☐	☒

Discussion: The project would not include any element that would physically divide an established community.

Q. POPULATION AND HOUSING

Would the project:

1. Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☒	☐

Discussion: The proposed project would not induce substantial population growth in an area because the roadway improvement project does not propose any physical or regulatory change that would remove a restriction to or encourage population growth in an area including, but limited to the following: new or extended infrastructure or public facilities; new commercial or industrial facilities; large-scale residential development; accelerated conversion of homes to commercial or multi-family use; or regulatory changes including General Plan amendments, specific plan amendments, zone reclassifications, sewer or water annexations; or LAFCO annexation actions.

The proposed project would not extend the road or increase its capacity.

2. Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

Discussion: The proposed project would not displace any existing housing since the site is a roadway and does not contain housing.

3. Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☒	☐

Discussion: The proposed project would not displace a substantial number of people since the site is an existing roadway and does not contain housing.

R. MANDATORY FINDINGS OF SIGNIFICANCE

	Potentially Significant Impact	Less than Significant with Mitigation	Less than Significant Impact	No Impact
1. Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☒	☐	☐

Discussion: The potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory were considered in the response to each question in Section III of this Initial Study. Resources that have been evaluated as significant include mitigation measures that clearly reduce these effects to a level below significance. These mitigation measures are identified in the body of the report. They address potential impacts to cormorants, impacts from potentially unstable soils, and potential noise related impacts, and traffic impacts during construction. As a result of this evaluation, there is no substantial evidence that, after mitigation, significant effects associated with this project would result. Therefore, this project has been determined not to meet this Mandatory Finding of Significance.

	Potentially Significant Impact	Less than Significant with Mitigation	Less than Significant Impact	No Impact
2. Does the project have impacts that are individually limited, but cumulatively considerable? ("cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☒	☐

Discussion: In addition to project specific impacts, this evaluation considered the projects potential for incremental effects that are cumulatively considerable. As a result of this evaluation, there were no impacts that were determined to be potentially significant cumulative effects, including to transportation and traffic. Therefore, this project has been determined not to meet this Mandatory Finding of Significance.

	Potentially Significant Impact	Less than Significant with Mitigation	Less than Significant Impact	No Impact
3. Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☒	☐	☐

Discussion: In the evaluation of environmental impacts in this Initial Study, the potential for adverse direct or indirect impacts to human beings were considered. As a result of this evaluation, there is no substantial evidence that, after mitigation, there are adverse effects to human beings associated with this project. These mitigation measures are identified in the body of the report. They address the potential impacts from potentially unstable soils, and potential noise related impacts, and potential traffic impacts. See body of initial study for recommended mitigation measures. Therefore, this project has been determined not to meet this Mandatory Finding of Significance.

IV. REFERENCES USED IN THE COMPLETION OF THIS ENVIRONMENTAL REVIEW INITIAL STUDY

County of Santa Cruz 1994 *General Plan and Local Coastal Program for the County of Santa Cruz, California*. Adopted by the Board of Supervisors on May 24, 1994, and certified by the California Coastal Commission on December 15, 1994.
Santa Cruz County GIS Mapping System, Planning Department Web Site
2010 Santa Cruz County Regional Transportation Plan
Volume II of the Zoning Ordinance
County Public Works Design Criteria

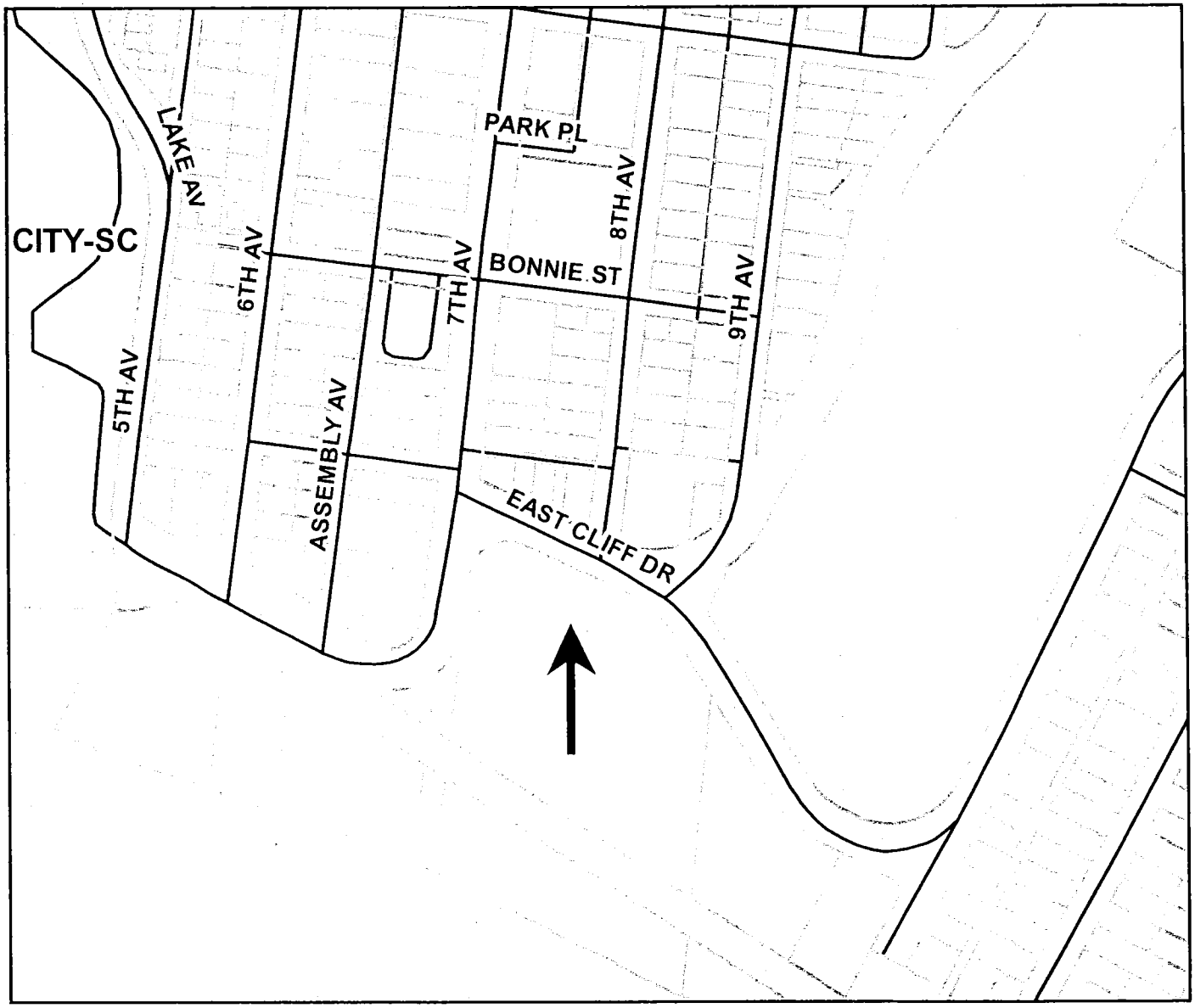
V. ATTACHMENTS

Report attachments include excerpts only (full report available on file at the Planning Department and on-line at the Planning Department web site)

1. Vicinity Map, Map of Zoning Districts, Map of General Plan Designations, Assessor's Parcel Map
2. Project Plan Sheets 1.1, 2.1, 3.1, 4.1, 5.1A, 6.1, 7.1, 8.1, 8.2, prepared by rrmdesigngroup, dated August 23, 2012
3. Updated Geologic Investigation by Rogers E. Johnson, dated June 4, 2009
4. Geotechnical Investigation by Haro, Kasunich and Associates, dated June 5, 2009 and revised August 27, 2009
5. Report Review by Joe Hanna, County Geologist, dated October 17, 2011 of the Halcrow Sea Wall Design Report, dated August 1, 2011; Engineering Geology Report by Rogers E. Johnson and Associates, dated June 4, 2009; and, Geotechnical Engineering Report by Haro, Kasunich, and Associates, dated June 5, 2009 and revised August 27, 2009
6. Geotechnical Review of Conceptual Project plans by Haro, Kasunich and Associates, Inc., dated February 23, 2012
7. Revised Preliminary Plan Review dated February 21, 2012 by Rogers E. Johnson and Associates
8. Halcrow Sea Wall Design Report, dated August 1, 2011
9. FEMA Plan Review, dated January 18, 2012 of the Halcrow Seawall Design Report, dated August 1, 2011
10. Design Development Plan Review by Halcrow, dated February 23, 2012
11. Drainage calculations prepared by rrmdesigngroup, dated July 19, 2011 and November 22, 2011
12. Arborists Report prepared by Nigel Belton, dated August 4, 2009, updated March 4, 2010, and July 30, 2012
13. Tree Relocation Feasibility Report, prepared by Monarch Consulting Arborists LLC, dated August 31, 2012
14. Tree transplant estimates, by Environmental Design, Inc., undated
15. Biotic Report Review Letter prepared by Matt Johnston, County Planning Department, dated September 16, 2011
16. Biotic Report prepared by John Gilchrest and Associates, dated January 29, 2010
17. Grading Report, prepared by rrmdesigngroup, dated July 2011
18. Discretionary Application Comments

19. Board of Supervisors Route Concept Letter, dated August 12, 2008
20. Public Correspondence
21. Response to public correspondence by Joe Hanna, dated August 1, 2012, of the Cotton, Shires and Associates letter, dated May 16, 2012
22. Response to public correspondence by Jack Sorhiakoff, Department of Public Works, dated June 14, 2006 and August 31, 2012, of the Traffic and Civil Engineering Consulting Services, dated May 16, 2012

Location Map



340 170 0 340 680 1,020 1,360 Feet

LEGEND

Assessors Parcels

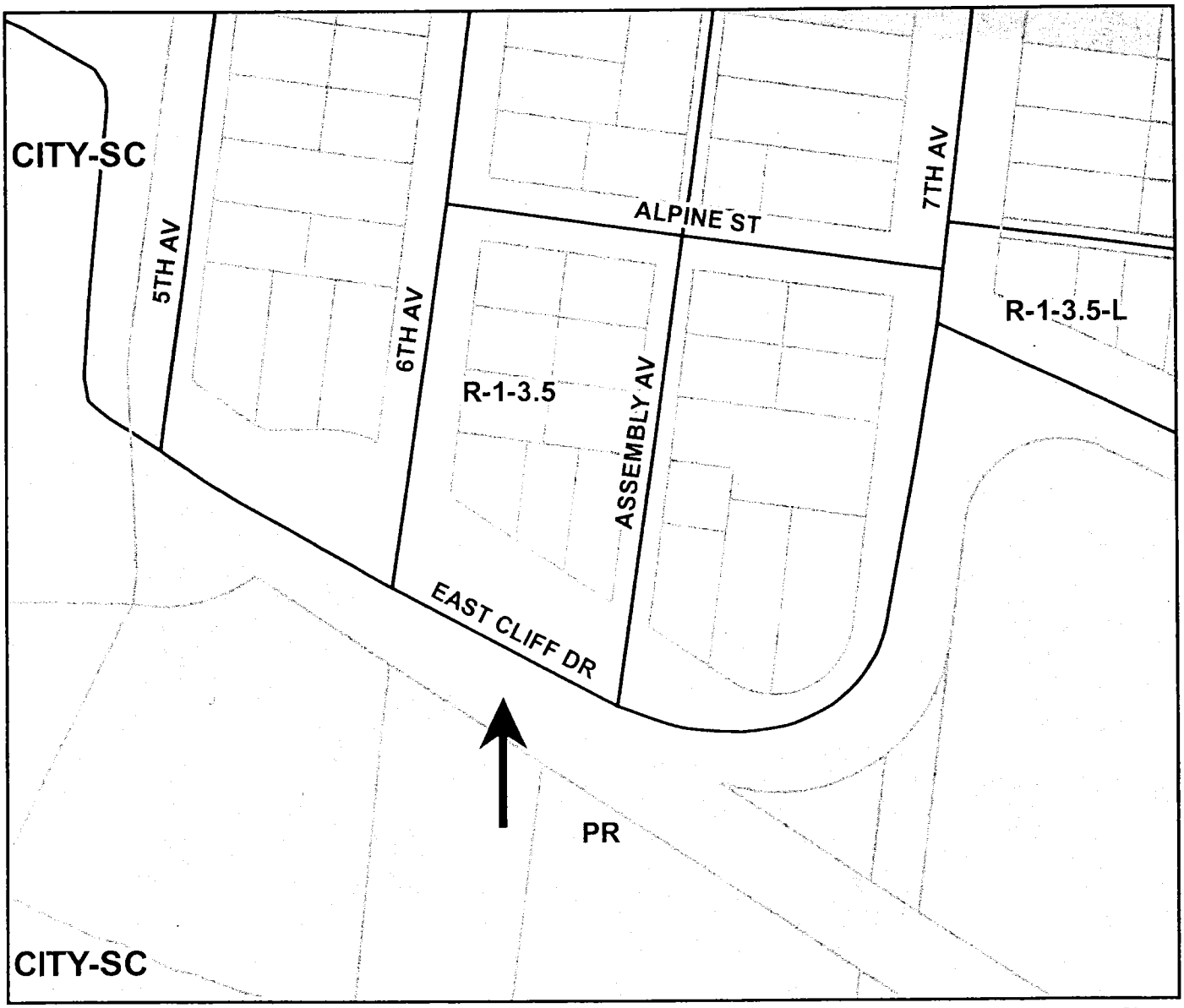
Streets

SANTA CRUZ

N W E S

Map Created by
County of Santa Cruz
Planning Department
August 2011

Zoning Map



140 70 0 140 280 420 560 Feet

LEGEND

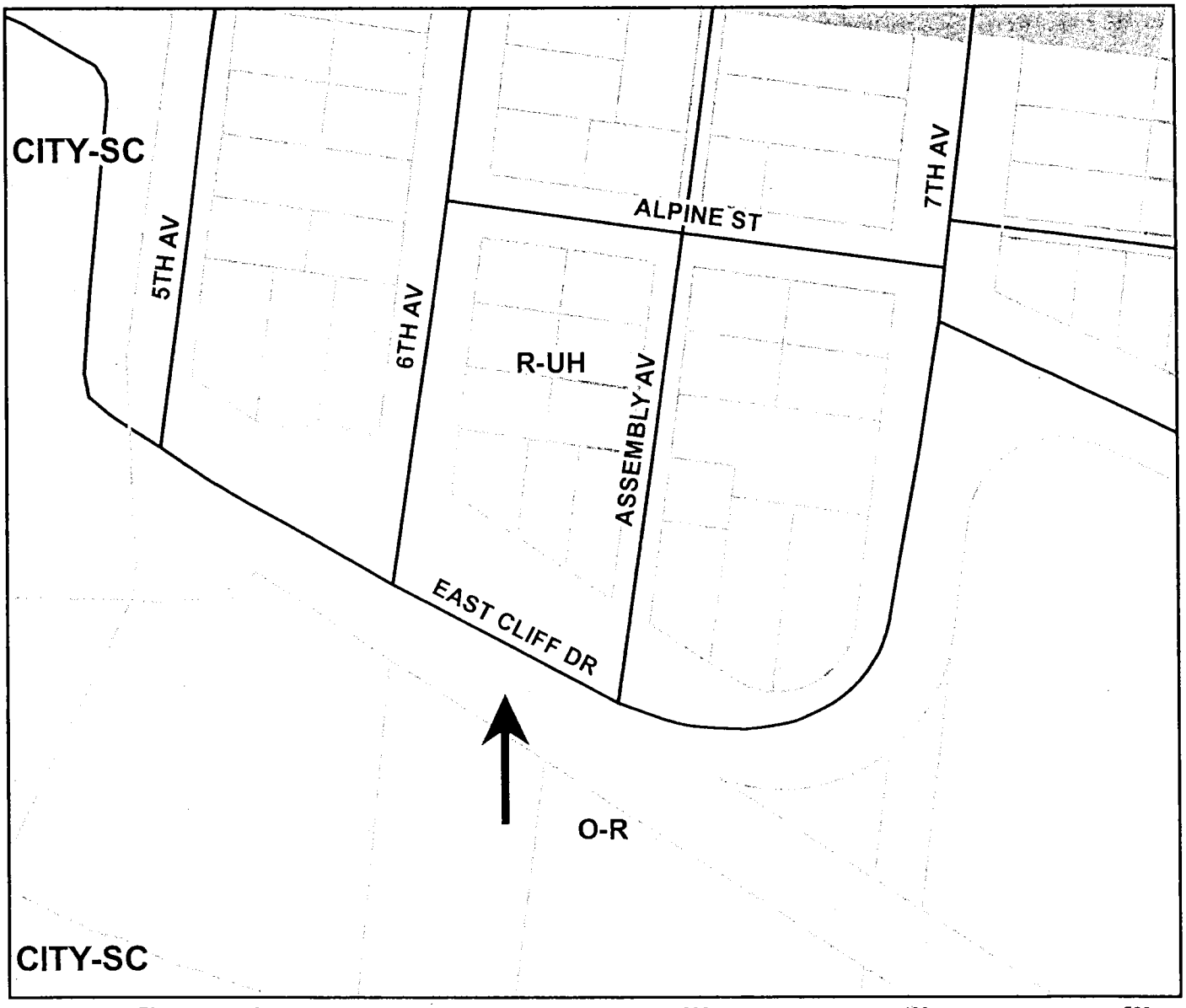
- Assessors Parcels
- Streets
- SANTA CRUZ
- RESIDENTIAL-SINGLE FAMILY
- PARK
- COMMERCIAL-NEIGHBORHOOD

N
W E
S

Map Created by
County of Santa Cruz
Planning Department
August 2011

ATTACHMENT 1

General Plan Designation Map



140 70 0 140 280 420 560 Feet

LEGEND

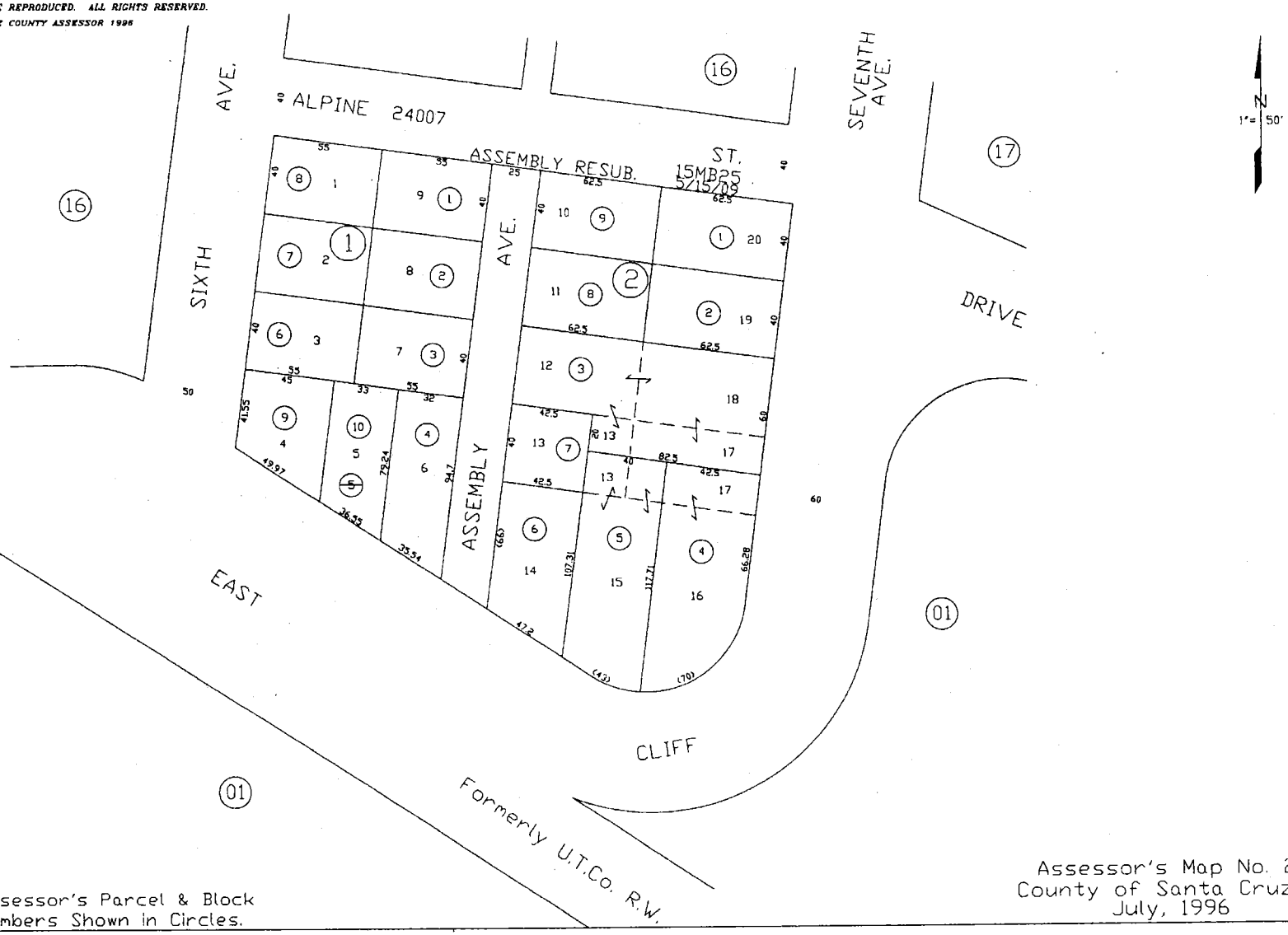
- Assessors Parcels
- Streets
- SANTA CRUZ
- Residential - Urban High Density
- Parks and Recreation

N W E S

Map Created by
County of Santa Cruz
Planning Department
August 2011

FOR TAX PURPOSES ONLY PTR. OF N.W.1/4 SEC. 20, T.11S., R.1W., M.D.B. & M. Tax Area Code 82-040 27-18

THE ASSESSOR MAKES NO GUARANTEE AS TO MAP ACCURACY NOR ASSUMES ANY LIABILITY FOR OTHER USES. NOT TO BE REPRODUCED. ALL RIGHTS RESERVED.
© COPYRIGHT SANTA CRUZ COUNTY ASSESSOR 1996



Note - Assessor's Parcel & Block Numbers Shown in Circles.

Assessor's Map No. 27-18
County of Santa Cruz, Calif
July, 1996

Electronically Rearrawn 1/9/97 rw
Rev. 4/22/98 GG (EA consolidation)
Rev. 4/3/01 nvm (changed page refs.)

ATTACHMENT 1

COUNTY OF SANTA CRUZ DEPARTMENT OF PUBLIC WORKS

PERMIT REVIEW PLANS FOR CONSTRUCTION OF

PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

5th Avenue to 7th Avenue

PROJECT DIRECTORY

APPLICANT
County of Santa Cruz Department of Public Works
701 Ocean Street, Room 410 — Phone 831 454 2160
Santa Cruz, CA 95060 — Fax 831 454 2385
Betsey Lynberg, Project Administrator
Sheryl Bailey, Project Manager

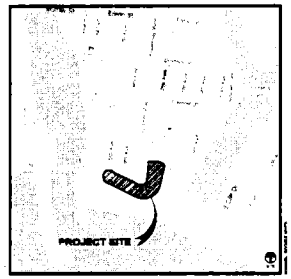
AGENT
Vanir Construction Management
4540 Duckhorn Drive, Suite 300 — Phone 916 575 8888
Sacramento, CA 95834 — Fax 916 575 8887
James R. Aboytes, Project Manger

LANDSCAPE ARCHITECT
RRM Design Group
3765 South Higuera Street, Suite 102 — Phone 805 543 1794
San Luis Obispo, CA 93401 — Fax 805 543 4609
Mike Sherrod, Project Manger

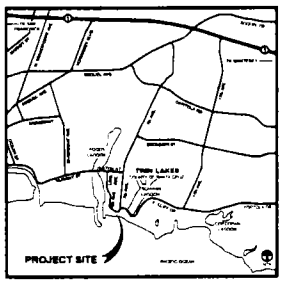
CIVIL ENGINEER
RRM Design Group
3765 South Higuera Street, Suite 102 — Phone 805 543 1794
San Luis Obispo, CA 93401 — Fax 805 543 4609
Jerry Michael P.E.

COASTAL ENGINEER
Haleiron Inc
5740 Fleet Street, Suite 120 — Phone 760 444 1130
Carlsbad, CA 92008 — Fax -
Claudio Fassetti

STATE OF CALIFORNIA



LOCATION MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE

ABBREVIATIONS

@	AT
ACP	ASPHALTIC CONCRETE
ADT	ABSORBENT
AGG	AGGREGATE
ALT	ALTERNATE
APPROX/APR	APPROXIMATE
B.O. / BOC	BACK OF CURB
BLDG	BUILDING
B.W.	BACK OF WALK
C.I.	CAST IRON
C&G	CURB AND GUTTER
CB	CATCH BASIN
CF	CUBIC FOOT
CIP	CAST IN PLACE
CL	CENTERLINE
CLR	CLEAR
CMU	CONCRETE MASONRY UNIT
CMP	CORRUGATED METAL PIPE
CO	CLEAN OUT
CONC	CONCRETE
CONST	CONSTRUCTION
CONT	CONTINUOUS, CONTINUE
CP	CENTER POINT
CTR	CENTER
DET	DETAIL
DI	DRAIN INLET
DIA	DIAMETER
DW	DRIVEWAY
DWY	DRIVEWAY
EA	EACH
EL or ELEV	ELEVATION
EQ	EQUAL
E.O.P.	EDGE OF PAVEMENT
EXIST	EXISTING
FL, FLG	FLASHING
F.C. / FOC	FRONT OF CURB
FC	FINISHED GRADE
FDN	FOUNDATION
FL	FLOWLINE
FP	FINISHED SURFACE OF PAVING/SURFACING
FTG	FOOTING
GAS	GAS
GB	GRADE BREAK
HDPE	HIGH DENSITY POLYETHYLENE
HP	HIGH POINT
LOC	LOCATION
MAX	MAXIMUM
MIN	MINIMUM
MISC	MISCELLANEOUS
N	NORTH
NTS	NOT TO SCALE
OC	ON CENTER
P.L.	PROPERTY LINE
POC	POINT OF CURVATURE
PP	POWER POLE
PROP	PROPOSED
PUE	PUBLIC UTILITIES EASEMENT
PVMT/PVMNT	PAVEMENT OR PAVING
R, RAD	RADIUS
RCP	REINFORCING PIPE
REF	REFERENCE
REINF	REINFORCE
REVISED, REVISED	REVISED, REVISED
ROW	RIGHT OF WAY
S	SOUTH
SAN CUT	SAN CUT
SD	STORM DRAIN
SDCB	STORM DRAIN CATCH BASIN
SDMH	STORM DRAIN MANHOLE
SQ FT	SQUARE FEET
SHT	SHEET
SQUARE	SQUARE
SS	SANITARY SEWER
SSMH	SANITARY SEWER MANHOLE
STA	STATION
STD	STANDARD
SURFACE	SURFACE
SW	SIDEWALK
TC	TOP OF CURB
TF / TOF	TOP OF FOOTING
TW	TOP OF WALL
TYP	TYPICAL
W	WEST
WATER	WATER
WM	WATER METER
WV	WATER VALVE
@	AT
℄	CENTERLINE

SHEET INDEX

1.1	TITLE SHEET
2.1	EXISTING CONDITIONS
3.1	SITE PLAN
4.1	ACCESSIBILITY PLAN
5.1	GRADING PLAN
5.1A	EXCAVATION AND STOCKPILE PLAN
6.1	EROSION CONTROL PLAN
7.1	LANDSCAPE PLAN
8.1	SITE SECTIONS
8.2	SITE SECTIONS

PROJECT DESCRIPTION

The primary goal of the Twin Lakes Beachfront Project is to provide for pedestrian and bicycle access along East Cliff Drive from 5th Avenue to 7th Avenue, and also to provide surrounding neighborhood access. In addition, the project will provide an upgraded storm drainage system, organized parking spaces, discontinuation of the roadside and pathway edge, while at the same time beautifying these changes to protect this beachfront shoreline and natural surroundings.

PROJECT BENCHMARK

County Benchmark 66
EL=18.66 (NGVD 29 Unadjusted)
Brass Disc in Concrete
Located 1' NE of Arnold M. Baldwin dedication plaque in the lands onbund between Lots 101 N from 'L' of East Cliff Drive at easterly edge of 6th Avenue

DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

RRM DESIGN GROUP COPYRIGHT 2011
RRM is a California Corporation

Santa Cruz County
Department of Public Works
701 Ocean St., Room 410,
Santa Cruz, CA 95060

rrm group
creating environments people enjoy
3765 South Higuera St., Ste. 102, San Luis Obispo, CA 93401
P (805) 543-1794 | F (805) 543-4609 | www.rrmdesign.com

PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

TITLE SHEET

DESIGNED BY	HS
DRAWN BY	JK
CHECKED BY	HS
DATE	August 23, 2012
JOB NUMBER	1309513
SHEET	1.1

ATTACHMENT 2

PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

EXISTING CONDITIONS

rrm group

creating environments people enjoy

Santa Cruz County Department of Public Works
701 Ocean St., Room 410, Santa Cruz, CA 95060

1309513

2.1

EXISTING CONDITIONS

ATTACHMENT 2

NOTE REGARDING EXISTING TREES:

* EXISTING TREE SYMBOL AND ASSOCIATED NUMBER PER ARBORIST REPORT DATED 9/23/12. SEE REPORT FOR DETAILED INFORMATION REGARDING TREES

EXISTING TREE SUMMARY

TREE/ SHRUB #	COMMON NAME	ACTION
1	EUCALYPTUS	PROTECT IN PLACE
2	EUCALYPTUS	PROTECT IN PLACE
3	EUCALYPTUS	PROTECT IN PLACE
4	MONTEREY CYPRESS	PROTECT IN PLACE
5	MYOPORUM	PROTECT IN PLACE
6	BANANA	PROTECT IN PLACE
7	YUCCA	REMOVE
8	WINDMILL PALM	REMOVE
9	WINDMILL PALM	REMOVE
10	WINDMILL PALM	REMOVE
11	HOLLYWOOD JUNIPER	REMOVE
12	BANANA	REMOVE
13	YUCCA	REMOVE
14	MEXICAN FAN PALM	REMOVE AND REPLACE AT 3:1 RATIO
15	MONTEREY CYPRESS	REMOVE AND REPLACE AT 1:1 RATIO
16	MEXICAN FAN PALM	RELOCATE WITHIN PUBLIC RIGHT-OF-WAY
17	CORDYLINE	REMOVE
18	WINDMILL PALM	REMOVE
19	MEXICAN FAN PALM	REMOVE AND REPLACE AT 3:1 RATIO
20	MEXICAN FAN PALM	PROTECT IN PLACE
21	MONTEREY CYPRESS	PROTECT IN PLACE
22	BANANA	REMOVE
23	YUCCA	PROTECT IN PLACE
24	WINDMILL PALM	RELOCATE WITHIN PUBLIC RIGHT-OF-WAY
25	QUEEN PALM	PROTECT IN PLACE
26	CALIFORNIA LILAC	REMOVE

PROJECT SUMMARY TABLE

ITEM	QUANTITY
PROJECT AREA	74,866 SF
EXISTING IMPERVIOUS SURFACE AREA	44,827 SF
PROPOSED IMPERVIOUS SURFACE AREA	66,364 SF
CUT VOLUME	1,556 CY
FILL VOLUME	7,334 CY
OVER-EXCAVATION & RECOMPACTION	756 CY

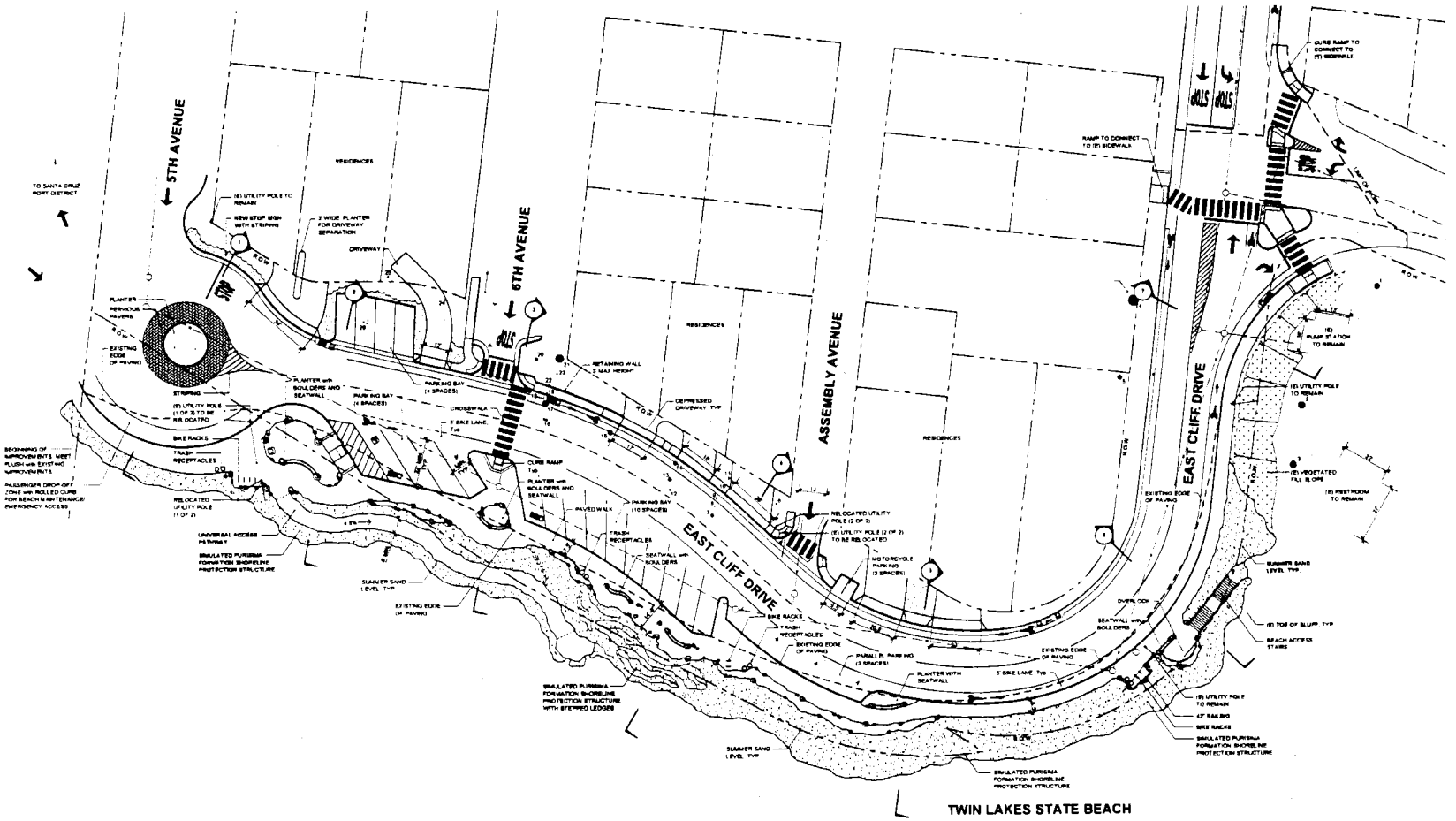
PARKING SUMMARY

PARKING SPACES*	70
ACCESSIBLE PARKING SPACES	4
MOTORCYCLE PARKING SPACES	2
TOTAL PARKING SPACES	73

* DOES NOT INCLUDE LOADING ZONES / SHORT TERM PARKING SPACES

GENERAL NOTES:

1. FOR LANDSCAPE ELEMENTS INCLUDING SITE FURNISHINGS MATERIALS AND PLANTING INFORMATION SEE SHEET 7.1
2. SEE SHEETS S.1 - S.2 FOR SITE SECTIONS



SITE PLAN

SCALE 1"=20'

NORTH

DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

Santa Cruz County
Department of Public Works
701 Ocean St., Room 410,
Santa Cruz, CA 95060

rrm group
creating environments people enjoy

PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

SITE PLAN

NO.	REVISION	DATE

August 23, 2012

1309513

3.1

PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

ACCESSIBILITY PLAN

rrm group

creating environments people enjoy®

Santa Cruz County Department of Public Works
701 Ocean St., Room 410, Santa Cruz, CA 95060

1309513

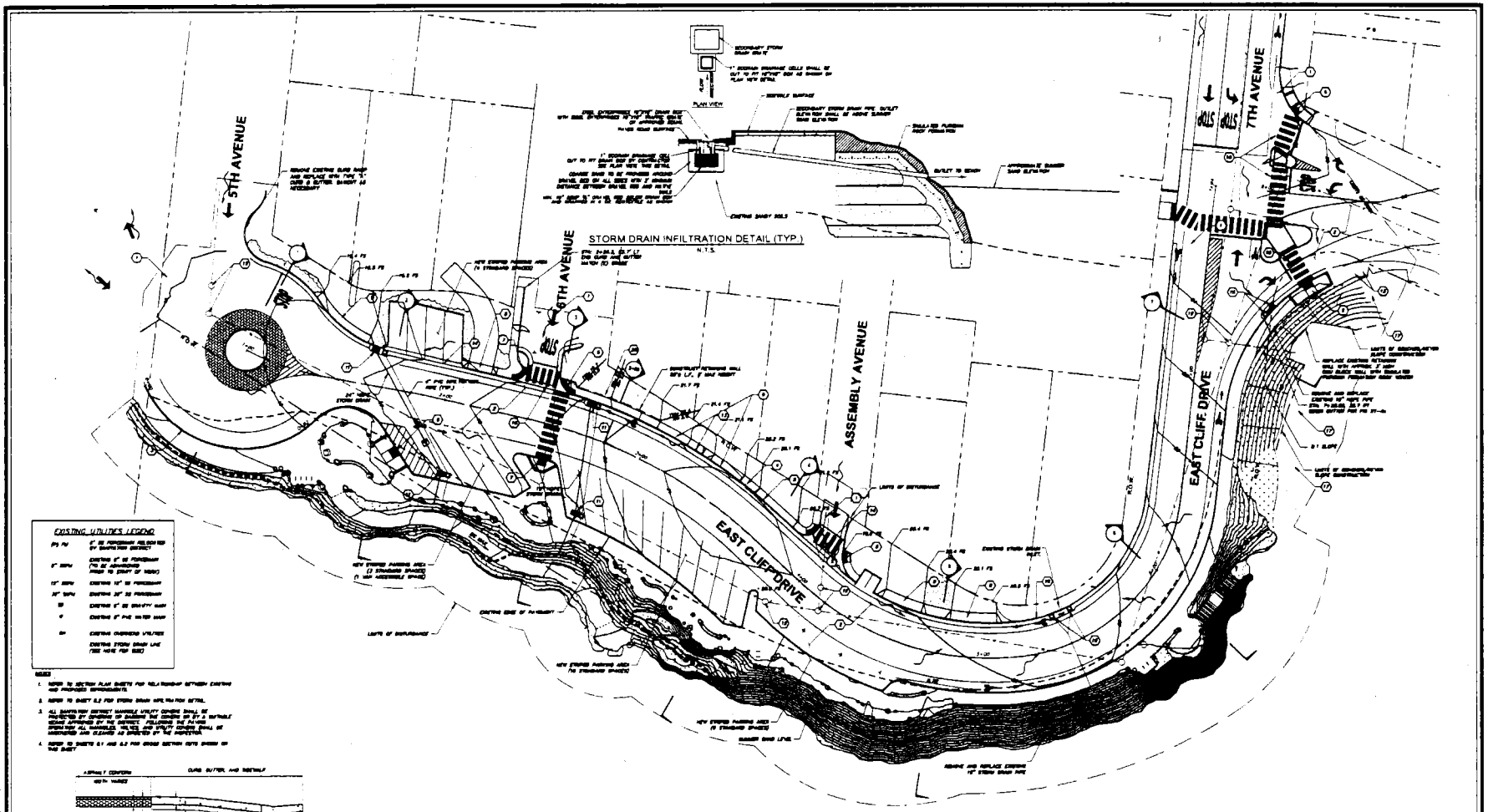
4.1

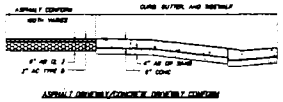
ACCESSIBILITY PLAN

DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

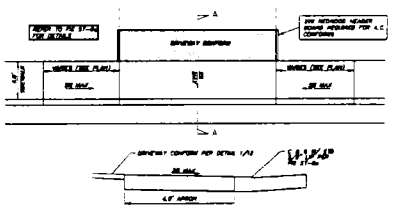
ATTACHMENT 2

pln056

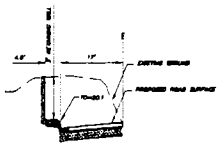




TYPICAL DRIVEWAY CONFORMS
N.T.S.



FULLY DEPRESSED DRIVEWAY APRON
N.T.S.



SECTION - STA: 2+80.00

CONSTRUCTION NOTES

GRADING PLAN

SCALE 1"=20'

NORTH

DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

Santa Cruz County
Department of Public Works
701 Ocean St., Room 410,
Santa Cruz, CA 95060

rrm group
creating environments people enjoy®

PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

GRADING PLAN

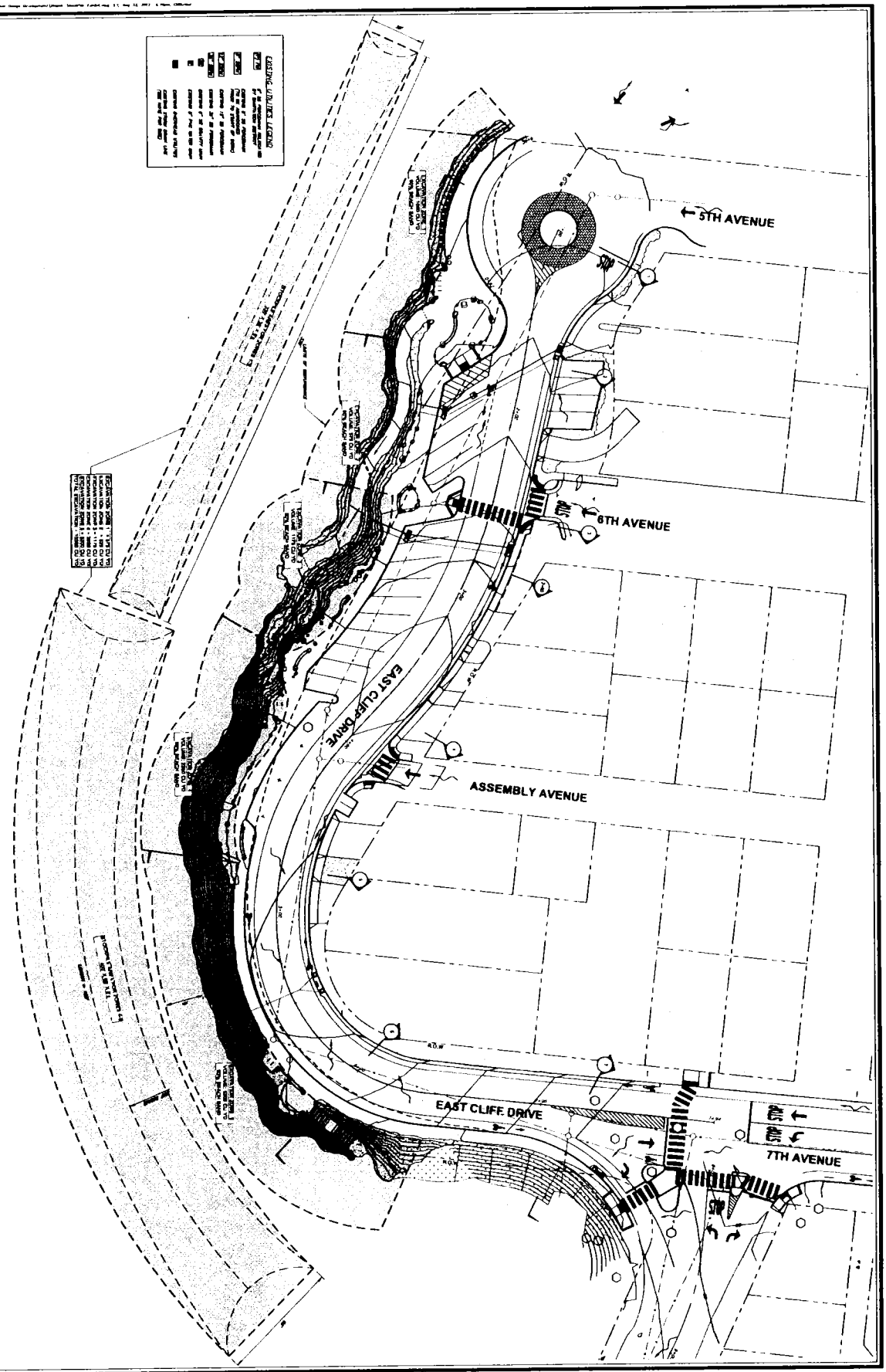
August 23, 2012

1309513

5.1

CONFIDENTIAL

EXCAVATION AND STOCKPILE PLAN

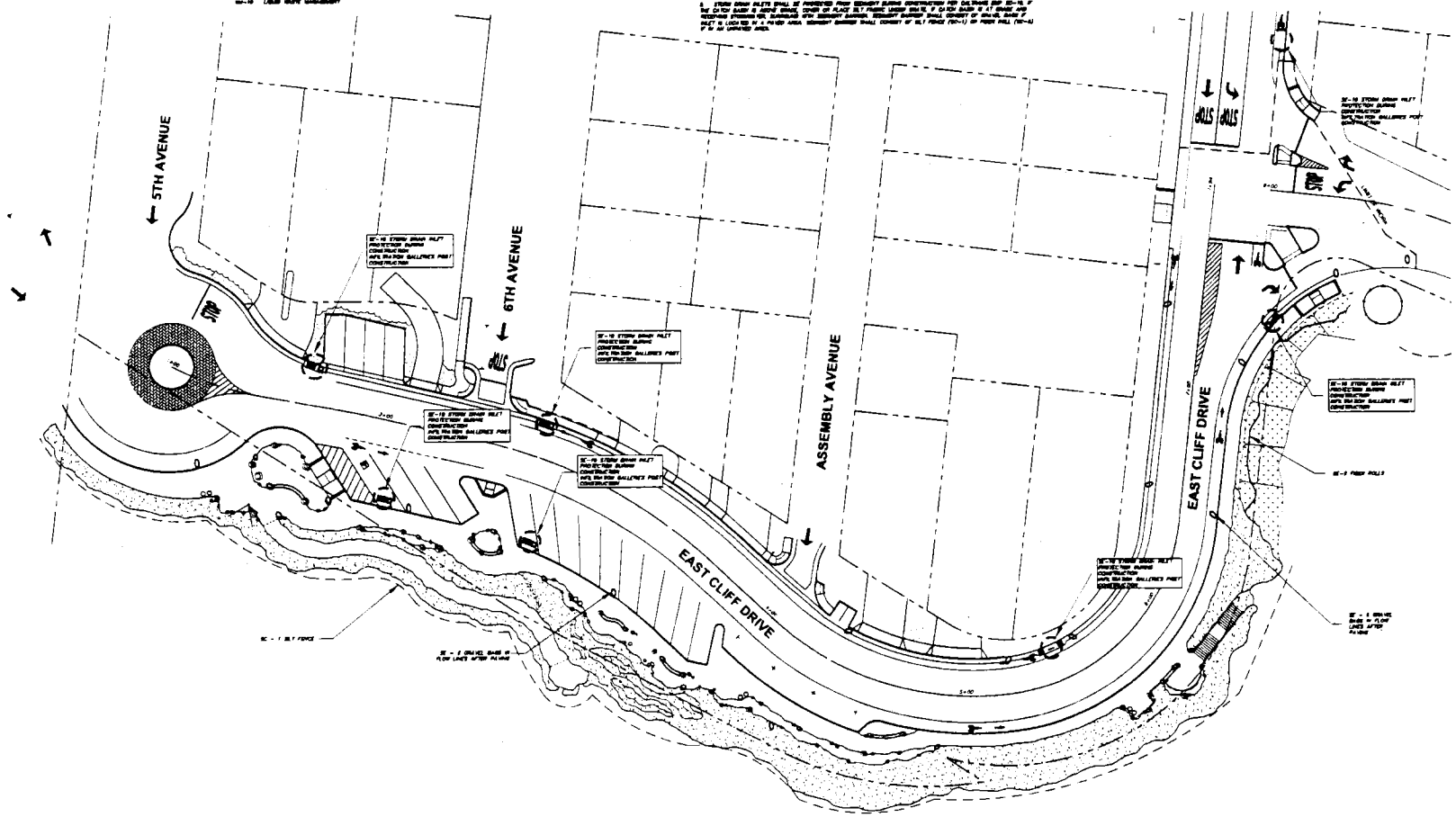


DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

5.1A	PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT EXCAVATION AND STOCKPILE PLAN	rrm group creating environments people enjoy®	Santa Cruz County Department of Public Works 701 Ocean St., Room 410, Santa Cruz, CA 95060	

BMP NOTE:

EROSION CONTROL MEASURES



EROSION CONTROL PLAN

SCALE 1"=20'

NORTH

DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

EROSION CONTROL PLAN

August 23, 2012

1309513

6.1

Santa Cruz County
Department of Public Works
701 Ocean St., Room 410,
Santa Cruz, CA 95060

rrm group
creating environments people enjoy®

ATTACHMENT 2

CONCEPTUAL PLANT LEGEND - TREES

	NEW TREES	QTY
	Cupressus macrocarpa / Monterey Cypress	7
	Metrosideros excelsus / New Zealand Christmas Tree	1
	TOTAL NEW TREES: 8	
	TOTAL REQUIRED REPLACEMENT TREES: 9 *	
	RELOCATED TREES	
	See Arborist Report for Species	2
	TOTAL REQUIRED RELOCATED TREES: 2 *	
	EXISTING TREES TO BE PROTECTED IN PLACE	
	See Arborist Report for Species	10

* Requirement per Arborist Report dated 8/23/12

CONCEPTUAL PLANT LEGEND - SHRUBS

NATIVE SHRUBS, PERENNIALS AND GRASSES — 4,500 sf

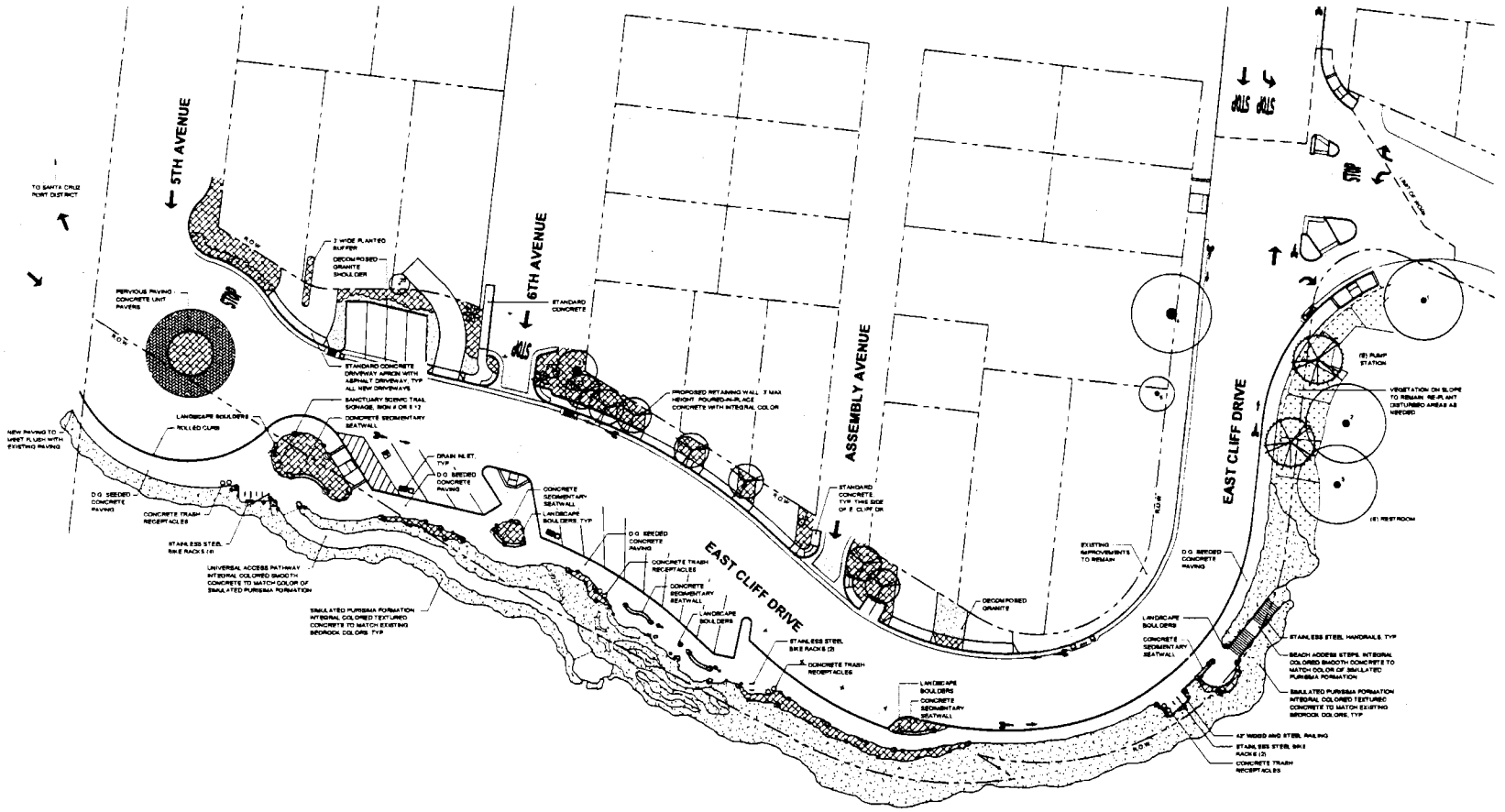
Achillea millefolium / Common Yarrow
Arctostaphylos edmundsii 'Carmel Sur' / Carmel Sur Manzanita
Artemisia californica 'Canyon Gray' / Riverside California Sagebrush
Carex divulsa 'Pearl St. Sedge' / Pearl St. Sedge
Ceanothus griseus horizontalis 'Yankee Point' / California Lilac
Ceanothus maritimus 'Frosty Dawn' / Maritime Ceanothus
Dudleya farinosa / Dudleya
Erigeron glaucus 'Wayne Roderick' / Seaside Daisy
Eriogonum sp. / Buckwheat
Eschscholzia californica / California Poppy
Festuca californica 'Serpentine Blue' / California Fescue
Gilia capitata 'Spreading Gilia' / Spreading Gilia
Leymus condensatus 'Canyon Prince' / Native Blue Rye
Muhlenbergia rigens / Deer Grass
Nassella pulchra / Purple Needle Grass
Rhus integrifolia / Lemonade Berry
Salvia leucophylla / Purple Leaf Sage

Decomposed Granite

NOTES

A. SEE ARBORIST REPORT DATED 8/23/12 FOR DETAILED INFORMATION REGARDING TREES
B. ALL TREES ARE TO BE 15 GAL CONTAINER SIZE UNLESS OTHERWISE NOTED
C. ALL SHRUBS ARE TO BE 5 GAL CONTAINER SIZE UNLESS OTHERWISE NOTED
D. PLANTER AREAS SHALL BE IRRIGATED WITH A COMBINATION OF WATER-EFFICIENT SPRAY AND DRIP COMPONENTS, AND OPERATED WITH AN AUTOMATIC CONTROLLER CAPABLE OF RECEIVING LOCAL WEATHER DATA

The Design Group COPYRIGHT 2011
RRM is a California Corporation



TWIN LAKES STATE BEACH

LANDSCAPE PLAN

SCALE 1"=20' — 0, 20, 40, 80 feet — NORTH

DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

Santa Cruz County
Department of Public Works
701 Ocean St., Room 410,
Santa Cruz, CA 95060

rrm group
creating environments people enjoy®
2511 Garden Rd, Bldg. A-210, Monterey, CA 93940
P: (831) 373-1214 | F: (831) 373-0402 | rrmdesign.com

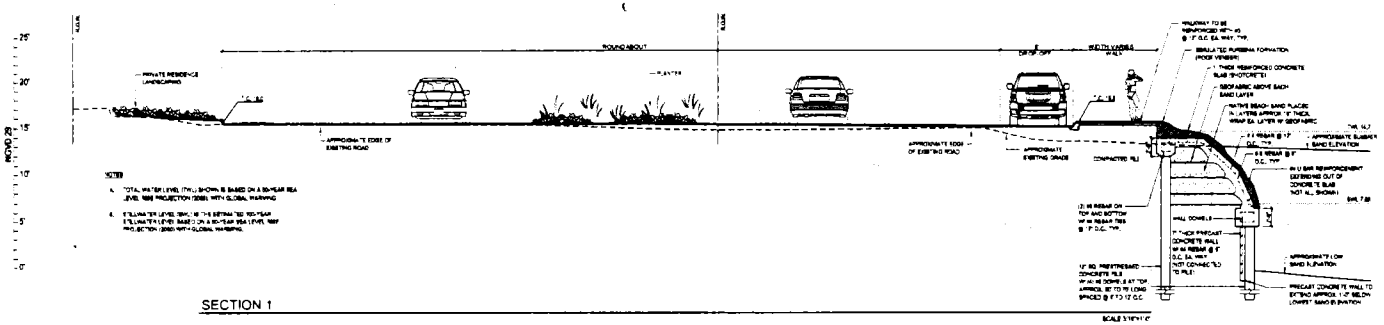
PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

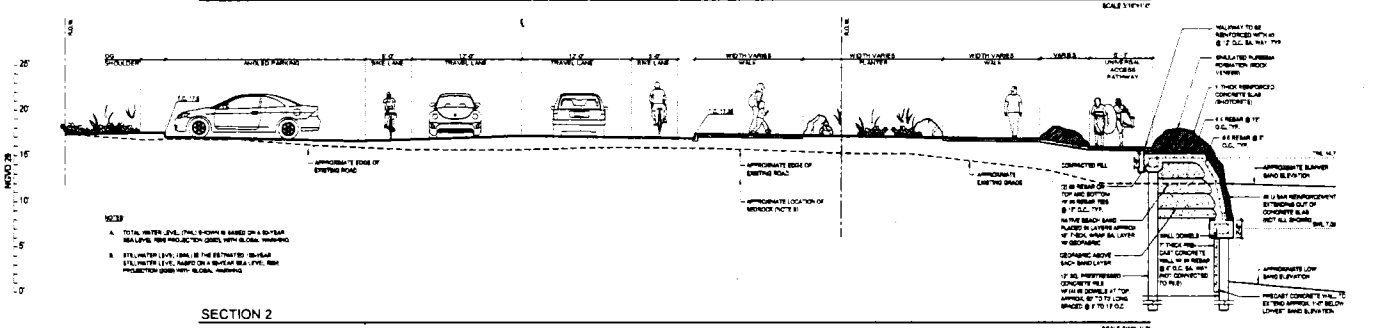
LANDSCAPE PLAN

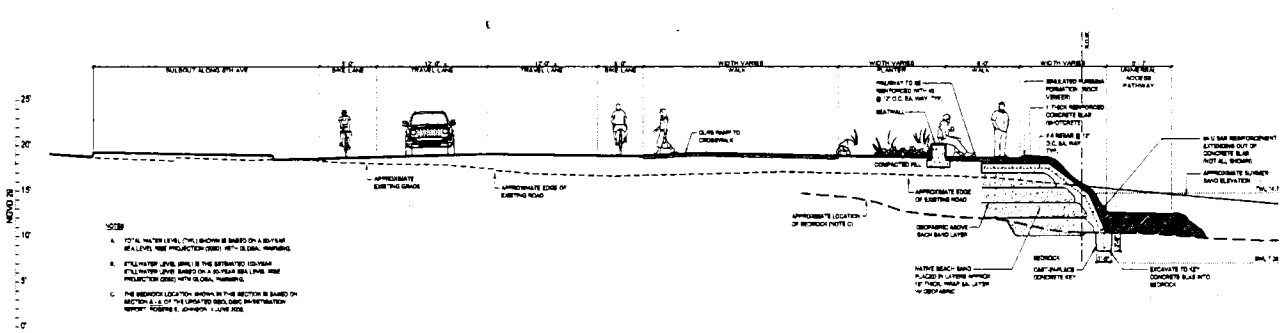
NO.	REVISION	DATE

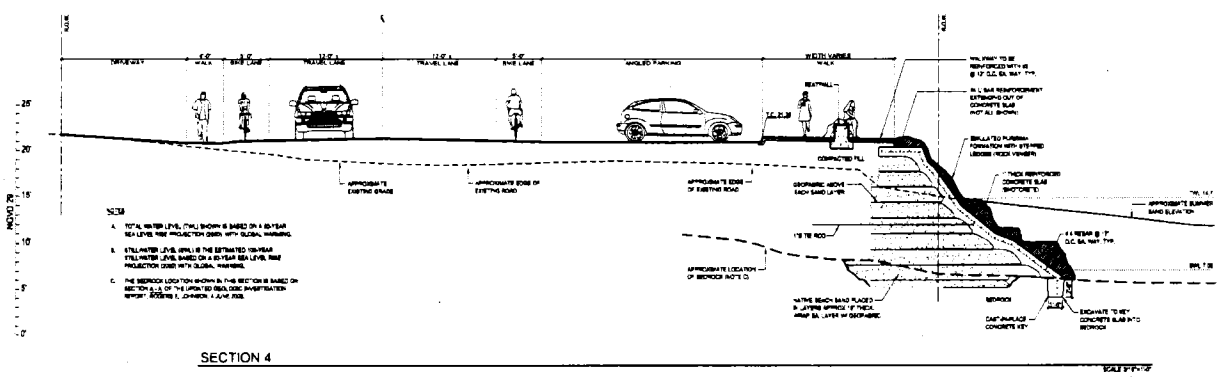
JR — DESIGNED BY — CHECKED BY: VS
DATE: August 23, 2012
DATE PLOTTED:
JOB NUMBER: 1309513
SHEET: 7.1

ATTACHMENT 2 pg 56









ABBREVIATIONS LEGEND	
APPROX.	APPROXIMATE
EA.	EACH
O.C.	ON CENTER
R.O.W.	RIGHT-OF-WAY
T.C.	TOP OF CURB
TYP.	TYPICAL
TW.	TOTAL WATER LEVEL
W.	WITH

DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

RRM DESIGN GROUP COPYRIGHT 2011
RRM is a California Corporation

Santa Cruz County
Department of Public Works
701 Ocean St., Room 410,
Santa Cruz, CA 95060

rrm group
creating environments people enjoy®

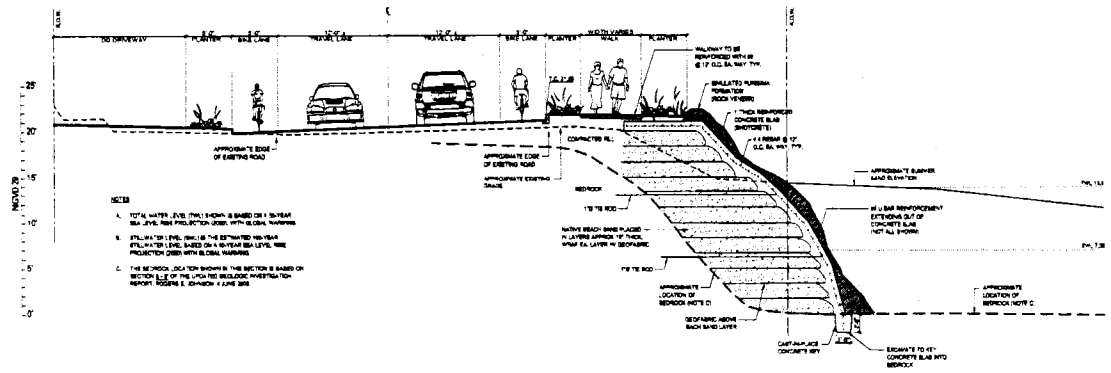
PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

SITE SECTIONS

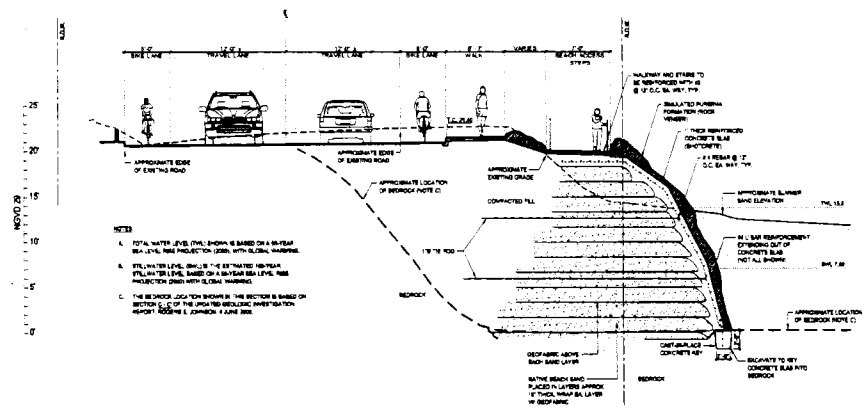
NO.	REVISION	DATE

PROJECT MANAGER: LM
DRAWN BY: VP
CHECKED BY: VS
DATE: August 23, 2012
CAD FILE: 1309513-SECTIONS.dwg
JOB NUMBER: 1309513
SHEET: 8.1

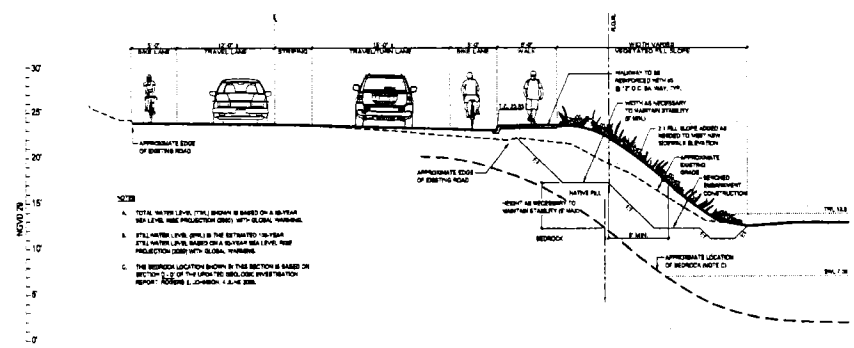
ATTACHMENT 2



SECTION 5
ALIGNED WITH GEOTECHINCAL SECTION B-B'



SECTION 6
ALIGNED WITH GEOTECHINCAL SECTION C-C'



SECTION 7
ALIGNED WITH GEOTECHINCAL SECTION D-D'

ABBREVIATIONS LEGEND	
APPROX.	APPROXIMATE
BA.	BACK
O.C.	ON CENTER
R.O.W.	RIGHT-OF-WAY
T.C.	TOP OF CURB
TYP.	TYPICAL
TW.	TOTAL WATER LEVEL
W.	WITH

DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

RRM DESIGN GROUP COPYRIGHT 2011
RRM is a California Corporation

Santa Cruz County
Department of Public Works
701 Ocean St., Room 410,
Santa Cruz, CA 95060

rrm group
creating environments people enjoy®

PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

SITE SECTIONS

NO.	REVISION	DATE

PROJECT MANAGER: LM
DRAWN BY: MP
CHECKED BY: MB
DATE: August 23, 2012
CAD FILE: 1309513-SECTIONS.dwg
JOB NUMBER: 1309513
SHEET: 8.2

ATTACHMENT

2
n056

ROGERS E. JOHNSON & ASSOCIATES
CONSULTING ENGINEERING GEOLOGISTS
41 Hangar Way, Suite B
Watsonville, California 95076
e-mail: rogersjohnson@sbcglobal.net
Ofc (831) 728-7200 • Fax (831) 728-7218

UPDATED GEOLOGIC INVESTIGATION
PROPOSED IMPROVEMENTS TO TWIN LAKES BEACHFRONT
EAST CLIFF DRIVE - 5TH AVENUE TO SCHWAN LAKE
SANTA CRUZ, CALIFORNIA

REJA Job No. C09001-54
4 June 2009

ATTACHMENT

ROGERS E. JOHNSON & ASSOCIATES
CONSULTING ENGINEERING GEOLOGISTS
41 Hangar Way, Suite B
Watsonville, California 95076-2458
e-mail: rogersjohnson@sbcglobal.net
Ofc (831) 728-7200 • Fax (831) 728-7218

4 June 2009

Jim Davies
Santa Cruz County Redevelopment Agency
701 Ocean Street, Room 510
Santa Cruz, CA 95060-4000

Job No. C09001-54

Re: Update to Geologic Investigation
Proposed Improvements to Twin Lakes Beachfront
East Cliff Drive - 5th Avenue to Schwan Lake
Santa Cruz, California

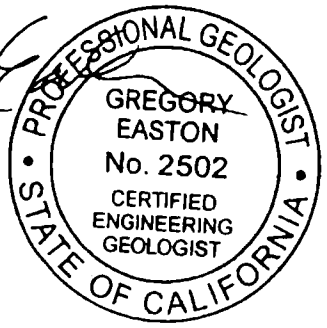
Dear Mr. Davies:

As requested, we have completed our updated geologic investigation of the Twin Lakes Beachfront Project on East Cliff Drive in Santa Cruz California. The project area lies between Fifth Avenue and Schwan Lake. Our initial investigation of the project area was completed in 1995, the text of which is included at the back of this report. The proposed improvements for the project include realigning portions of East Cliff Drive, widening the roadway to accommodate bike lanes, creating off-street parking spaces and creating a pedestrian walkway with access to Twin Lakes State Beach. Much of the proposed improvements will extend seaward of the existing roadway. The purpose of our work was to provide an updated evaluation of the current geologic conditions at the project area. Specifically, we have analyzed the proposed improvements with respect to the underlying geologic conditions. In addition we, along with the project coastal engineers, evaluated the potential impact of coastal erosion in order to provide recommendations on the best methods to construct the proposed improvements.

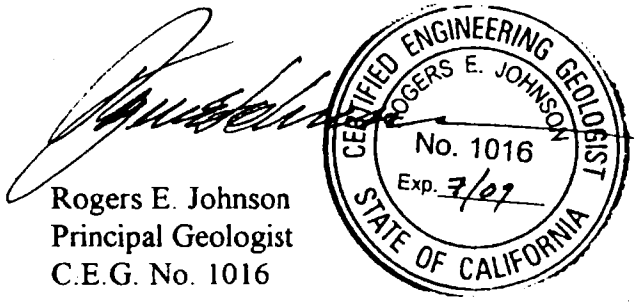
Please contact us if you have any questions regarding this report.

Sincerely,

ROGERS E. JOHNSON & ASSOCIATES



Gregory Easton
Project Geologist
C.E.G. No. 2502



Rogers E. Johnson
Principal Geologist
C.E.G. No. 1016

GFE/REJ/gfe

Copies: Addressee (4)
Haro, Kasunich and Associates, attn: Rick Parks (1)

ATTACHMENT 8

TABLE OF CONTENTS

INTRODUCTION 1
Earth Materials and Geologic Structure 1
Cone Penetration Test Borings 2
Exploratory Test-Pits 2
Site Reconnaissance 3
Synthesis of Data 3
GEOLOGIC HAZARDS 6
Wave Runup and Wave Erosion 6
Platform Abrasion Rate 7
Coastal Flooding 7
Sea Level Rise 8
Sea Level Rise vs. Local Tectonic Uplift 8
Seismic Shaking 8
Table 1: Modified Mercalli Intensity Scale 9
Table 2: Faults, Earthquakes and Deterministic Seismic Shaking Data 10
Deterministic Seismic Shaking Analysis 10
Pseudostatic Slope Stability Analysis 11
Liquefaction 11
CONCLUSIONS 12
RECOMMENDATIONS 13
INVESTIGATION LIMITATIONS 14
REFERENCES 15

APPENDICES:
Appendix A 19
Figure 1: Site Location Map 20
Figure 2: 1998 El Nino Photographs 21
Figure 3: 1998 El Nino Photographs 22
Appendix B: 1995 Geologic Report Text 23
Appendix C: Storm History of Monterey Bay and the Central Coast, 1910 to Present 62
Appendix D: Scale of Acceptable Risks from Geologic Hazards 67

PLATES:
Plate 1a: Site Geologic Map . . . . . Pocket
Plate 1b: Site Geologic Map . . . . . Pocket
Plate 2a: Road and Beach Cross Sections . . . . . Pocket
Plate 2b: Road and Beach Cross Sections . . . . . Pocket
Plate 3: Log of Test Pits . . . . . Pocket

ATTACHMENT 3

INTRODUCTION

This report presents the results of our updated geologic investigation of the Twin Lakes Beachfront area along East Cliff Drive between 5th Avenue and Schwan Lake. The coastline site is located at the northern end of Monterey Bay in Santa Cruz County, California (Figure 1; Site Location Map). The Santa Cruz County Redevelopment Agency is proposing to improve the site's accessibility by realigning the roadway, creating parking areas, and creating bicycle lanes and a pedestrian walkway. Much of the proposed improvements will be constructed seaward of the existing alignment of East Cliff Drive.

Our initial evaluation of the Twin Lakes Beachfront site was completed in 1995. Erosion during the winter of 1998 exposed much of the underlying bedrock in the western portion of the subject area. Taking advantage of the exposures afforded by this erosion, we took numerous photographs of the exposed bedrock and resurveyed several of the geologic cross sections we had surveyed in 1995. Please refer to our 1995 Geologic Report for background information pertaining to this project. The text of our 1995 report is located at the back of this Updated Geologic Investigation (Appendix B).

The scope of work performed for this updated investigation included 1) review of published and unpublished literature relevant to the site and vicinity; 2) analysis of stereo-aerial photographs; 3) geologic mapping of the site; 4) subsurface investigation comprised of 6 cone penetration test borings and 7 test-pits; 5) coordination with the project professionals; 6) compilation and analysis of the resulting data; and 7) preparation of this report and accompanying illustrations, including a geologic map, cross sections and logs of test-pits.

Earth Materials and Geologic Structure

We obtained additional subsurface data by advancing 6 cone penetration test borings as well as 7 excavator-dug test-pits, during our recent investigation. In addition, the photographs taken during 1998 provided valuable insight regarding the subsurface earth materials at the western portion of the site (Figures 2 and 3; 1998 El Nino Photographs). We note that in the area of the existing restrooms and pump station there are abundant underground utilities, for some of which the locations are known and some unknown (Plates 1a and 1b). Also, there is an infilled swimming pool here. Because of this, excavation and advancement of test-pits and borings by conventional means was not feasible in this portion of the subject area. Hand excavated pits were considered as a means of subsurface exploration, however due to time constraints the pits were not excavated. With a lack of subsurface information in the area of the restrooms and pump station, we provide estimates as to the type and depth of the materials underlying this portion of the study area. We recommend hand excavating at a later date, or alternatively, field inspection of construction excavations by a representative of our firm.

ATTACHMENT 5

Cone Penetration Test Borings

We, along with Haro, Kasunich and Associates, advanced 6 cone penetration (CPT) borings at beach level at the locations shown on Plates 1a and 1b. CPT-1, advanced south of the mouth of the Schwan Lake outflow structure encountered 11 feet of beach sand overlying lagoonal deposits to the maximum explored depth of 60.5 feet. CPT-2, advanced about 120 feet seaward of the Schwan Lake outflow structure, encountered 7 feet of beach sand underlain by a 25 foot thick sequence of lagoonal deposits. Underlying the lagoonal deposits was Purisima Formation bedrock. CPT-3 was advanced about 110 feet seaward of the intersection of East Cliff Drive and 9th Avenue. This boring encountered 12 feet of beach sand, underlain by 4 feet of lagoonal deposits which rest on Purisima Formation bedrock. CPT-4, advanced about 120 feet southeast of the beach restrooms, encountered 10 feet of beach sand overlying Purisima bedrock. Similarly, CPT's 5 and 6, advanced seaward of East Cliff Drive in the western portion of the subject area, encountered Purisima bedrock overlain by 9 and 10 feet of beach sand, respectively.

The subsurface information obtained in the CPT borings advanced seaward of the proposed developments is consistent with our subsurface data and interpretation from our 1995 work.

Exploratory Test-pits

We excavated 6 exploratory test-pits (TP) along the existing alignment of East Cliff Drive to determine the existence and extent, if any, of rip-rap armoring in the area proposed for improvements, and also to examine the subsurface materials. Because of the caving hazards presented by the thick accumulation of loose sands at the excavation areas, the test-pits were not entered and not logged in detail. The test-pit locations are shown on Plates 1a and 1b. Please refer to the Log of Test-pits on Plate 3 for a graphical depiction of the materials encountered in the pits.

TP-1 and TP-2 are located southeast of the Schwan Lake outflow structure and encountered beach sands overlying the face of a rip-rap embankment protecting East Cliff Drive. In TP-1 no quarrystones were encountered below about 7 feet depth from the beach surface. Similarly, no quarrystones were encountered in TP-2 below 6 feet depth. Groundwater and flowing sands prevented deeper excavation of the test-pits. TP-3 revealed a large quarrystone at the ground surface with no other stones placed below it. The quarrystone rests upon 1-2 feet of asphalt and concrete debris. Heavy mineral laminated beach sands were also exposed in the test-pit to an excavated depth of 4.5 feet. TP-4 also encountered a quarrystone at the ground surface, with a mixture of fill and laminated sands to 2 feet below the beach surface. Of note was a small square piece of lumber pulled out of the bottom of the test-pit between 2 and 6 feet depth. Thus it is possible that fill may exist to 6 feet depth. Below 6 feet, the excavation revealed lagoonal clays. TP-5 revealed 3 feet of mixed fill and soil with abundant roots below the beach surface. Layered sands separated by root zones extended from 3 feet to 8 feet depth, with lagoonal clays extending to the bottom of the test-pit to an excavated depth of about 10 feet. At the curve in East Cliff Drive near Assembly Avenue, we excavated TP-6 to a depth of 12 feet and encountered

interfingering soil and sand layers at its landward end. The soils consisted of partially decomposed iceplant, and sands contained heavy mineral laminations. We encountered Purisima Formation bedrock in the bottom foot of the test-pit. A block of concrete with protruding rebar steel was observed in the spoils from the bottom of the test-pit, presumably resting upon the bedrock. We noted a piece of buried trash at a depth of about 7 feet. TP-7 was excavated close to the intersection of Assembly Avenue and East Cliff Drive. The upper 5 feet of the pit revealed sand, with the lower 4 feet being laminated. We saw a piece of trash at 3.5 feet depth. Below the sand, we saw a 2 foot thick A/B soil horizon, and the underlying Purisima Formation bedrock below 7 feet depth.

Site Reconnaissance

For this updated investigation, we surveyed 7 cross-sections spanning a portion of East Cliff Drive and across the surface of Twin Lakes Beach (Plates 2a and 2b). The cross-sections were surveyed in the same general locations as our 1995 cross-sections (Plates 1a and 1b). Plotting the subsurface information gathered in our 1995 and current work on the cross-sections, along with the limits of the proposed improvements, we have a more thorough and accurate interpretation of the distribution of earth materials underlying the proposed improvements.

We analyzed several sets of aerial photographs of the project area to observe any changes that may have occurred since our 1995 investigation. The most obvious changes we saw occurred between September 2002 and June 2003; the beach sand and iceplant which typically covers the rip-rap at the curve in East Cliff Drive was scoured away, exposing some of the rip-rap and a portion of the adjacent fill slope. By October 2005 sand had for the most part re-covered the scoured area, though the iceplant had not yet fully regrown.

Synthesis of Data

Based on the Conceptual Plan for the project drawn by the Santa Cruz County Redevelopment Agency (SCCRDA, 2008), the proposed improvements will be constructed across areas underlain by man-placed fill, rip-rap, beach sand and bedrock. In portions of the development area, lagoonal deposits are present between the surficial deposits (fill, rip-rap and sand) and bedrock.

The proposed improvements consist of a realigned and widened East Cliff Drive roadway with dedicated bike lanes in both directions. Seaward of the bike lanes will be a pedestrian walkway which will follow the blufftop and provide beach access points and overlook areas. Vehicle parking will be provided in select areas between the roadway and walkway. We show the seaward margins of these proposed improvements on our Geologic Site Maps (Plates 1a and 1b) and Road and Beach Cross Sections (Plates 2a and 2b).

In the western portion of the Twin Lakes Beachfront area, between 5th and Assembly Avenues, the proposed improvements are underlain by Purisima Formation bedrock. Locally, the bedrock is overlain by a soil horizon, sand and artificial fill. At 5th Avenue, along the seaward edge of the

proposed pedestrian walkway, the bedrock elevation is approximately +2 feet. Between 5th and 6th Avenues, the bedrock surface rises to about +11 feet elevation at the seaward edge of the proposed walkway at the end of 6th Ave.

Between 6th and Assembly Avenues, the proposed improvements are located seaward of erosional scarps exposed during the 1998 storms. The approximate location of the scarps is depicted on Plate 1a and can be seen in profile view on Cross Section A-A' (Plate 2a). The bedrock elevations along this segment of proposed improvements will deepen seaward of the scarps, which were measured up to about 5 feet high. At the seaward edge of the proposed walkway at the intersection of Assembly Ave. and East Cliff Drive, bedrock elevation measured in TP-7 was approximately +11 feet, or 8.5 feet below the road surface. A few feet seaward of TP-7 lies a 4-5 foot high erosional scarp which is currently covered by beach sand, but was exposed during the 1998 storms. The proposed walkway crosses seaward of the currently buried scarp here, with the Purisima Formation bedrock at the base of this scarp at an elevation of approximately +5 feet, or 14.5 feet or so below the road elevation.

To the east of Assembly Ave., East Cliff Drive begins a broad curve inland. Beginning just east of Assembly Ave., the seaward edge of the proposed improvements is underlain by a rip-rap slope that helps protect East Cliff Drive from wave attack. The rip-rap is presumably resting upon Purisima bedrock and extends up to the top of the slope at the edge of East Cliff Drive. The rip-rap and the bedrock upon which it rests was at least partially exposed during the 1998 storms (Figures 2 and 3). In the vicinity of Cross Section B-B', bedrock beneath the rip-rap lies at about elevation 0 (zero) feet (Plate 2a). To the east, the bedrock elevation beneath the rip-rap is about +4.5 feet. The depth to bedrock along this portion of the proposed improvements is up to (and possibly exceeds) 20 feet.

A little further around the curve in East Cliff Drive, heading eastward, the nature of the earth materials underlying the outboard edge of the proposed improvements transition to artificial fill and sand, with the bedrock becoming somewhat deeper (lower in elevation). As depicted on Cross Section C-C', the outer edge of the proposed pedestrian walkway is underlain by about 23 feet of fill and sand, with bedrock below 0 (zero) feet in elevation (Plate 2a).

In the area of the existing Twin Lakes Beach restrooms, the slope at the outboard edge of East Cliff Drive consists of artificial fill overlying beach sand in a similar manner as described above. Below the beach sand lies lagoonal deposits which are in turn underlain by Purisima Formation bedrock. Exploratory boring B-3, advanced in 1995 near the restrooms, encountered about 3 feet of lagoonal deposits beneath the beach sand. Bedrock was encountered at an elevation of +2 feet in B-3. The outboard edge of the proposed pedestrian walkway is situated between the edge of East Cliff Drive and B-3. Because of the underground utilities in this portion of the study area and consequent lack of subsurface data as mentioned above, we were not able to establish accurate geologic contacts but we estimate the depth to bedrock along the outboard edge the proposed walkway could be up to 20.5 feet below the current road elevation. As depicted on Cross Section D-D', the Purisima Formation bedrock lies approximately 15.5 feet (elevation + 4 feet) below the

proposed outboard edge of the pedestrian walkway, as measured from its projection outward from the existing street elevation (Plate 2a). However, there is some uncertainty in the elevation and location of the bedrock surface in this area: the bedrock elevation may be higher, or as low as +2 feet.

East Cliff Drive curves eastward at its intersection with 7th Avenue. Eastward, beyond the curve, the slope between Twin Lakes Beach and the road continues to be underlain by bedrock, lagoonal deposits, beach sand and fill. We estimate that the Purisima bedrock underlying the edge of the proposed walkway near the locations of TP-6 (1995) and B-2 (1995) is between elevation +1 and +7. About 3.5 feet of lagoonal deposits overlie the bedrock here.

Eastward of 8th Avenue, the depth to bedrock deepens as East Cliff Drive nears Schwan Lake. The lake is a coastal lagoon formed by the rising of sea level since the last glacial maximum (ice age). The lagoon, which was formerly a deep stream canyon, has filled with silts, clays and peaty deposits as sea level has risen. As the elevation of the bedrock surface drops toward the axis of the infilled stream canyon (the site of Schwan Lake), the lagoonal deposits thicken above it. It is in this same area that rip-rap quarrystones have been placed on the ground surface along the edge of East cliff Drive. From our mapping and subsurface work, it appears the stones are situated only at the ground surface on the northwest side of the Schwan Lake outflow structure. The quarrystones have been placed alongside East Cliff Drive to help protect the existing roadway and parking areas from wave runup and erosion. The proposed improvements in this area overlie artificial fill, rip-rap, lagoonal deposits and bedrock at depth. The rip-rap southeast of the outflow structure is more extensive and will be described in more detail below.

The elevation of lagoonal deposits encountered in Test-pits 4 and 5 was +3.2 and +4.5 feet respectively. We saw no rip-rap beneath the ground surface in pits 3, 4 and 5 (Plate 3). We saw no lagoonal deposits in Test-pit 3, however we saw small cobbles and gravels at the bottom of the pit. These alluvial materials likely represent the former surface of the outflow channel from Schwan Lake. Cross Section G-G', located near the outflow structure, depicts the lagoonal deposits at elevation 0 (zero)(Plate 2b).

To the southeast of the Schwan Lake outflow structure, we did not see lagoonal deposits in Test-pits 1 and 2. We did observe rip-rap to depths of about 4 (elev 0.0) and 6 (elev. +2) feet below the beach surface in Test-pits 1 and 2, respectively (Plate 3). The rip-rap rests upon beach sand. Exploratory boring B-8 (1995), advanced in the vicinity of Test-pits 1 and 2, encountered lagoonal deposits at elevation -4 feet. Test-pit 2 encountered several fugitive quarrystones between 10 and 25 feet seaward of the stacked rip-rap observed in the test-pit. The conceptual plan of the proposed improvement area does not extend southeast of the outflow structure. From the subsurface information gathered, the proposed improvements will overlie rip-rap, beach sand and lagoonal deposits.

GEOLOGIC HAZARDS

Wave Runup and Wave Erosion

Subsequent to our 1995 geologic investigation there have been numerous significant storms within Monterey Bay. These storms have caused very little damage to structures. The El Nino winter storms during January and February 1998, however, did cause some structural damage. Numerous roads and properties adjacent to coastal bluffs in Monterey Bay were threatened. Several rip-rap revetments along the stretch of coast between Natural Bridges State Park, to the west, and Capitola Beach, to the east, were damaged by the large surf generated by these storms. To our knowledge, there were no buildings damaged in the Monterey Bay area, although the Capitola wharf lost several pilings in February 1998. For comparison purposes we have attached an updated version of the Storm History of Monterey Bay and the Central Coast, 1910-1998 (Appendix C).

The most striking effects of the winter storms of 1997-1998 at Twin Lakes Beach were the near-complete erosion of the beachfront along the western portion of the subject area (from 5th Avenue to Assembly Avenue and beyond) and the possible overtopping of East Cliff Drive in the eastern portion of the subject area (at Schwan Lake). A representative from our firm observed the conditions at Twin Lakes Beach during and shortly after these storms, re-surveying several cross sections originally surveyed in 1995 and taking numerous photographs. We have included several photographs of the area between 5th and Assembly Avenues for illustrative purposes (Figures 2 and 3).

As visible in the photographs, the beach sand which typically resides year-round at the subject site was scoured away during the 1998 storms, revealing the bedrock wave-cut platform. Notice how undulatory the eroded platform can be. Also visible in the erosional scarps at the back edge of the platform are the overlying soils and fill material. At the curve in East Cliff Drive, just east of Assembly Avenue, the rip-rap became well exposed as a result of the storms. The road, as it heads northward toward its intersection with 7th Avenue, is underlain in part by artificial fill.

In the eastern portion of the Twin Lakes Beach area, wave runup was the more prevalent mark of the 1998 winter storms. Waves encroached to the base of the fill slope and possibly overtopped East Cliff Drive near the Schwan Lake outflow structure.

Since the 1998 storms, wind and wave action has gradually replenished the beach with sand, with the beach's current configuration resembling that of its pre-1998 condition.

Each winter, storm waves and littoral drift deposit sand within the harbor mouth, which shoals the harbor entrance and makes vessel passage difficult if not impossible. During the winter months the harbor channel is dredged of the sand. The dredge spoils are deposited on Twin Lakes Beach, typically at the water line. Though the beach is nourished with the dredged sand to some extent, most of it is likely re-introduced into the littoral drift system.

Because of the relatively infrequent occurrence of severe winter storms exposing the bluff which flanks the outboard edge of East Cliff Drive through the Twin Lakes Beach project area, the rate of bluff erosion due to wave runup is low. However, with a continued rise in sea-level, the bluffs will probably be subjected to more frequent wave attack.

The wave runup analysis performed by the project coastal engineers indicates that wave runup will overtop the entire project area during the lifetime of the proposed improvements.

The existing restrooms on Twin Lakes Beach are susceptible to wave attack.

Platform Abrasion Rate

The natural rate of wave-cut platform abrasion and lowering is not well documented in the Santa Cruz area. Approximations of abrasion rates can be made by measuring the dip or angle of the wave-cut platform and the rate of retreat of the bluff. For example, given a bluff retreat rate of 1 foot per year and a wave-cut platform with a dip of 2 degrees (3.5 percent gradient) we would estimate 3.5 feet of abrasion within 100 years. However, if the dip of the platform was 4 degrees (7 percent gradient) the rate would double to 7 feet. Actual in-situ measurements would be better than estimates based on projected retreat rates and approximate platform geometries.

The bedrock wave-cut platform however, is not well exposed in the Twin Lakes Beach project area. It is typically covered by a thick layer of beach sand which helps both protect the bedrock platform or underlying lagoonal deposits from abrasion and diminishes wave energy as they break onshore. Twin Lakes Beach is also shadowed to some degree from wave action by the jetties which protect the Santa Cruz Harbor entrance. The jetties help shield the beach from direct wave attack. As mentioned previously, the portion of the wave-cut platform along East Cliff Drive from 5th Ave. to the curve beyond Assembly Ave. is subject to scour and abrasion during severe winter storms such as last occurred in 1998. Beyond the curve near Assembly Avenue and to the east, wave runup does not appear to scour the beach sands sufficiently enough to expose and abrade the bedrock platform or lagoonal deposits. Because the bedrock platform at the subject area is infrequently exposed to wave action, the rate of platform abrasion at Twin Lakes Beach is low.

Coastal Flooding

A flood insurance rate map published by the Federal Emergency Management Agency (FEMA) indicates that the 100-year base flood zone extends up to elevation +13 feet mean sea level (NGVD) in the vicinity of the Schwan Lake outflow structure (FEMA, 2006). This flood elevation does not take into account wave heights nor velocities. Other proposed improvement areas within the Twin Lakes Beach project area are categorized as either falling within an area of 1% annual chance flood with average depth of less than 1 foot, or falling outside the 0.2% chance of annual floodplain area. Based on our analysis of the FEMA flood map and historical observation, the potential for flooding to impact the portion of East Cliff Drive fronting Schwan Lake is high.

Sea Level Rise

The FEMA analysis does not account for potential accelerated sea level rise due to Greenhouse Effects. In simple terms, theories regarding the Greenhouse Effect state that there is ongoing, accelerating global warming due to entrapment of gases and resultant reflection of radiation in the atmosphere due, in part, to increased production of atmospheric waste by industrial societies throughout the world. With time, the continued warming of the atmosphere could cause increased melting of the polar ice caps, which in turn will result in an accelerated rise in sea level.

Since 1880, global sea level has risen nearly 8 inches. Satellite measurements of the world's oceans since 1993 show that sea levels are rising 0.12 inches or more per year. This is approximately double the rate of sea level rise since 1880. In 2007, the Intergovernmental Panel on Climate Change (IPCC) projected sea levels to rise between about 7 and 23 inches by 2100. This range in rates roughly matches the sea level rise rate since 1880 on the low end, and again doubles the measured rate of sea level rise since 1993. The IPCC 2007 did not factor into their estimates uncertainties in the climate-carbon cycle feedback, nor the full effects of ice sheet flow. The Climate Change International Scientific Congress in 2009 concluded that the IPCC 2007 estimates may be a lower-bound for global sea level rise, with sea levels rising by 20 to 40 inches by 2100.

Until modeling practices become better refined and the human contribution to global warming and resulting sea-level rise is more understood, it is difficult to predict what future rates of sea-level rise will be. During the lifetime of the proposed improvements however, it is apparent that sea level will continue to rise.

Sea Level Rise vs. Local Tectonic Uplift

Various researchers have determined long term uplift rates of the Santa Cruz coastline, either through the age-dating of marine terraces, examining fission tracks in rocks, or by geodesy. The rates of coastal uplift in the Santa Cruz area reported from this research ranges between about 0.1 to 1.0 millimeter per year. Since 1993, satellite measurements have shown that the oceans are rising 3 millimeters (0.12 inches) or more per year, or about three times the highest reported uplift rate.

Seismic Shaking

Seismic shaking at the subject site will be intense during the next major earthquake along local fault systems. Modified Mercalli Intensities of up to VIII are possible at the site (see Table 1), based on the intensities reported by Lawson et al. (1908) for the 1906 earthquake and by Stover et al. (1990) for the 1989 Loma Prieta earthquake. It is important that recommendations regarding seismic shaking be used in the design for the proposed development.

TABLE 1
Modified Mercalli Intensity Scale

The modified Mercalli scale measures the intensity of ground shaking as determined from observations of an earthquake's effect on people, structures, and the Earth's surface. Richter magnitude is not reflected. This scale assigns to an earthquake event a Roman numeral from I to XII as follows:

I	Not felt by people, except rarely under especially favorable circumstances.
II	Felt indoors only by persons at rest, especially on upper floors. Some hanging objects may swing.
III	Felt indoors by several. Hanging objects may swing slightly. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
IV	Felt indoors by many, outdoors by few. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing automobiles rock. Windows, dishes, doors rattle. Wooden walls and frame may creak.
V	Felt indoors and outdoors by nearly everyone; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset; some dishes and glassware broken. Doors swing; shutters, pictures move. Pendulum clocks stop, start, change rate. Swaying of tall trees and poles sometimes noticed.
VI	Felt by all. Damage slight. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks and books fall off shelves; pictures off walls. Furniture moved or overturned. Weak plaster and masonry cracked.
VII	Difficult to stand. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary buildings; considerable in badly designed or poorly built buildings. Noticed by drivers of automobiles. Hanging objects quiver. Furniture broken. Weak chimneys broken. Damage to masonry; fall of plaster, loose bricks, stones, tiles, and unbraced parapets. Small slides and caving in along sand or gravel banks. Large bells ring.
VIII	People frightened. Damage slight in specially designed structures; considerable in ordinary substantial buildings, partial collapse; great in poorly built structures. Steering of automobiles affected. Damage or partial collapse to some masonry and stucco. Failure of some chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed pilings broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
IX	General panic. Damage considerable in specially designed structures; great in substantial buildings, with some collapse. General damage to foundations; frame structures, if not bolted, shifted off foundations and thrown out of plumb. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground; liquefaction.
X	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Landslides on river banks and steep slopes considerable. Water splashed onto banks of canals, rivers, lakes. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
XI	Few, if any masonry structures remain standing. Bridges destroyed. Broad fissures in ground; earth slumps and landslides widespread. Underground pipelines completely out of service. Rails bent greatly.
XII	Damage nearly total. Waves seen on ground surfaces. Large rock masses displaced. Lines of sight and level distorted. Objects thrown upward into the air.

ATTACHMENT

TABLE 2
Faults, Earthquakes and Deterministic Seismic Shaking Data

Fault	Moment Magnitude of Characteristic or Maximum Earthquake (M_w)	Estimated Recurrence Interval (years)	Site Classification	Distance from Site (km)	Estimated Mean Peak Ground Acceleration (g)	Estimated Mean + One Dispersion Ground Acceleration (g)
San Andreas (1906 rupture)	7.9	210	Rock	17.5	0.31	0.48
San Gregorio	7.3	400	Rock	17	0.26	0.4
Zayante-Vergeles	6.8	8,820	Rock	12	0.3	0.48
Monterey Bay - Tularcitos	7.1	2,600	Rock	11	0.35	0.54

Deterministic Seismic Shaking Analysis

For the purpose of evaluating deterministic peak ground accelerations for the site, we have considered the San Andreas, San Gregorio, Zayante and Monterey Bay-Tularcitos fault zones. While other faults or fault zones in this region may be active, their potential contribution to seismic shaking at the site is overshadowed by these four faults. Table 2 shows the moment magnitude of the characteristic or maximum earthquake, its estimated recurrence interval and the distance from the causative fault to the site. We took the fault data from "Database of potential sources for earthquakes larger than magnitude 6 in Northern California" (WGNCEP, 1996) and "Probabilistic seismic hazard assessment for the state of California" (Petersen et al., 1996).

Also shown on Table 2 are deterministically derived accelerations. These accelerations are based on an attenuation relationship developed from the analysis of historical earthquakes. It is important to understand that shaking estimates of potential future earthquakes are based on the statistical analysis of shaking generated by past earthquakes. The calculated accelerations listed in Table 2 are the best estimates given the current methods and their application to the current database of past earthquakes. Therefore, we caution that the listed values are approximations, rather than precise predictions. Actual measured "free-field" accelerations at the site may be larger. Because the historical data can be interpreted in different ways, there are a number of different attenuation relationships available.

We have employed a fairly conservative attenuation relationship derived by Abrahamson and Silva (1997) in estimating the acceleration values. Given their methods, the listed accelerations are based upon numerous factors, including: magnitude, closest distance to the rupture plane, fault type (strike slip, normal or reverse with position on hanging wall or footwall) as well as site classification ("rock" site or "deep soil" site). In addition, their regression was developed for the specific setting of shallow crustal earthquakes in active tectonic regions (e.g. western North

America). It therefore provides region-specific flexibility within the tectonic setting of California. We have not performed site specific seismic shaking evaluations. No on-site or laboratory measurements were made to evaluate site specific seismic response. The values listed, however, do reflect the site classification.

If the deterministically derived accelerations are used for engineering analysis of the subject area, we recommend utilizing the accelerations generated by the San Andreas fault. This is due to the high predicted ground accelerations and the short recurrence interval of the San Andreas fault zone. Based on the results listed in Table 2, the earthquake ground motion (mean acceleration plus one dispersion) expected at the subject property will be approximately 0.48g, based on a M_w 7.9 earthquake centered on the San Andreas fault 17.5 kilometers northeast of the site. The duration of strong shaking is dependent on magnitude. Abrahamson and Silva (1996) have suggested a relationship between magnitude, distance and duration of strong shaking. On the basis of their relationship, the duration of strong shaking associated with a San Andreas faulting event generating a magnitude 7.9 earthquake and occurring 17.5 km from the site is estimated to be about 31 seconds. This long duration of seismic shaking may be even more critical as a design parameter than the peak acceleration itself.

Pseudostatic slope stability analysis

Pseudostatic slope stability analysis of the coastal bluff, if performed by project geotechnical engineer, should utilize our geologic cross sections and a site-specific seismic coefficient (k). Ashford and Sitar (2002) developed a method for calculating a site-specific pseudostatic seismic coefficient (k) specifically for a coastal bluff-top setting.

Current Santa Cruz County standards require that the pseudostatic slope stability analysis show the site stable beyond a 1.2 factor of safety. Given this standard, a minimum seismic coefficient (k) of 0.15 should be used as suggested within Special Publication 117 (California Division of Mines and Geology, 1997).

Liquefaction

The beach sands underlying portions of the Twin Lakes Beach development area are prone to liquefaction. Dupré (1975) indicates there is a high potential for liquefaction in beach sand in Santa Cruz County. No liquefaction or associated effects were noted in the project area by Youd and House (1978) resulting from the 1906 San Francisco Earthquake or by Dupré and Tinsley (1998) resulting from the 1989 Loma Prieta Earthquake.

Where improvements proposed for the Twin Lakes Beach improvement area are underlain by beach sand, there is a high potential for liquefaction to compromise their stability if they are not properly engineered and constructed. Specifically, the portion of East Cliff Drive between 8th Avenue and extending southeast of the Schwan Lake outflow structure is highly prone to liquefaction.

ATTACHMENT 2

The liquefaction analysis performed by the project coastal engineer indicates that the beach sands in the subject area will liquefy during a seismic event.

CONCLUSIONS

The Twin Lakes Beachfront improvement area is situated along East Cliff Drive between 5th Avenue and Schwan Lake in Santa Cruz County, California. The Santa Cruz County Redevelopment Agency is proposing to construct the improvements seaward of the existing alignment of East Cliff Drive.

We initially investigated the subject area in 1995. We revisited the site in during winter in 1998 to document the geologic conditions. During our current update investigation, we collected subsurface data utilizing a cone penetration test rig and track-mounted excavator.

The proposed improvements will be constructed across areas underlain by artificial fill, rip-rap, beach sand, lagoonal deposits and bedrock and will be subject to wave runup and erosion, coastal flooding, seismic shaking and liquefaction. With continued sea level rise, the proposed improvements will be subject to more frequent wave attack, erosion and flooding during their lifetime. The existing restrooms, pump house and various underground utilities will also be subject to wave runup, erosion and flooding during the lifetime of the project.

During the winter storms of 1997-1998 at Twin Lakes Beach, the beach sand fronting the western portion of the project area was scoured away, exposing the underlying bedrock and artificial fill to surf erosion. The eastern portion of the project area was subject to wave runup as well as erosion and flooding. Since the 1998 storms, wind and wave action has deposited sand to the beach, restoring it to pre-storm conditions.

The Federal Emergency Management Agency indicates that the 100-year base flood zone extends up to elevation +13 feet mean sea level (NGVD) in the vicinity of the Schwan Lake outflow structure. This flood elevation does not take into account wave heights nor velocities, nor does it take into account potential accelerated sea level rise due to Greenhouse Effects.

Since measurements began in the late 19th century, global sea levels have risen at increasing rates. Because of uncertainties in the modeling process, rates of sea level rise vary greatly. Current estimates indicate between 7 and 40 inches of sea level rise may occur by 2100.

The site is located in an area of high seismic activity and will be subject to strong seismic shaking in the future. Modified Mercalli Intensities of up to VIII are possible. The controlling seismogenic source for the subject property is the San Andreas fault, 17.5 kilometers to the northeast. The design earthquake on this fault should be M_w 7.9. Expected duration of strong shaking for this event is about 31 seconds. Deterministic analysis for the site yields a mean peak ground acceleration plus one dispersion of 0.48g. Pseudostatic slope stability analysis fo the coastal bluff, if performed by the project geotechnical engineer, should utilize our geologic cross sections and a

site-specific seismic coefficient (k), or a minimum coefficient of 0.15 which produces a factor of safety greater than 1.2.

The liquefaction hazard is high where proposed improvements in the project area are underlain by beach sand. In particular, the portion of East Cliff Drive between 8th Avenue and extending southeast of the Schwan Lake outflow structure is highly prone to liquefaction.

Provided our recommendations are followed we project the proposed improvements should remain protected from significant bluff-top erosion over the next 100 years. *This requires that the constructed improvements, existing and proposed, are constructed and maintained to protect the entire project area along East Cliff Drive.*

The proposed improvements will be subject to "ordinary" risks (as defined in Appendix D) over the assumed design lifetime of 100 years if our recommendations and those of the project coastal engineer are followed. Appendix D should be reviewed in detail by the Santa Cruz County Redevelopment Agency to determine whether an "ordinary" level of risk is acceptable. If "ordinary" risks as defined are unacceptable, then the geologic hazards in question should be further mitigated to reduce the corresponding risks to a lower level.

RECOMMENDATIONS

1. The proposed improvements should be founded in bedrock where possible. Where improvements will not be embedded in bedrock, they should penetrate below the depth of wave scour (i.e. beneath the beach sand). The project coastal engineers have provided design criteria for several types of structures for founding the proposed improvements in their report.

2. Because of the existence of abundant underground utilities in the vicinity of the existing restrooms and pump station, we recommend hand excavated pits to obtain subsurface geologic information in this area. Alternatively, field inspection of construction excavations can be made by a representative of our firm to determine the type and position of geologic materials.

3. The project engineers should review our seismic shaking parameters and choose a value appropriate for their particular analyses.

4. Drainage from improved surfaces such as walkways, roadways and parking areas along the project area should be collected in impermeable gutters or pipes and either carried to the beach level via closed conduit or discharged into an established storm drain system that does not issue onto the exposed bluff. Any drain water on paved areas should not be allowed to flow toward the bluff-top. The control of runoff is essential for control of erosion and prevention of ponding.

5. We request the privilege of reviewing all geotechnical engineering, civil engineering, drainage, and architectural reports and plans pertaining to the proposed improvements.

INVESTIGATION LIMITATIONS

1. The conclusions and recommendations contained herein are based on probability and in no way imply that the proposed development will not possibly be subjected to ground failure, seismic shaking, coastal erosion or landsliding of such a magnitude that it overwhelms the site. The report does suggest that using the site for residential purposes in compliance with the recommendations contained herein is an acceptable risk.

2. This report is issued with the understanding that it is the duty and responsibility of the owner or his representative or agent to ensure that the recommendations contained in this report are brought to the attention of the architect and engineers for the project, incorporated into the plans and specifications, and that the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

3. If any unexpected variations in soil conditions or if any undesirable conditions are encountered during construction, Rogers E. Johnson and Associates should be notified so that supplemental recommendations may be given.

REFERENCES

Aerial Photographs

1928 (date uncertain) (1928-H), frames SC-31 and 32, black and white, nominal scale 1:12,000, California Joint Highway District No. 9.

22 June 1994 (1994), frames BIG CREEK LUMBER 14-1 and 2, black and white, nominal scale 1:15,840, Big Creek Lumber.

20 September 1997 (1997), frames WAC-97CA 14-255 and 256, black and white, nominal scale 1:24,000, WAC Corporation.

7 June 2001 (2001), frames CCC-BOK-C 123-4 and 5, color, nominal scale 1:12,000, California State Dept. of Water Resources.

26 June 2003 (2003-A), frames AMBAG, CA 332-10 and 11, color, nominal scale 1:7,200, Association of Monterey Bay Area Governments.

Photos are available for viewing at the Map Room in the Science Library at the University of California, Santa Cruz. References to the Map Room collection (e.g., 1990-B, etc.) are provided for convenience.

Maps and Reports

Abrahamson, N.A., and Silva, W.J., 1996, Empirical ground motion models, report prepared for Brookhaven National Laboratory, New York, NY, May, 144pp.

Abrahamson, N.A. and Silva, W.J., 1997, Empirical response spectral attenuation relations for shallow crustal earthquakes, Seismological Research Letters, v. 68, p. 94-127.

Ashford, S.A., and Sitar, N., 2002, Simplified method for evaluating seismic stability of steep slopes, Journal of Geotechnical and Geoenvironmental Engineering, American Society of Civil Engineers, v. 128, no. 2, p. 119-128.

Bixby, H.C., Jr., 1962, Storms causing harbor and shoreline damage through wind and waves--Monterey, California. Naval Postgraduate School, Monterey, California, unpublished Master's thesis.

California Coastal Commission, 1978, Wave damage along the California Coast, December 1977-March 1978. Publ. San Francisco, California.

California Coastline.org, various years, Oblique Aerial Photos of Twin Lakes Beach Area, http://www.californiacoastline.org/ , accessed on 1 June 2009.

California Division of Mines and Geology, 1997, Guidelines for Evaluating and Mitigating Seismic Hazzards in California, Special Publication 117, 74p.

Climate Change International Scientific Congress, 2009, Rising Sea Levels to Have Major Impacts Around the World, http://climatecongress.ku.dk/newsroom/rising_sealevels/ , accessed on 1 June 2009.

Dupré, W.R., 1975, Geology and Liquefaction Potential of Quaternary Deposits in Santa Cruz County, California, U.S. Geological Survey Miscellaneous Field Studies Map MF-648, 2 sheets, scale 1:62,500.

Dupré, W.R., and Tinsley, J.C., III, 1998, Evaluation of Liquefaction-Hazard Mapping in the Monterey Bay Region, Central California, in Holtz, T.L. (editor), The Loma Prieta, California, Earthquake of October 17, 1989 – Liquefaction, U. S. Geological Survey Professional Paper 1551-B, p. 273-285.

Federal Emergency Management Agency (FEMA), 2006, Flood Insurance Rate Map, Santa Cruz County, California and incorporated areas, Map No. 06087C0334D, effective date March 2, 2006, scale 1:24,000.

Federal Emergency Management Agency (FEMA), 2006, Flood Insurance Rate Map, Santa Cruz County, California and incorporated areas, Map No. 06087C0353D, effective date March 2, 2006, scale 1:24,000.

Griggs, G.B., and Johnson, R.E., 1976, Effects of the Santa Cruz Harbor on coastal processes of northern Monterey Bay, California, Environmental Geology, v. 1, p. 299-312.

Griggs, G.B., and Johnson, R.E., 1979, Coastline erosion: Santa Cruz County, California, Geology, v. 32, p. 67-76.

Griggs, G.B., and Johnson, R.E., 1983, Impact of 1983 storms on the coastline, northern Monterey Bay and Santa Cruz County, California, California Geology, v. 36, p. 163-174.

Griggs, G.B., 1990, Coastal erosion and protection, northern Monterey Bay, in Griggs, G.B. and Weber, G.E., eds., Coastal Geologic Hazards and Coastal Tectonics, Association of Engineering Geologists Field Trip Guide, p. 1-49.

Intergovernmental Panel on Climate Change, 2007, I.P.C.C. Fourth Assessment Report: Climate Change 2007: A Report of the Intergovernmental Panel on Climate Change, I.P.C.C., Valencia, Spain, Summary for Policy Makers, 22p.

Johnson, Rogers E. & Associates, 1987, Marina Dunes Shoreline Recession Study, unpublished consultants report.

Johnson, Rogers E. & Associates, 1995, Geologic Report, Proposed Improvements to East Cliff Drive, Santa Cruz Harbor to Schwan Lake, Santa Cruz County, California, unpublished consultants report, job no. C95033-68, prepared 16 October 1995, 57p.

Lawson, A.C., Gilbert, G.K., Reid, H.F., Branner, J.C., Fairbanks, H.W., Wood, H.O., Hayford, J.F., Baldwin, A.L., Omori, F., Leuschner, A.O., Davidson, G., Matthes, F.E., Anderson, R., Louderback, G.D., Holway, R.S., Eakle, A.S., Crandall, R., Hoffman, G.F., Warring, G.A., Hughes, E., Rogers, F.J., and Baird, A., 1908, The California Earthquake of April 18, 1906, Report of the State Earthquake Investigation Commission, Carnegie Institution of Washington, Publication 87, 2 v. and atlas, 600 p.

National Marine Consultants, 1960, Wave statistics for seven deep water stations along the California coast. Prepared for U.S. Army Corps of Engineers, Los Angeles and San Francisco districts, 20.p.

Petersen, M.D., Bryant, W.A., Cramer, C.H., Cao, T., Reichle, M.S., Frankel, A.D., Lienkamper, J.J., McCrory, P.A., Schwartz, D.P., 1996, Probabilistic seismic hazard assessment for the State of California: California Division of Mines and Geology Open-File Report issued jointly with United States Geological Survey, CDMG 96-08 and USGS 96-706, 52 p.

Santa Cruz County Redevelopment Agency, 2008, Twin Lakes Beachfront Project, Concept Plan, Revised 28 July 2008.

Stover, C.W., Reagor, B.G., Baldwin, F.W., and Brewer, L.R., 1990, Preliminary isoseismal map for the Santa Cruz (Loma Prieta), California, earthquake of October 18, 1989 UTC, U. S. Geological Survey Open-File Report 90-18, 24 p.

U.S. Army Corps of Engineers, 1958, Santa Cruz County, California, Beach Erosion Control Study, U.S. Government Printing Office, Washington, D.C., 91 p.

U.S. Army Corps of Engineers, 1998, Field Wave Gauging Program: Pt. Reyes Buoy (CDIP 02901) and Santa Cruz Harbor Array (CDIP 00601); U.S. Army Corps of Engineers, Coastal and Hydraulics Laboratory [Internet data].

U.S. Geological Survey, 1954 (photo revised 1981), Santa Cruz Quadrangle, California, U.S. Geological Survey 5 x 11 minute topographic series, scale 1:24,000.

U.S. Geological Survey, 1954 (photo revised 1994), Soquel Quadrangle, California, U.S. Geological Survey 7.5' topographic series, scale 1:24,000.

Wiegel, R.L., 1964, Oceanographical Engineering, Prentice-Hall, Inc., Englewood Cliffs, NJ.

Working Group on Northern California Earthquake Potential, 1996, Database of potential sources for earthquakes larger than magnitude 6 in northern California, U. S. Geological Survey Open-File Report 96-705, 53 p.

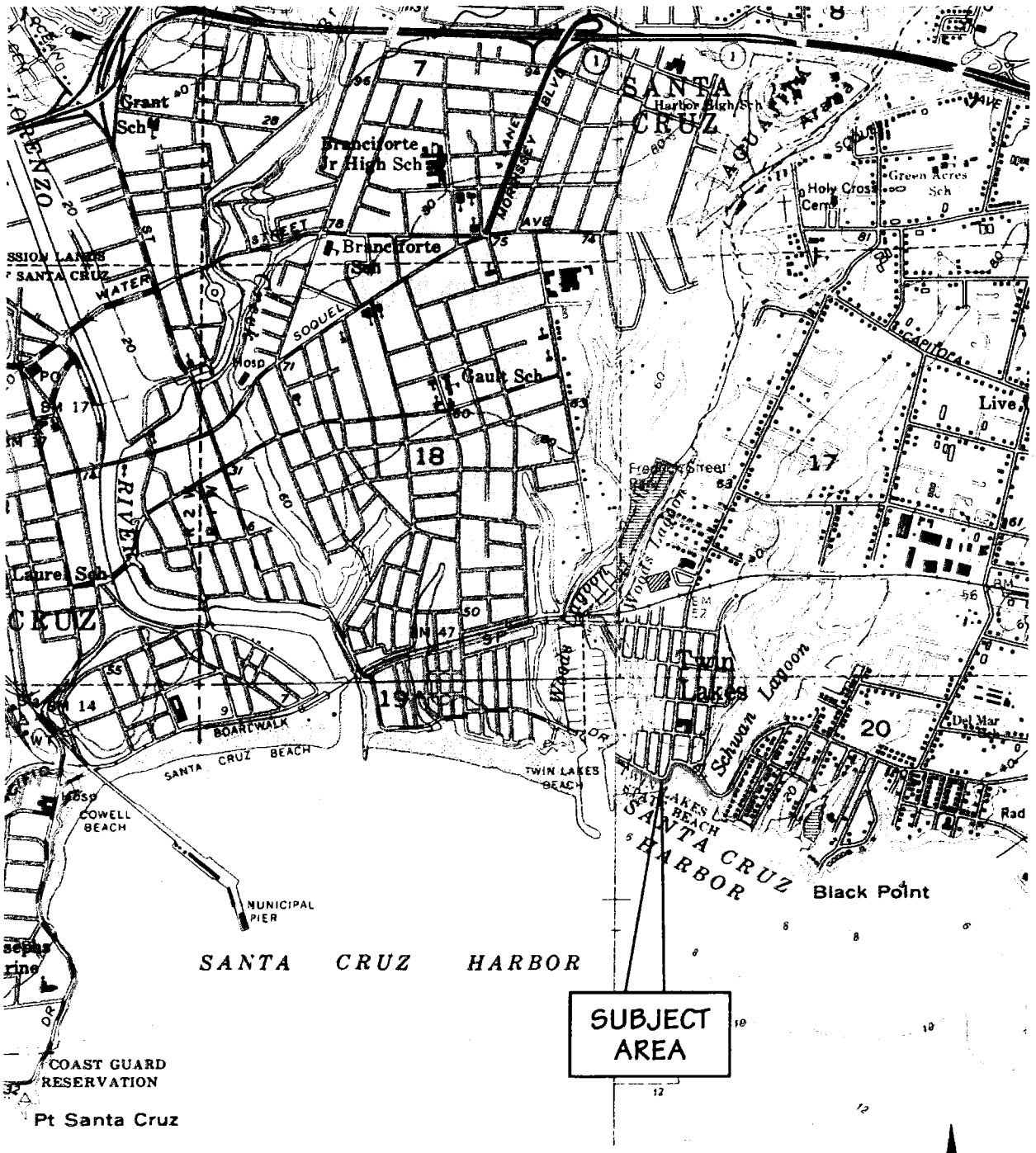
Youd, T.L., and Hoose, S.N., 1978, Historic ground failures in northern California triggered by earthquakes, U. S. Geological Survey Professional Paper 993, 177 p.

ATTACHMENT

APPENDIX A

FIGURES 1 through 3

ATTACHMENT 3



Base Maps: SANTA CRUZ QUADRANGLE, California, 5 x 11 Minute, United States Geological Survey, 1954 (revised 1981) and SOQUEL QUADRANGLE, California, 7.5 Minute Series, United States Geological Survey, 1954 (revised 1994), scales 1:24,000.

0 feet 2,000

ROGERS E. JOHNSON & ASSOCIATES Consulting Engineering Geologists 41 Hangar Way, Suite B Watsonville, California 95076 (831)728-7200 FAX (831)728-7218	**SITE LOCATION MAP** *Twin Lakes Beachfront Project* East Cliff Drive Santa Cruz County Redevelopment Agency Santa Cruz County, California	**FIGURE #** 1 JOB # C09001-54

Photo 1 - view to the north

See Plates 1a and 1b for photograph locations.

Photos taken on 9 February 1998

Photo 2 - view to the northeast

Photo 3 - view to the north

Photo 4 - view to the northeast

1998 El Nino Photographs
Twin Lakes Beachfront Project
East Cliff Drive
Santa Cruz County Redevelopment Agency
Santa Cruz, California

Drawing # Figure 2
Project # 609001-54
Date: 6/2/09
Revised:
Scale: no scale
Drawn By: GFE

ROGERS E. JOHNSON & ASSOCIATES
Consulting Engineering Geologists
41 Hangar Way, Suite B
Watsonville, California 95076
(831)728-7200 FAX (831)728-7218

ATTACHMENT 3

Photo 5 - view to the east

Photo 6 - view to the northeast

Photo 7 - view to the west

Photo 8 - view to the west

See Plates 1a and 1b for photograph locations.

Photo 5 taken on 5 February 1998

Photos 6 and 7 taken on 6 February 1998

Photo 8 taken on 25 February 1998

ROGERS E. JOHNSON & ASSOCIATES
Consulting Engineering Geologists
41 Hangar Way, Suite B
Watsonville, California 95076
(831)728-7200 FAX (831)728-7218

1998 El Nino Photographs
Twin Lakes Beachfront Project
East Cliff Drive
Santa Cruz County Redevelopment Agency
Santa Cruz, California

Scale:	no scale
Drawn By:	GFE
Date:	6/2/09
Revised:	
Drawing #	Figure 3
Project #	C09001-54

ATTACHMENT 2

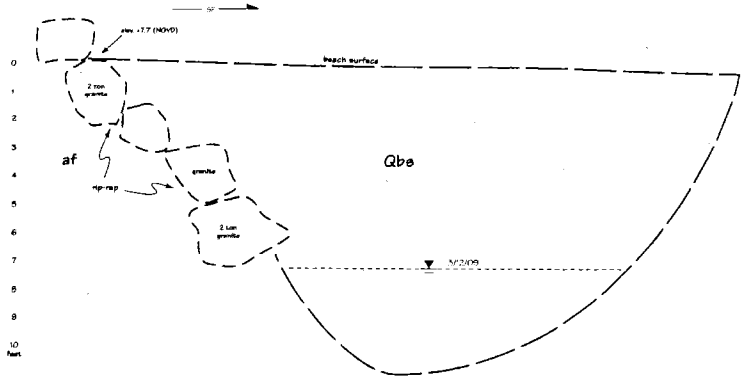
ATTACHMENT 3

LOG OF TEST-PITS
Twin Lakes Beachfront Project
East Cliff Drive
Santa Cruz County Redevelopment Agency
Santa Cruz, California

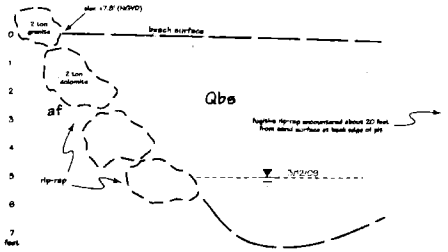
ROGERS E. JOHNSON & ASSOCIATES
Consulting Engineering Geologists
4 Harbor Way, Suite B
Watsonville, California 95076
(831)728-7250 FAX (831)728-7184

PLATE 3

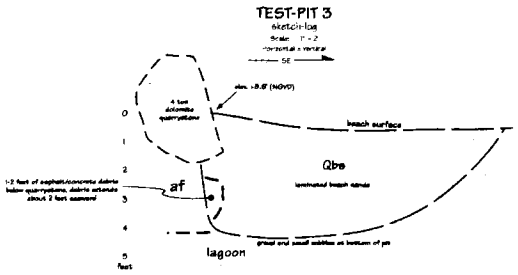
TEST-PIT 1
sketch log
Scale: 1" = 2'
Horizontal = Vertical



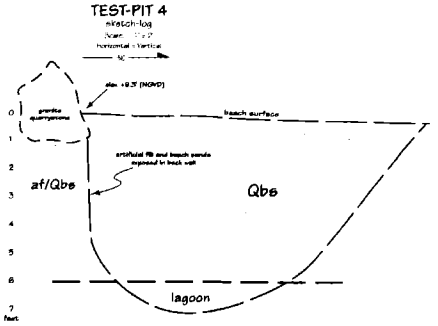
TEST-PIT 2
sketch log
Scale: 1" = 2'
Horizontal = Vertical



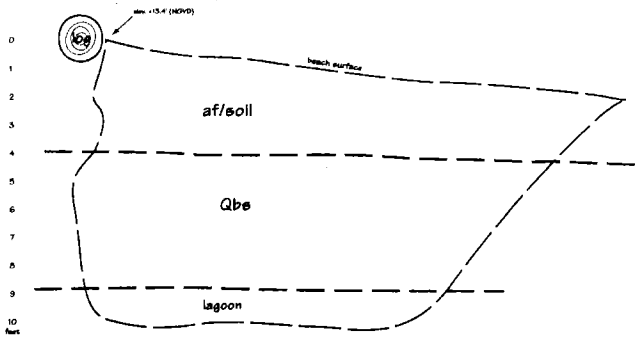
TEST-PIT 3
sketch log
Scale: 1" = 2'
Horizontal = Vertical



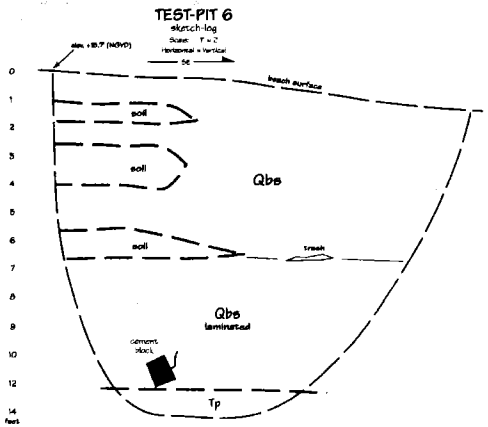
TEST-PIT 4
sketch log
Scale: 1" = 2'
Horizontal = Vertical



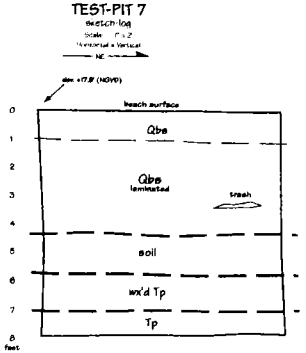
TEST-PIT 5
sketch log
Scale: 1" = 2'
Horizontal = Vertical



TEST-PIT 6
sketch log
Scale: 1" = 2'
Horizontal = Vertical



TEST-PIT 7
sketch log
Scale: 1" = 2'
Horizontal = Vertical



TEST-PIT EXPLANATION

SYMBOLS

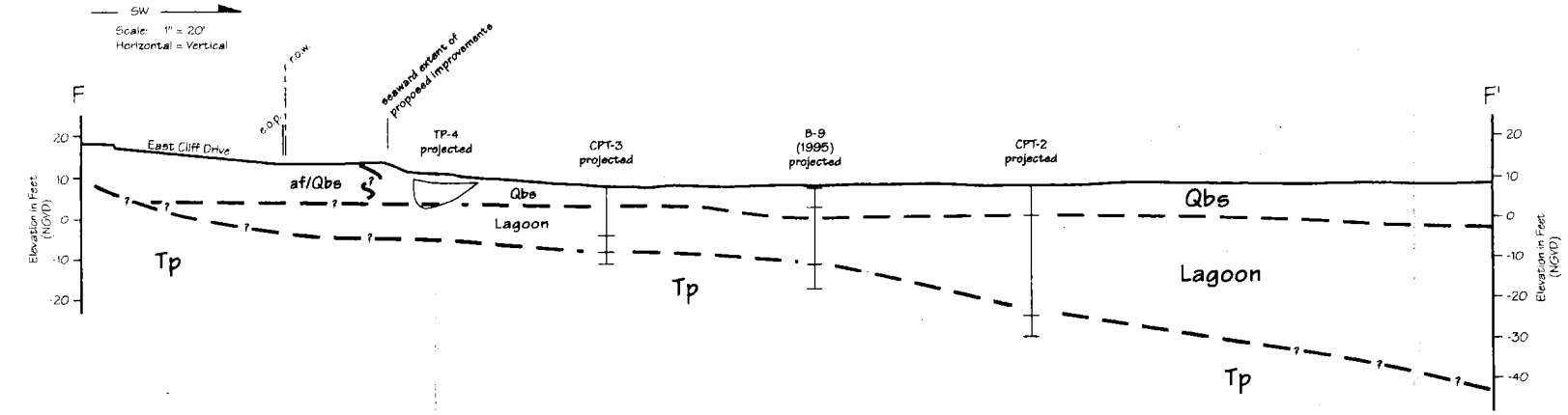
- Geologic contact — dashed where approximate, queried where uncertain.
- Fault contact, dashed where approximate, queried where uncertain.
- 3/12/09 — Elevation and date of observed groundwater

EARTH MATERIALS

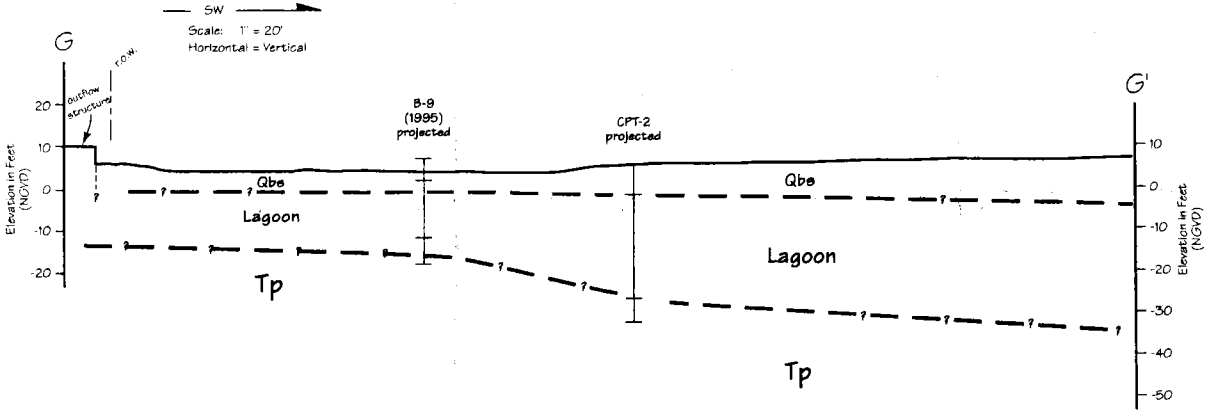
af	Artificial fill
Qbs	Beach sand
lagoon	Continental deposits consisting of lagoonal clays and sands
Tp	Purisima formation bedrock - silty sandstone

ENGINEERING GEOLOGY

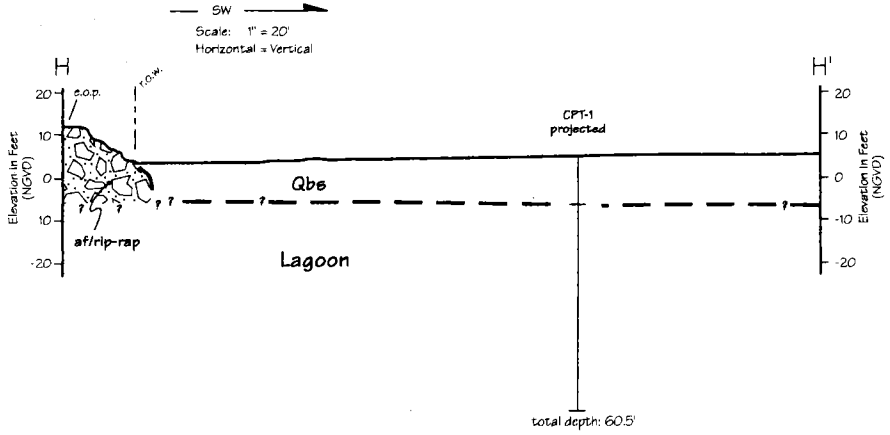
East Cliff Drive Cross Section F-F'



East Cliff Drive Cross Section G-G'



East Cliff Drive Cross Section H-H'



EXPLANATION

Symbols

?	Geologic contact - dashed where approximate, queried where uncertain.
r.o.w.	Existing right of way.
e.o.p.	Existing edge of pavement.
CPT-6 projected	Exploratory cone penetration test hole (advanced 2 March 2009; Haro, Kasunich & Associates).
B-9 (1995) projected	Exploratory boring advanced in 1995; Haro, Kasunich & Associates.
TP-4 projected	Exploratory test-pit (excavated 12 March 2009; Rogers Johnson & Associates).
TP-2 (1995) projected	Exploratory test-pit excavated in 1995; Rogers Johnson & Associates.

Earth Materials

af	Artificial fill
Qbs	Beach sand
lagoon	Continental deposits - lagoonal clays and sands
Tp	Purisima Formation bedrock - silty sandstone

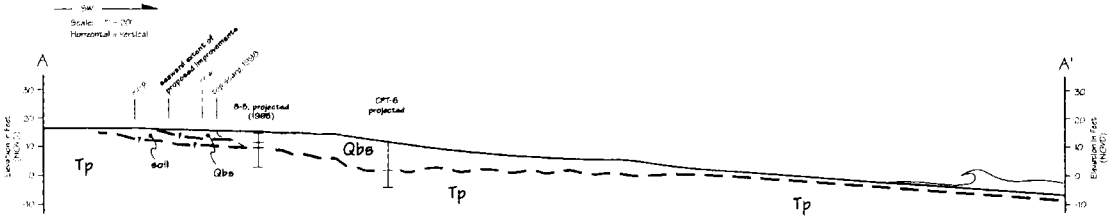
0 Feet 20

ROAD AND BEACH CROSS SECTIONS
Twin Lakes Beachfront Project
East Cliff Drive
Santa Cruz County Redevelopment Agency
Santa Cruz, California

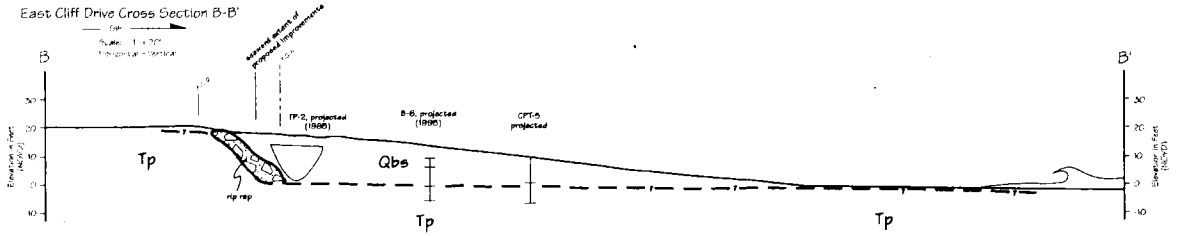
Scale: 1" = 20' H=V	Date: 5/15/09	Job # CO9001-54	Drawing Number PLATE 2b
By: R.E.J., G.F.L. etc	Revised:		

ROGERS E. JOHNSON & ASSOCIATES
Consulting Engineering Geologists
41 Hangar Way, Suite B
Watsonville, California 95076
(831)728-7200 FAX (831)728-7215

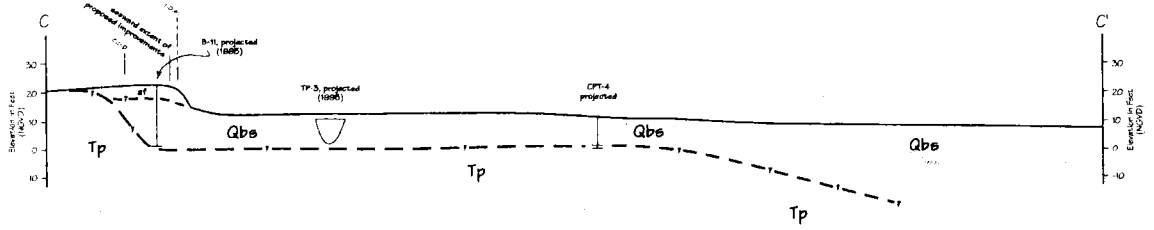
East Cliff Drive Cross Section A-A'



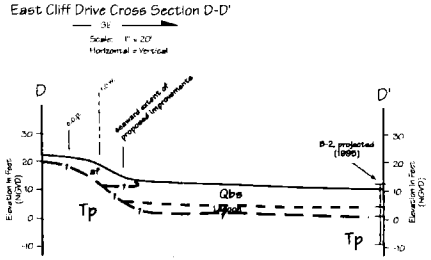
East Cliff Drive Cross Section B-B'



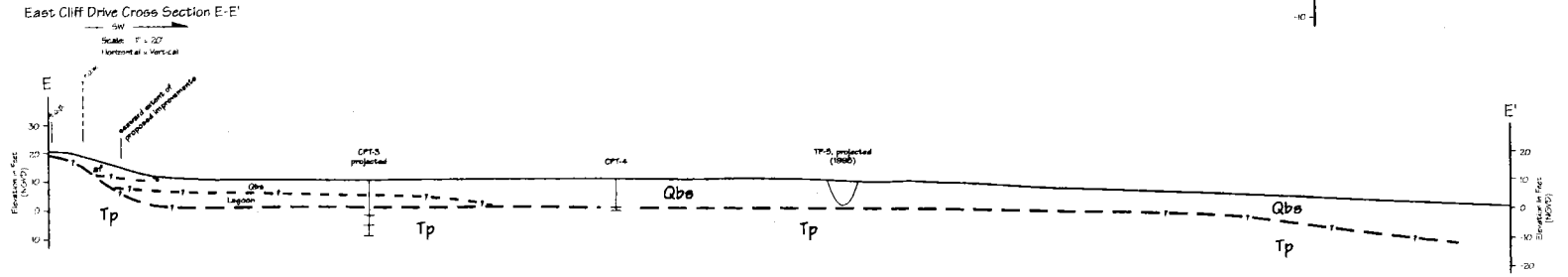
East Cliff Drive Cross Section C-C'



East Cliff Drive Cross Section D-D'



East Cliff Drive Cross Section E-E'



ROAD AND BEACH CROSS SECTIONS
Twin Lakes Beachfront Project
East Cliff Drive
Santa Cruz County Redevelopment Agency
Santa Cruz, California

Scale: 1" = 20' Horz.	Date: 3/30/09	Job # G08001-04
By: RJ, SFT, ph	Revised:	Drawing Number PLATE 2a

ROGERS E. JOHNSON & ASSOCIATES
Consulting Engineering Geologists
41 Hangar Way, Suite B
Watsonville, California 95076
(831)728-7200 FAX (831)728-7218

EXPLANATION

Symbols

- Geologic contact - dashed where approximate, queried where uncertain.
- r.o.w. — Existing right of way.
- e.o.p. — Existing edge of pavement.
- CPT-6 projected — Exploratory cone penetration test boring (advanced 2 March 2009, Hart, Kawuich & Associates).
- B-9 (1995) projected — Exploratory boring advanced in 1995, Hart, Kawuich & Associates.
- TP-4 projected — Exploratory test pit (excavated 12 March 2009, Rogers Johnson & Associates).
- TP-2 (1995) projected — Exploratory test pit excavated in 1995, Rogers Johnson & Associates.

Earth Materials

af	Artificial fill
Qbs	Beach sand
lagoon	Continental deposits - lagoonal clays and sands
Tp	Purisima Formation bedrock - silty sandstone

ATTACHMENT 3

ATTACHMENT 3

APPENDIX B

1995 GEOLOGIC REPORT TEXT

ATTACHMENT 3

GEOLOGIC REPORT

PROPOSED IMPROVEMENTS TO EAST CLIFF DRIVE

SANTA CRUZ HARBOR TO SCHWAN LAKE

SANTA CRUZ COUNTY, CALIFORNIA

REJA Job No. C95033-68

16 October 1995

Rogers E. Johnson & Associates

ATTACHMENT 3

16 October 1995

Mr. Carl Rom
Santa Cruz County Department of Public Works
701 Ocean Street
Santa Cruz, California 95060

Job No. C95033-68

Re: Proposed Improvements to East Cliff Drive
Santa Cruz Harbor to Schwan Lake
Santa Cruz County, California

Dear Mr. Rom:

Attached is our geologic report on the road alignment referenced above, which documents geologic and oceanographic conditions in the study area and addresses potential hazards to the proposed road improvement project, such as surf erosion, seismic shaking, and liquefaction. The companion report by Haro, Kasunich and Associates presents quantitative wave runup analyses for the beach adjacent to East Cliff Drive and gives specific engineering recommendations for mitigating the hazard to the road improvements posed by wave runup and scour. A detailed liquefaction analysis for the segment flanking Schwan Lake was beyond the scope of our combined services.

If you have any questions or comments regarding this report, please contact us at your earliest convenience.

Sincerely,

ROGERS E. JOHNSON AND ASSOCIATES

Alan O. Allwardt
R.G. No. 5520

Rogers E. Johnson
C.E.G. No. 1016

AOA/REJ/cjd

ATTACHMENT

TABLE OF CONTENTS

EXECUTIVE SUMMARY v
Purpose v
Findings v
Levels of Risk vi
Recommendations vii

INTRODUCTION 1

REGIONAL GEOLOGIC SETTING 1

SHORELINE HAZARDS IN MONTEREY BAY 3
Overview 3
Storm History of Monterey Bay, 1910-1983 5
Deep-Water Wave Conditions 9
Wave Runup Analysis 10
Human Intervention and Coastal Processes 13

AERIAL PHOTOGRAPHIC INTERPRETATION 15

FIELD INVESTIGATION 19
Geologic Setting 19
Subsurface Investigation 20
Subsurface Synthesis 26

SEISMICITY 29
Coseismic Slope Stability and Liquefaction 33

CONCLUSIONS 34

RECOMMENDATIONS 36

INVESTIGATION LIMITATIONS 37

REFERENCES 39

APPENDICES
Appendix 1: Storm History of Monterey Bay and the Central Coast, 1910-1983
Appendix 2: Sketch Logs of Exploratory Test Pits

TABLE
Table 1: Modified Mercalli Intensity Scale 32

ATTACHMENT 3

Table of Contents (contd.)

FIGURES

Figure 1: Plan View and Longitudinal Section from San Lorenzo Point to Soquel Point 2
Figure 2: Regional Geology 4
Figure 3: Offshore Wave Direction and Frequency 7
Figure 4: Wave Refraction in Monterey Bay, California . . 8
Figure 5: Schematic Cross Section Illustrating Wave Runup Terms 11
Figure 6: Beach Widths Before and After Construction of the Santa Cruz Yacht Harbor 14
Figure 7: Seacliff Erosion Before and After Construction of the Santa Cruz Yacht Harbor 16
Figure 8: Aerial Photographic Interpretation, Santa Cruz Harbor to Schwan Lake 18
Figure 9: Transverse Section X-X' 21
Figure 10: Transverse Section Y-Y' 22
Figure 11: Regional Earthquake Epicenters 31

PLATES

Plate 1: Geologic Site Plan . . . . . Pocket
Plate 2: Geologic Cross Sections . . . . . Pocket

ATTACHMENT 3

EXECUTIVE SUMMARY

Purpose

The stretch of East Cliff Drive between 5th Avenue and Schwan Lake is slated for improvements including widening of the roadway and addition of a bike/walkway. The attached geologic report and companion geotechnical report document the geologic and oceanographic conditions on the site, assess the hazards to the proposed improvements, and provide recommendations for mitigating those hazards.

Findings

The road alignment in question follows the edge of the beach between the Santa Cruz Harbor and Schwan Lake. The road in this area consists of two straight segments near beach level separated by a more elevated, pronounced S-turn. The two straight segments are constructed on fill embankments over beach and/or lagoonal deposits. The S-turn occupies a partial bench cut in the low, moderately steep coastal bluff, with a fill wedge on the outboard side. The coastal bluff consists of Purisima Formation overlain by partially stripped terrace deposits.

The beach is underlain by coastal deposits of variable thickness resting on Purisima bedrock. Between Woods Lagoon (now the harbor) and Schwan Lake, the buried bedrock surface is a wave-cut platform, and the beach deposits (and localized lagoonal deposits) are generally 15 feet thick or less. Seaward of Schwan Lake, however, the beach is underlain by at least 80 feet of Holocene beach and lagoonal deposits occupying the drowned and

ATTACHMENT 2

backfilled mouth of a Pleistocene drainage. A similar buried bedrock depression occupies the mouth of Woods Lagoon (the harbor), just west of the study area.

Levels of Risk

Construction of the Santa Cruz Harbor in the early 1960s disrupted the normal littoral flow of sand in northern Monterey Bay, leaving the downcoast beaches partially "starved" in the winter months. Although dredging of the harbor mouth has rectified this situation somewhat, many of the downcoast beaches still offer less protection for the shoreline during major storms than they did prior to construction of the harbor.

Aerial photographs of the study area taken in the 1980s show that wave runup and scour have encroached on East Cliff Drive in two locations: 1) along the seaward portion of the S-turn, near the foot of Assembly Avenue, and 2) along the embankment fronting Schwan Lake. The risk at these locations has been quantified by the project geotechnical engineers in their wave runup analysis. The geotechnical engineers have also analyzed wave runup for the straight segment of road between the harbor and the S-turn, where the risk is lower but still significant.

The only segment of road in the study area where the risk from wave runup and beach scour is low is the landward portion of the S-turn, approaching the intersection of East Cliff Drive with 7th Avenue. This area is in a "shadow" zone by virtue of the coastline geometry.

The study area is in a seismically active region with a moderate to high probability for strong seismic shaking during the design lifetime of the proposed road improvements. The road alignment across the mouth of Schwan Lake overlies Holocene coastal deposits more than 80 feet thick, some of which may be susceptible to liquefaction.

Recommendations

As we understand, the proposed road improvements will be implemented in three phases.

Phase 1 corresponds with the landward portion of the S-turn, where wave runup and scour do not pose a serious risk. The project geotechnical engineer has supplied design criteria for retaining walls along this stretch as necessary.

Phase 2 includes the straight segment of road immediately east of the harbor and the seaward portion of the S-turn, where the risk from wave runup and scour is moderate to high. The project geotechnical engineer has provided design criteria for various types of seawalls.

Phase 3 corresponds with the straight segment of road seaward of Schwan Lake, where the risk from wave runup and scour is high. The project geotechnical engineer has provided design criteria for various types of sea wall. Bear in mind, however, that a detailed liquefaction analysis for this area may be warranted and the results could have a bearing on the final design parameters.

All earthwork and structural design should accommodate the seismic-shaking parameters presented herein for the "design" earthquake.

ATTACHMENT 3

INTRODUCTION

This report presents the results of our geologic investigation along East Cliff Drive from the Santa Cruz Harbor to Schwan Lake. Our investigation was undertaken in conjunction with Haro, Kasunich and Associates, geotechnical engineers, to: 1) document geologic and oceanographic conditions in the study area, 2) evaluate potential hazards to a road improvement project planned by the Santa Cruz County Department of Public Works, and 3) provide recommendations for mitigating the identified hazards.

The scope of work performed for this investigation included: 1) review of existing published and unpublished literature relevant to the site and vicinity; 2) analysis of stereo-aerial photographs spanning the period 1931-1989; 3) excavation of eight backhoe test pits and eleven exploratory borings in conjunction with Haro, Kasunich and Associates; 4) compilation of a geologic site plan and several cross sections; 5) geologic inspection of the low coastal bluff along the road; 6) compilation and analysis of the resulting data; and 7) preparation of this report and accompanying illustrations. We have worked closely in this project with Haro, Kasunich and Associates and staff of the Santa Cruz County Department of Public Works.

REGIONAL GEOLOGIC SETTING

The study area is located in northern Monterey Bay along the coastline between San Lorenzo Point and Soquel Point, which trends roughly west to east and is characterized by a low seacliff interrupted by several coastal lagoons (Figure 1). This is one of many such cliffs in the Santa Cruz area exposing gently

dipping, late Tertiary marine sedimentary rocks overlain by nearly horizontal, Quaternary terrace deposits of marine and eolian origin. The seismicity of the region is influenced primarily by the northwest-trending San Andreas fault situated northeast of the study area, and the San Gregorio fault located offshore in Monterey Bay (Figure 2; see also Hall et al., 1974 and Greene, 1977). The seismicity of the site will be discussed in more detail below.

The orientation of the coastline in northern Monterey Bay greatly influences the development of sandy beaches that protect the seacliffs against surf attack. From San Lorenzo Point to Soquel Point, for example, the west-to-east shoreline lies at a high angle to the dominant direction of approach for refracted waves, which is conducive to the formation of fairly wide beaches. In contrast, the southwest-to-northeast shoreline between Soquel Point and Capitola is nearly parallel to the approaching waves, causing rapid littoral drift that inhibits the formation of a continuous beach (Griggs, 1990). Instead, a series of pocket beaches have formed, Capitola Beach being the largest, which are very sensitive to seasonal changes and human intervention. At New Brighton State Beach the shoreline turns to a northwest-southeast orientation, which is again conducive to the formation of a wide, continuous beach. These oceanographic factors and their implications for coastal development will be discussed in more detail below.

SHORELINE HAZARDS IN MONTEREY BAY

Overview

Most of the northern end of Monterey Bay is flanked by prominent seacliffs 20 to 120 feet high, a clear indication of active surf erosion (in a geological time frame). From Santa Cruz to Capitola, where the beach is generally narrow and discontinuous, the documented rate of cliff retreat due to surf attack has averaged over one foot per year in some areas (Griggs and Johnson, 1979). Of course, this cliff retreat is not a steady process as the quoted rate might seem to imply, but rather occurs episodically every few seasons in response to large storms and/or when surf-cut notches at the base of the bluffs intercept prominent bedrock joints or other zones of structural weakness.

From New Brighton State Beach to La Selva Beach, the seacliff was formed in the same manner, but this fact has been less obvious to the layman because of the relatively wide and continuous beach at the foot of the bluff. Both public and private developments have taken place on the beach in this area simply because the hazard from surf attack lacks a certain degree of immediacy. Naturally the construction of permanent structures in this inherently impermanent setting has met with mixed success, depending on the engineering precautions that were taken in each case. The relevant oceanographic factors are discussed in more detail below.

Storm History of Monterey Bay, 1910-1983

Review of the storm history of Monterey Bay leads us to several immediate conclusions:

1) The number of large storms affecting Monterey Bay is relatively large.

2) The storms which produced the greatest damage in the interior of the Bay often came from the west or southwest.

3) Structures directly exposed to wave action, or designed to protect ocean front properties from such action, have been regularly damaged or destroyed.

For the period of most detailed record, 1910-1960, there have been at least 45 storms of some significance (i.e., either high seas, strong winds, and/or damage to at least some portion of the Monterey Bay region). Thus, considering the 50 years of detailed records, this amounts to a major storm every 1.1 years on the average. Analysis of the record (Appendix 1) reveals that no major storms were recorded for some intervals as long as seven years (1916-1923), but in other cases, five significant storms occurred within a single year (1931). If we consider the entire period, 1910-1983, we have a major storm every 1.5 years on the average.

This historical record indicates that the northern one-half of Monterey Bay (Moss Landing to Santa Cruz) is most susceptible to damage from storms arriving from the west or southwest (Griggs and Johnson, 1983; Johnson and Associates, 1987). Waves from the northwest, which predominate along the central coast (Figure 3), undergo refraction or bending, which results in a significant energy loss prior to striking beaches along the interior of the Bay (Figure 4). Thus, although waves from the WNW and NW dominate along the coastline, their effect on the interior of the Bay

ATTACHMENT 8

appears to have been relatively small. In contrast, the storm waves approaching from the W, WSW and SW pass primarily over the deep water on their way to the shoreline within the Bay and lose little energy. These storms have produced the greatest recorded damage at the north end of the Bay.

Of the 45 major storms in the study period, 1910-1960, 20 have been listed as coming from the southwest or west; only 12 are described as arriving from the north or northwest (the remainder list no direction of approach). Of the 13 storms which have produced significant damage along the Bay's interior, only one is described as coming from the northwest; 11 arrived from the southwest, and for two of these, the direction was not listed. Thus, at least 85 percent of the storms which have caused damage approached from the south or southwest. Looking at the frequency of arrival of these storms, 13 have occurred in 69 years. In other words, damaging storms will strike the area every 5.3 years on the average. This does not mean that storms will actually occur every 5.3 years, of course.

The record of historical storm damage illuminates some other processes of relevance to the study area. The past damage to the Monterey Bay coastal area was often caused by the coupling or simultaneous occurrence of high tide and huge waves.

Deep-Water Wave Conditions

Wave data has been compiled from three different sources of numerous deep-water stations and also visual observations off Central California.

1) Ships' sea and swell reports summarized by the National Climatic Center and published by the U.S. Naval Weather Service Command as "Summary of Synoptic Meteorological Observation (SSMO)--North American Coastal Marine Areas--Pacific Coast".

2) "Wave Statistics for Seven Deep Water Stations along the California Coast", published by National Marine Consultants (1960).

3) "Deep-Water Wave Statistics for the California Coast", published by Meteorology International Incorporated (1977), based on hindcasts by the U.S. Fleet Numerical Weather Central.

As mentioned in the previous discussion of storms, the great majority of waves arrive from the northwest, but these must undergo significant energy loss through diffraction. Thus, waves from the southwest are normally of greater concern. Using hindcasting data from a station offshore from San Francisco (Nat. Mar. Cons., 1960), we can expect waves in excess of nine feet in height, on the average, 23 days of each year, and waves in excess of 15 feet three days each year. The storm record discussed earlier indicates storm waves ranging in height from 20 to 25 feet, arriving from the southwest, were recorded in 1939, 1940 and 1941. This data indicates that waves in excess of 10 to 15 feet are common in an average year, and waves in excess of 20 feet occur as well, although less frequently.

The potential impact of such storm waves on any given site can be quantified by wave runup analysis, as discussed in the next section.

Wave Runup Analysis

Coastal flood hazards can be quantified to some degree by using wave runup analysis. This procedure is site specific, taking into account past storm frequencies, wave characteristics, bathymetry, and beach profile, as well as antecedent astronomical and meteorological conditions. Wave runup analysis can be explained in a qualitative way by reference to the generalized sketch in Figure 5. The first step is to establish the expected "stillwater" elevation, representing the static water surface upon which the waves will be superimposed. Note that the stillwater elevation is higher than mean sea level for a number of reasons. The normal tidal range must be taken into account, obviously, because shoreline damage will be most severe during high tide. However, there are additional, less intuitive factors that tend to raise the stillwater elevation. Abnormally low barometric pressure and persistent onshore winds during storms, for instance, will both push up the water surface to some degree.

Stillwater elevations are expressed in probabilistic terms, much like storm frequencies. For design purposes, the Federal Emergency Management Agency (FEMA) and other governmental agencies have typically adopted the "100-year" conditions as a basis for their runup analyses. In this time frame, the slow but general rise of sea level must also be accommodated in the analysis (e.g., see Environmental Protection Agency, 1983; Hoffman, 1984).

ATTACHMENT 3

With the stillwater elevation established, the next step is to superimpose the effects of storm waves on the shoreline, using computer models. These models typically use historical data for deep-water wave conditions and direction of approach combined with field data for bathymetry and beach profiles. Again, the results are expressed in probabilistic terms with the 100-year event as the benchmark. Along the relevant portions of East Cliff Drive, FEMA (1986) has not calculated 100-year wave runup elevations for any specific sites. For this reason, the project geotechnical engineer has completed detailed wave runup analyses for the beach adjacent to the study area, incorporating the shoreline configuration depicted on our geologic cross sections (Plate 2).

Human Intervention and Coastal Processes

Previous studies have shown that almost all of the annual sand supply for beaches in the Santa Cruz area can be attributed to littoral drift moving "downcoast" from north to south (see Griggs and Johnson, 1976, and references therein). Thus, any human intervention disrupting the normal littoral flow of sand would have a serious impact on these beaches. The construction of the Santa Cruz Yacht Harbor in 1962-1964 represented just such an event, as documented by Griggs and Johnson (1976). Their aerial photographic studies showed that the beach at Capitola, for example, averaged about 180 feet in width for the period 1932 to 1961, prior to construction of the yacht harbor. When the west jetty for the harbor was completed in late 1962, the annual littoral flow of sand totaling about 300,000 cubic yards was effectively cut off, causing the upcoast beaches to expand and the downcoast beaches to shrink (Figure 6). By 1965 the beach at

ATTACHMENT 3

Capitola had been reduced in width by almost 90 percent, to an average of only 20 feet. This beach remained depleted until 1970, when the city built a groin nearly 250 feet long at the downcoast end of the beach to help trap the diminished littoral supply and also brought in 2,000 truckloads of quarry sand as a supplement.

The beaches immediately downcoast from the harbor fared better, recovering somewhat after a few years as the buildup of sand on the upcoast side peaked and littoral drift began bypassing the jetties (Figure 6). However, some of the sand bypassing the jetties is now diverted into the deeper water of the bay and never actually reaches the downcoast beaches. In the winter months, furthermore, the harbor mouth traps up to 30 per cent of the entire annual littoral flow of sand (Griggs and Johnson, 1976). Although this sand is now dredged and reintroduced into the littoral drift system, the downcoast beaches are nevertheless deprived of a portion of this sand in the winter months when they need it the most.

With the downcoast beaches starved of sand by construction of the yacht harbor, the adjacent seacliffs are subjected to intensified surf attack and accelerated erosion. In 1963 and 1965 the U.S. Army Corps of Engineers installed riprap revetments along portions of the coastline to combat erosion, a measure that has met with mixed success. Griggs and Johnson (1976; 1970) established 60 stations along the coastline between San Lorenzo Point and New Brighton Beach and measured the rate of cliff top retreat at each, using maps and aerial photographs covering the period 1853-1973. Their results, shown in Figure 7, mirror the changes in the beaches shown in Figure 6.

ATTACHMENT 8

Although the Griggs and Johnson study is valuable as background information for understanding coastal processes in northern Monterey Bay and the impact of human intervention, most of the data are not directly applicable to the study area. Furthermore, the Griggs and Johnson study ended more than twenty years ago, predating the period most relevant to our current investigation. Hence, we have conducted our own aerial photographic study, focusing on local changes to the beach and bluff since construction of the harbor (and especially during the storm years of the 1980s).

AERIAL PHOTOGRAPHIC INTERPRETATION

We have examined 13 sets of large-scale, stereo aerial photographs of the study area and vicinity, covering the period 1931 to 1989. The photos taken prior to 1964 reveal seasonal and progressive changes to the beach, dune, and lagoon environments in the pre-harbor era. These older photos also show two significant alterations to East Cliff Drive that occurred between 1931 and 1948: the road alignment between 5th Avenue and 7th Avenue was straightened and moved seaward; and the wooden bridge across Schwan Lake was replaced by an embankment and restricted outlet for the lake.

The primary focus of our aerial photographic study, however, was beach and bluff erosion in the post-harbor era along the stretch of East Cliff Drive between the harbor and Schwan Lake. Figure 8 summarizes beach erosion for selected winters since the harbor was built. We can probably discount 1964 because the beach had not yet re-equilibrated following construction of the harbor jetties. The remaining data show a fairly consistent pattern,

with wave runup and beach scour encroaching on East Cliff Drive primarily in two locations: 1) along the seaward portion of the prominent S-turn in the road (near its intersection with Assembly Avenue), and 2) along the embankment fronting Schwan Lake.

At the beginning of the S-turn, near Assembly Avenue, the worst storm erosion occurred in the winter of 1983, when the low bluff flanking the outboard shoulder of East Cliff Drive retreated approximately 20 feet (based on careful measurements of 1982 and 1984 aerial photographs). Riprap was subsequently emplaced at this bend in the road to prevent localized undermining of the roadbed. It is clear that the road alignment will be threatened in the future, but only during the largest storms: the bluff retreat along East Cliff Drive near the foot of Assembly Avenue in 1983 (20 feet) exceeded the cumulative retreat at this location for the entire period of 1931 to 1973 (14 feet; see Griggs and Johnson, 1979). At the second location, near Schwan Lake, erosion of the old dune field seaward of East Cliff Drive has been progressive. By 1986 almost all of this dune field, along with the parking area built over it, had disappeared. Future wave runup during the largest storms will now impact the entire stretch of East Cliff Drive fronting Schwan Lake. (The hazard here to the road is certainly not new, however; see the entry for 26-27 December 1940 in Appendix 1).

Figure 8 shows that the shoreward portion of the S-turn in East Cliff Drive (near its intersection with 7th Avenue) is generally protected from surf attack by the geometry of the coastline. In 1986 the swash line reached the public bathrooms in this "shadow zone" but the berm representing significant beach scour lay considerably seaward. We will return to the geologic constraints

ATTACHMENT 9

on beach scour throughout the study area in our discussion of the geologic cross sections.

FIELD INVESTIGATION

Geologic Setting

The road alignment in question follows the edge of the beach between the Santa Cruz Harbor and Schwan Lake. From 5th Avenue (the edge of the harbor) to 9th Avenue (the edge of Schwan Lake) the beach is backed by a low, moderately steep coastal bluff consisting of Purisima Formation (Pliocene) overlain by partially stripped terrace deposits (Pleistocene). Figure 1 shows that the base of the terrace deposits should lie at an elevation of about 21.5 to 22.5 feet in the study area; we corroborated this supposition by examining bulldozer cuts on the corner lot near the S-turn (APN 27-182-04), where a house was demolished in September. The cuts at the back of the lot (elevation 24 to 29 feet) exposed soil and reddish brown, poorly consolidated, gravelly sands typical of the terrace deposits in the northern Monterey Bay area. In contrast, the bulldozer operator reported encountering "dense sandstone" beneath the floor of the dug-out garage at an elevation of 21 to 22 feet (personal communication), which probably represented the top of the Purisima. The roadbed for East Cliff Drive at this location is also between 21 and 22 feet in elevation. It appears, therefore, that the bench cut for the S-turn was created by scraping the terrace deposits off the denser Purisima bedrock below and dumping the spoils on the outboard edge to create a fill wedge. Exposures on the fill slope confirm that the fill material was derived from terrace deposits.

ATTACHMENT 9

The beach is underlain by Holocene coastal deposits including beach sand and lagoonal sands and muds, which rest on Purisima Formation bedrock. As discussed later, the distribution of beach and lagoonal deposits is variable, as is their thickness. Briefly, between the modern lagoons the coastal deposits are generally 15 feet thick or less and the bedrock surface beneath them is a wave-cut platform. Seaward of the lagoons, however, the coastal deposits are more than 80 feet thick, filling the mouths of drowned Pleistocene drainages. These stratigraphic relationships are depicted on the cross sections (Plate 2) and transverse sections (Figures 9 and 10).

Subsurface Investigation

In conjunction with Haro, Kasunich and Associates, geotechnical engineers, we excavated eight backhoe test pits and eleven 6-inch diameter borings throughout the study area in July and August, 1995. Sketch logs of the test pits are presented in Appendix 2 of this geological report; logs of the borings are presented in the companion geotechnical report by Haro, Kasunich and Associates.

The borings and excavations (and limited outcrops) revealed the following earth materials. Their distributions are shown on the cross sections, which will be discussed individually later.

Fill: Fill is typically found beneath the existing roadbed of East Cliff Drive and its outboard shoulder, but its composition and configuration vary considerably along the length of the alignment. Beneath the low-lying straight segment of road between 5th Avenue and the S-turn, the fill consists of base rock and local borrow from the adjacent beach environment (aerial

ATTACHMENT 9

photographs from 1931 suggest that this segment of road was constructed in part on an old dune). These materials are visible where storm scour has undermined portions of the outboard shoulder.

Along the S-turn the outboard shoulder is underlain by fill derived from terrace deposits excavated from the bluff during construction of the partial bench cut for the road. This material is typically composed of weathered, reddish-brown, gravelly sand with a variable content of silt and clay binder.

The outboard shoulder of the S-turn is also locally armored by riprap near the intersection of East Cliff Drive and Assembly Avenue, where wave scour attacked the shoulder in 1983 (as discussed earlier). This riprap appears undersized and was probably installed on an emergency basis. Riprap also protects the parking area on the seaward side of East Cliff Drive near the intersection with 9th Avenue.

Along the low-lying, straight segment of road fronting Schwan Lake, the roadbed is again constructed on an embankment composed largely of local borrow from the beach environment, as shown on undated, pre-1948 Public Works plans discovered by Ralph Norberg, civil engineer for the current project.

Colluvium: Colluvium underlies portions of the embankment along the outboard side of the S-turn, where it was deposited by slopewash at the base of the bluff. Like the fill wedge in this area, the colluvium has the lithologic character of its parent material, the terrace deposits exposed at the top of the bluff. However, the colluvium could be distinguished from the fill by

the presence of a distinct soil profile developed on the former (e.g., in TP-6). The toe of the colluvium interfingers with the coastal deposits beneath the beach; the presence of the mature soil indicates that the colluvium is much older than the upper layers of beach sand, however.

Beach Sand: The beach sand in the study area consists largely of loose, fine to medium-grained sand with a "salt and pepper" appearance (typical of local beaches) due to its feldspathic composition with lesser amounts of dark mica and heavy minerals. Some horizons beneath the beach, however, were distinctive because of their unusual concentrations of coarse to very coarse sand, gravel, broken shells, and/or heavy mineral laminations. These horizons were noted in the test pits and borings because they represent lag deposits from storm events. The lag deposits were an important constraint for the geotechnical engineer's wave runup analysis and were thus included on the cross sections (see discussion below).

Lagoonal Deposits: The lagoonal deposits encountered in the test pits and borings were distinguished by 1) their mottled, blue-green color and hydrogen sulfide odor, both indicative of a chemically reducing environment, and 2) the presence of marsh grass rootlets and (occasionally) the shells of tiny, fresh or brackish-water snails. The sediments themselves ranged from 1) fine to medium-grained sand very similar to beach sand, except for the chemical reduction "overprint," to 2) clayey sands or muds, which were sometimes interbedded with the cleaner sands. The coarser deposits were undoubtedly laid down by storms breaching the dune or beach ridge that normally blocked the mouth of the lagoon. Boring B-7, seaward of Schwan Lake and 80 feet

deep, demonstrated that the alternation of muds and sands in the lagoonal environment persisted at this location for most of Holocene time.

The lagoonal deposits represent an important constraint for the wave runup analysis for one simple reason: their presence at any particular location and depth indicates that recent wave scour has been insufficient to erode them. This point will be discussed further in connection with the cross sections.

Terrace Deposits: As noted earlier, Pleistocene terrace deposits are exposed sporadically in the study area above the elevation of about 21.5 to 22.5 feet. In the recent bulldozer cuts on the corner lot adjacent to the S-turn, the terrace deposits consisted of weathered, reddish brown, silty sand and sand with pebbly and cobbly horizons. Where the original ground surface was undisturbed, these deposits were overprinted by a mature soil profile between 3 and 4 feet thick. The terrace deposits in this area normally rest with slight angular unconformity on the Purisima Formation bedrock (Pliocene), which is described below.

Purisima Formation: The Purisima bedrock encountered in one test pit and most of the borings consisted of dense but relatively unlithified, olive brown, fine to medium-grained sandstone. The Purisima sandstone was lithologically very similar to the overlying beach deposits but clearly distinct from them on the basis of color and density. The lack of lithification was notable, however, and explains how the bluff at the beginning of the S-turn could retreat 20 feet in a single winter (1983).

ATTACHMENT 8

Subsurface Synthesis

Our synthesis of the subsurface data is presented in six cross sections at a scale of 1"=20' (Plate 2) and two transverse sections at a scale of 1"=50' (Figures 9 and 10), using topographic data furnished by surveyors for the Department of Public Works. The locations of these sections are shown on Plate 1, and each of them is explained below. Several of the sections on Plate 2 were used by the project geotechnical engineers in their wave runup analyses, as detailed in the companion geotechnical report.

Cross Section A-A': This section, located off 5th Avenue, depicts a thin veneer of beach sand on a wave-cut bedrock platform. Scour in the beach deposits (stippled pattern) was indicated in TP-1 by multiple shell horizons and a displaced riprap boulder at depth (see test pit logs, Appendix 2). Bedrock was encountered at 9 feet, separated from the beach sand by a half-foot of lagoonal deposits (not shown). The bedrock gradient seaward from TP-1 (about 2 percent) is based on the published, regional average for the inner wave-cut platform (Bradley and Griggs, 1976). The rise in the bedrock surface landward of TP-1 is conjectural but in some senses irrelevant to our hazard assessment because the Purisima sandstone in this area is unlithified and consequently prone to wave scour.

Cross Section B-B': This section was located at the beginning of the S-turn in East Cliff Drive, near the foot of Assembly Avenue. The beach deposits were 15 feet thick or less, with scour indicated by gravels, shell layers, and/or heavy mineral concentrations in TP-2 and B-6. Depth to bedrock was established

in B-6 and the regional platform gradient was applied. Note that the landward projection of the bedrock surface passes just beneath TP-2, where 20 feet of horizontal bedrock scour apparently occurred in 1983 (as deduced from aerial photographs). The subsurface configuration of the emergency riprap is conjectural but somewhat constrained by outcrops in the road shoulder and by several small, displaced boulders encountered in TP-2.

Cross Section C-C': This section extended seaward from the recessed portion of the S-turn. TP-6 revealed fill, colluvium, and lagoonal deposits at the base of the bluff. Buried beneath the beach, about 3 feet of lagoonal deposits rest on the bedrock surface in B-2 and B-3 but not, apparently, at TP-3. At various times in the historic past, an arm of Schwan Lake has extended westward toward the sites of B-2 and B-3 (e.g., 1931 aerial photographs). Consequently, it is not difficult to envision a more extensive lagoonal arm in the distant past, as implied by C-C'. It is conceivable, moreover, that these lagoonal deposits once extended farther seaward than shown and were subsequently scoured away. This scenario is consistent with the distribution of lag deposits shown on the section and also supports the "shadow zone" postulated for the recessed portion of the S-turn (see Aerial Photographic Interpretation, above). In any event, we can safely conclude that the depth of recent scour between B-2 and B-3 is constrained by the presence of the lagoonal deposits.

Depth to bedrock (generally 10 to 15 feet) was established in B-2, B-3 and B-4, yielding a seaward platform gradient for C-C' similar to the published regional average employed on A-A' and B-B'.

ATTACHMENT 8

Cross Section D-D': This section off the foot of 8th Avenue shows up to 7 feet of lagoonal deposits buried beneath the beach. Depth to bedrock was established in B-1 and the regional platform gradient was applied. The total thickness of coastal deposits above the bedrock platform is generally 15 feet or less. The landward termination of the coastal deposits, as shown on the section, is conjectural.

Depth of wave scour along D-D' is constrained by 1) the buried lagoonal deposits landward of B-9, and 2) the bedrock platform seaward of B-9. The most probable zones of wave scour lie within the stippled pattern, representing the projected upper and lower limits of the lag deposits encountered in B-1, B-9, TP-4 and TP-5.

Cross Section E-E': This section lies seaward of Schwan Lake, where bedrock is buried by more than 80 feet of beach and lagoonal deposits dating back to the rise in sea level at the end of the Pleistocene ice ages. The alternation of muddy and sandy intervals in B-7 is only approximate, since sampling below the water table was not possible with the drill rig employed.

Depth of wave scour between B-7 and B-8 is constrained by the top of the buried lagoonal deposits. The most probable zones of wave scour lie within the stippled pattern, representing the projected upper and lower limits of the lag deposits encountered in B-7 and B-8.

Cross Section F-F': This short section was located in the middle of the S-turn and depicts the partial bench cut and outboard fill wedge along East Cliff Drive in relation to the bedrock surface

and beach. Note that B-11 drilled through 10 feet of fill into at least 12 feet of beach sand, indicating that the fill wedge encroaches a considerable distance onto the beach at this point. Thus, the fill/beach/bedrock geometry midway through the S-turn differs considerably from the geometry at the two ends of the S-turn (see Cross Sections B-B' and C-C').

Transverse Section X-X': This section between the harbor and the seaward end of the S-turn shows the approximate depth to bedrock along the road alignment. The bedrock depression west of B-10 is the edge of the former Woods Lagoon. Elsewhere, the bedrock surface lies within 15 feet of the surface.

Transverse Section Y-Y': This section extends from the landward end of the S-turn past the mouth of Schwan Lake. The bedrock depression occupied by Schwan Lake extends under the beach roughly as shown. Establishing the exact geometry of this depression would require additional drilling.

SEISMICITY

The study area is located approximately 11 miles southwest of the San Andreas fault; the main trace of the San Gregorio fault lies approximately 12 miles to the southwest (Figure 2). These faults are possible sources of damaging earthquakes but the San Andreas is considered to be the most active fault within the region (Figure 11). The 1989 Loma Prieta earthquake probably relieved some stress along the segment of the San Andreas fault closest to the study area, called the southern Santa Cruz Mountains segment. However, the assumed 100-year economic lifetime for coastal developments is sufficiently long to allow stress on this segment

ATTACHMENT 9

to build up again and trigger a repeat of the Loma Prieta event. Therefore, using estimates from The Working Group on California Earthquake Probabilities (1990), the "design earthquake" for the subject site is a magnitude 7.0 earthquake centered on the southern Santa Cruz Mountains segment of the San Andreas fault. A magnitude 7.0 earthquake on the San Francisco Peninsula segment of the San Andreas (Working Group, 1990) or a magnitude 7.7 earthquake on the San Gregorio (Wesnousky, 1986) could also produce strong shaking at the site.

Ground shaking from a magnitude 7.0 earthquake 11 miles from the site would have a Modified Mercalli Intensity of approximately VII to VIII+ (Table 1), with a mean peak horizontal ground acceleration (MPHGA) of about 0.35 gravity (Seed and Idriss, 1982) and repeatable high ground accelerations (RHGA) of about 0.25 gravity, rounded to the nearest 0.05g (Ploessel and Slossen, 1974). The duration of ground shaking from this design event would be about 16 seconds (Dobry and others, 1978).

No active or potentially active faults have been mapped near the site. The bedrock faults exposed in the seacliffs between Santa Cruz and Capitola do not disrupt the wave-cut platform below the terrace deposits. This surface is at least 85,000 years old (Weber, 1990).

Coseismic Slope Stability and Liquefaction

Both the seismic setting and the site-specific geology influence the stability of the seacliffs in this area. As previously mentioned, the study area will be subjected to strong ground shaking in the

event of a large magnitude earthquake centered on the nearby San Andreas or San Gregorio faults.

Review of the local newspaper coverage (Youd and Hoose, 1978), and the Carnegie Commission Report (Lawson et al., 1908) of the 1906 earthquake disclosed no documented accounts of large-scale seacliff failure in Santa Cruz County due to the earthquake, though there was much sloughing of "earth" from the bluffs near Capitola (Lawson et al., 1908, p. 272). This apparently involved portions of the poorly consolidated terrace deposits that were shaken loose during the earthquake.

Another seismically generated failure occurred on the steep coastal bluff along Opal Cliffs Drive on 24 April 1984 (Morgan Hill earthquake, Magnitude 5.8-6.2), resulting in about six feet of localized retreat. This amount of coseismic bluff retreat is similar to that which occurs during storm-generated bluff retreat. We are not aware of bluff retreat at the subject property as a result of the Morgan Hill earthquake.

The 1989 Loma Prieta earthquake generated numerous localized coastal bluff failures in Santa Cruz County, including soil sloughing, rockfalls, blufftop fissuring, and shallow translational landslides (Sydnor et al., 1990).

Dupré (1975) has mapped the river mouths and coastal lagoons in the Santa Cruz area as having a high potential for liquefaction. Historical accounts indicate that ground failures due to liquefaction during the 1906 earthquake were common in the lower San Lorenzo River flood plain (e.g., Youd and Hoose, 1978). Although no such occurrences were reported from the mouth of Schwan Lake, borings B-7 and B-8 show sandy strata at depth that could be susceptible to liquefaction (see Cross Section E-E' and Transverse Section Y-Y'). A detailed liquefaction analysis for this area may be warranted.

CONCLUSIONS

The stretch of East Cliff Drive between 5th Avenue and Schwan Lake is slated for improvements including widening of the roadway and addition of a bike/walkway. This geologic report and the companion geotechnical report document the geologic and oceanographic conditions on the site, assess the hazards to the proposed improvements, and provide recommendations for mitigating those hazards.

The road alignment in question follows the edge of the beach between the Santa Cruz Harbor and Schwan Lake. The road in this area consists of two straight segments near beach level separated by a more elevated, pronounced S-turn. The two straight segments are constructed on fill embankments over beach and/or lagoonal deposits. The S-turn occupies a partial bench cut in the low, moderately steep coastal bluff, with a fill wedge on the outboard side. The coastal bluff consists of Purisima Formation overlain by partially stripped terrace deposits.

The beach is underlain by coastal deposits of variable thickness resting on Purisima bedrock. Between Woods Lagoon (now the harbor) and Schwan Lake, the buried bedrock surface is a wave-cut platform, and the beach deposits (and localized lagoonal deposits) are generally 15 feet thick or less. Seaward of Schwan Lake, however, the beach is underlain by at least 80 feet of Holocene beach and lagoonal deposits occupying the drowned and backfilled mouth of a Pleistocene drainage. A similar buried bedrock depression occupies the mouth of Woods Lagoon (the harbor), just west of the study area.

Construction of the Santa Cruz Harbor in the early 1960s disrupted the normal littoral flow of sand in northern Monterey Bay, leaving the downcoast beaches partially "starved" in the winter months. Although dredging of the harbor mouth has rectified this situation somewhat, many of the downcoast beaches still offer less protection for the shoreline during major storms than they did prior to construction of the harbor.

Aerial photographs of the study area taken in the 1980s show that wave runup and scour have encroached on East Cliff Drive in two locations: 1) along the seaward portion of the S-turn, near the foot of Assembly Avenue, and 2) along the embankment fronting Schwan Lake. The risk at these locations has been quantified by the project geotechnical engineers in their wave runup analysis. The geotechnical engineers have also analyzed wave runup for the straight segment of road between the harbor and the S-turn, where the risk is lower but still significant.

The only segment of road in the study area where the risk from wave runup and beach scour is low is the landward portion of the S-turn, approaching the intersection of East Cliff Drive with 7th Avenue. This area is in a "shadow" zone by virtue of the coastline geometry.

The study area is in a seismically active region with a moderate to high probability for strong seismic shaking during the design lifetime of the proposed road improvements. The road alignment across the mouth of Schwan Lake overlies Holocene coastal deposits more than 80 feet thick, some of which may be susceptible to liquefaction.

RECOMMENDATIONS

As we understand, the proposed road improvements will be implemented in three phases.

Phase 1 corresponds with the landward portion of the S-turn, where wave runup and scour do not pose a serious risk. The project geotechnical engineer has supplied design criteria for retaining walls along this stretch as necessary.

Phase 2 includes the straight segment of road immediately east of the harbor and the seaward portion of the S-turn, where the risk from wave runup and scour is moderate to high. The project geotechnical engineer has provided design criteria for various types of seawalls.

ATTACHMENT 5

Phase 3 corresponds with the straight segment of road seaward of Schwan Lake, where the risk from wave runup and scour is high. The project geotechnical engineer has provided design criteria for various types of sea wall. Bear in mind, however, that a detailed liquefaction analysis for this area may be warranted and the results could have a bearing on the final design parameters.

All earthwork and structural design should accommodate the seismic-shaking parameters presented herein for the "design" earthquake: MPHGA 0.35g; RHGA 0.25g; duration approximately 16 seconds.

We request the opportunity to review all forthcoming engineering plans for conformity with our geological findings and recommendations.

INVESTIGATION LIMITATIONS

1) The conclusions and recommendations contained herein are based on probability and in no way imply that the road alignment will not possibly be subjected to ground failure, seismic shaking or coastal erosion by wave inundation and/or impact causing significant damage. The report does suggest that constructing the road improvements in compliance with the recommendations contained herein is an acceptable risk over the 100-year design period stipulated by the California Coastal Commission.

2) This report is issued with the understanding that it is the responsibility of the owner or his representative or agent to ensure that the recommendations contained herein are brought to the attention of the project engineer, are incorporated into the plans and specifications for the project, and that the necessary steps are taken to ensure that the contractor and subcontractors carry out such recommendations in the field.

3) If any unexpected variations in soil conditions or if any undesirable conditions are encountered during construction, Rogers E. Johnson and Associates should be notified so that supplemental recommendations can be given.

Sincerely,

ROGERS E. JOHNSON & ASSOCIATES

Alan O. Allwardt
R.G. No. 5520

Rogers E. Johnson
C.E.G. No. 1016

AOA/REJ/cjd

ATTACHMENT 3

REFERENCES

Aerial Photographs

1 April 1931, Frames [C-1437] B32 and 33, black and white, nominal scale 1:12,000, City of Santa Cruz.

25 April 1948, Frames CDF5-4 61 and 62, black and white, nominal scale 1:10,000, California Division of Forestry.

25 August 1953, Frames [CCL] SC 44 and 45, black and white, nominal scale 1:10,000, Beach Erosion Board, Washington, D.C.

6 December 1961, Frames SC 1-34 and 35, black and white, nominal scale 1:10,000, U.S. Army Corps of Engineers.

13 June 1964, Frames 1-1 and 2, black and white, nominal scale 1:6,000, California Recreation Board #3.

11 May 1965, Frames SC 1-36 and 37, black and white, nominal scale 1:10,000, U.S. Army Corps of Engineers.

14 October 1975, Frames SCZCO 2-62 and 63, black and white, nominal scale 1:12,000, Santa Cruz County Planning Department.

5 October 1976, Frames DNOD-AFU-C 171 and 172, color, nominal scale 1:12,000, California Department of Navigation and Ocean Development.

8 January 1982, Frames JSC 9-1 and 2, black and white, nominal scale 1:20,000, U.S. Geological Survey.

13 October 1982, Frames AV-2192-08 10 and 11, black and white, nominal scale 1:6,000, City of Santa Cruz.

12 April 1984, Frames MONTEREY 93 and 94, color, nominal scale 1:12,000, U.S. Army Corps of Engineers, Los Angeles District.

16 March 1986, Frames CDBW-APU-C 226 and 227, color, nominal scale 1:12,000, California Department of Boating and Waterways.

18 October 1989, Frames SANTA CRUZ-B 22174 and 22175, black and white, nominal scale 1:7,200, Air Flight Service (Santa Clara).

Maps and Reports

Bixby, H.C., Jr., 1962, Storms causing harbor and shoreline damage through wind and waves -- Monterey, California. Naval Post-graduate School, Monterey, California, unpublished Master's thesis.

Brabb, E.E., 1989, Geologic map of Santa Cruz County, California, U. S. Geological Survey Miscellaneous Investigations Series Map I-1905, scale 1:62,500.

Bradley, W.C., 1957, Origin of marine-terrace deposits in the Santa Cruz area, California, Bulletin of the Geological Society of America, v. 68, p. 421-444.

Bradley, W.C., and Griggs, G.B., 1976, Form, genesis, and deformation of central California wave-cut platforms, Geological Society of America Bulletin, v. 87, p. 433-449.

California Coastal Commission, 1978, Wave damage along the California Coast, December 1977 - March 1978, Published San Francisco, California.

Dobry, R., Idriss, I.M., and Ng, E., 1978, Duration characteristics of horizontal components of strong motion earthquake records, Bulletin of the Seismological Society of America, v. 68, p. 1487-1520.

Dupré, W.R., 1975, Geology and liquefaction potential of Quaternary deposits in Santa Cruz County, California, U. S. Geological Survey Miscellaneous Field Studies Map MF-648, 2 sheets, scale 1:62,500.

Environmental Protection Agency, 1983, Projecting sea level rise, methodology, estimates to the year 2100 and research needs, stock 055-000-00236-3, document EPA 230-09-007.

Federal Emergency Management Agency (FEMA), 1986, Flood Insurance Study, Santa Cruz County, California, Unincorporated Areas; 2 volumes plus Floodway Boundary and Flood Insurance Rate Maps (FIRM).

Fulton-Bennett, K., and Griggs, G.B., 1986, Coastal Protection Structures and their Effectiveness, California Department of Boating and Waterways/Marine Sciences Institute, University of California at Santa Cruz, 48 p.

Greene, H.G., 1977, Geology of the Monterey Bay region, California, U. S. Geological Survey Open-File Report 77-718, 347 p., 9 plates, scale 1:200,000.

ATTACHMENT 3

Griggs, G.B., 1990, Coastal erosion and protection, northern Monterey Bay, in Griggs, G.B. and Weber, G.E., eds., Coastal Geologic Hazards and Coastal Tectonics, Association of Engineering Geologists Field Trip Guide, p. 1-49.

Griggs, G.B., and Johnson, R.E., 1976, Effects of the Santa Cruz Harbor on coastal processes of northern Monterey Bay, California, Environmental Geology, v. 1, p. 299-312.

Griggs, G.B., and Johnson, R.E., 1979, Coastline erosion: Santa Cruz County, California Geology, v. 32, p. 67-76.

Griggs, G.B., and Johnson, R.E., 1983, Impact of 1983 storms on the coastline, northern Monterey Bay and Santa Cruz County, California, California Geology, v. 36, p. 163-174.

Hall, N.T., Sarna-Wojcicki, A.M., and Dupré, W.R., 1974, Faults and their potential hazards in Santa Cruz County, California, U. S. Geological Survey Miscellaneous Field Studies Map MF-626, 3 sheets, scale 1:62,500.

Hoffman, J.S., 1984, Estimates of future sea level rise, in Barth, M.C., Titus, J.G., and Ruckelshaus, W.D., eds., Greenhouse Effect and Sea Level Rise, Van Nostrand Reinhold Company, New York, p. 79-105.

Jennings, C.W. et al., 1975, Fault map of California, California Division of Mines and Geology, California Geologic Data Map Series, map no. 1.

Jennings, C.W. et al., 1977, Geologic map of California, California Division of Mines and Geology, California Geologic Data Map Series, map no. 2.

Johnson, Rogers E. & Associates, 1987, Marina Dunes Shoreline Recession Study, unpublished report.

Lawson, A.C. et al., 1908, The California Earthquake of April 18, 1906, Report of the State Earthquake Investigation Commission, Carnegie Institute of Washington, Publication 87, 2 v., 600 p.

Meteorology International Incorporated, 1977, Deep water wave statistics for the California coast, published by California Department of Boating and Waterways.

National Marine Consultants, 1960, Wave statistics for seven deep water stations along the California coast, prepared for U.S. Army Corps of Engineers, Los Angeles and San Francisco districts, 20 p.

ATTACHMENT 2

Ploessel, M.R., and Slossen, J.E., 1974, Repeatable high ground accelerations from earthquakes, California Geology, v. 27, p. 195-199.

Seed, H.B., and Idriss, I.M., 1982, Ground motion and soil liquefaction during earthquakes (Engineering Monographs on Earthquake Criteria, Structural Design and Strong Motion Records, v. 5), Earthquake Engineering Research Institute, Berkeley, California.

Sydnor, R.H., Griggs, G.B., Weber, G.E., McCarthy, R.J., and Plant, N., 1990, Coastal bluff landslides in Santa Cruz County resulting from the Loma Prieta earthquake of 17 October 1989, in McNutt, S.R., and Sydnor, R.H. (editors), The Loma Prieta (Santa Cruz Mountains), California Earthquake of 17 October 1989, California Division of Mines and Geology Special Publication, 104, p. 67-82.

U.S. Army Corps of Engineers, 1958, Santa Cruz County, California, Beach Erosion Control Study, U.S. Government Printing Office, Washington, D.C., 91 p.

U.S. Army Corps of Engineers, San Francisco District, 1969, City of Capitola, Beach Erosion Study, Santa Cruz County, California, Detailed Project Report. unpublished report dated November 1969.

Weber, G.E., 1990, Pleistocene marine terraces and neotectonics of the San Gregorio fault zone in Santa Cruz and San Mateo counties, California in Griggs, G.B., and Weber, G.E., (editors), Coastal Engineering and Coastal Tectonics, Association of Engineering Geologists Field Trip Guide, part 2, p. 1-97.

Wesnousky, S.G., 1986, Earthquakes, Quaternary faults, and seismic hazard in California, Journal of Geophysical Research, v. 91, p. 12587-12631.

Wiegel, R.L., 1964, Oceanographical Engineering, Prentice-Hall, Englewood Cliffs, New Jersey.

Working Group on California Earthquake Probabilities, 1990, Probabilities of large earthquakes in the San Francisco Bay region, California, U. S. Geological Survey Circular 1053, 51 p.

Yanev, P., 1974, Peace of Mind in Earthquake Country, Chronicle Books, San Francisco, 304 p.

Youd, T.L., and Hoose, S.N., 1978, Historic ground failures in northern California triggered by earthquakes, U. S. Geological Survey Professional Paper 993, 177 p.

APPENDIX C

STORM HISTORY OF MONTEREY BAY AND THE CENTRAL COAST, 1910 TO PRESENT

ATTACHMENT

STORM HISTORY OF MONTEREY BAY AND THE CENTRAL COAST 1910 TO PRESENT

(Compiled from U. S. Army Corps of Engineers, 1958, 1998; Bixby, 1962; California Coastal Commission, 1978; Griggs and Johnson, 1983; Santa Cruz Sentinel and Watsonville Register-Pajaronian)

Date	*Description and Damage*	*Direction or Type of Storm*
Mar 21 1910	Heavy storm off coast, mountainous seas. No damage.	.....
Nov 22 1910	Bay was very rough and surf was running high. No ships able to enter or leave Monterey harbor. No damage.	.....
Feb 13 1911	Mountainous waves reported along the beach north of Monterey. No damage.	.....
Oct 4-11 1912	Strong northwest wind and heavy swell. Several wharves at Monterey damaged and boats beached. Heavy surf.	.....
Dec 1912	Watsonville Wharf damaged; waves washed up to Casino building; heaviest seas in history of Monterey Bay.	.....
Apr 29-30 1915	Heavy surf and strong winds. Considerable damage to structures and boats.	.....
Nov 26 1915	Large and powerful waves breaking over wharves at Monterey. No damage.	.....
Jan 27 1916	Southwest gale. Steamship pier at Moss Landing destroyed by tremendous swells.	"southwest gale"
Nov 29-Dec 1 1923	Northeast gale swept 15 boats ashore at Monterey. Heavy seas outside harbor. Freighter beached at Santa Cruz.	"northeast gale"
Feb 11-15 1926	Southerly gale winds and wave damage all along California coast. Pier damaged at Moss Landing. High tide and waves destroyed bathhouse at Santa Cruz; concession building lost practically all of underpinnings. Downtown Capitola flooded. Venetian Court apartments undercut. High waves washed completely over 2,000 feet of new sea wall at Seacliff State Beach, carrying debris back to cliff. Portions of sea wall undercut and caved in. Beach road washed almost entirely away. Sea wall at Swanton Beach partially destroyed. Seaside Company's bandstand collapsed. Breaker broke into and destroyed Ideal Fish Restaurant.	"southerly gale"
Oct 25 1926	Heavy swells running into bay. Giant combers rolled shoreward carrying bay waters almost up to high line of last February's storm. Swept up to Casino.	.....
Dec 8-9 1926	Heavy swells washed one boat ashore at Monterey. No significant damage.	.....

EXHIBIT

Date	*Description and Damage*	*Direction or Type of Storm*
Feb 14-16 1927	At the time, reported to be most violent storm in history of Pacific coast. During high tide, breakers rolled clear to the esplanade. Dashed against Casino. Concrete sea wall at Seacliff State Beach destroyed.	"heavy southwester"
Oct 4 1927	Huge breakers reported along Central California coast. No damage reported.	.....
Dec 30 1928	Powerful surges in Monterey harbor causing damage to freighter attempting to moor.	.....
Jan 3 1931	Piling of Municipal Pier loosened. Boarding in front of Casino damaged.	heavy southwest swell
Feb 4 1931	Damage at Santa Cruz Casino building. High breakers and ground swells. Waves reached bottom of wharf, 14 to 20 feet above mean lower low water.	.....
Feb 20 1931	North winds of gale intensity. Several small boats wrecked.	north winds
Nov 20-21 1931	Strong winds and heavy seas beached numerous small boats at Monterey. No damage to Santa Cruz wharf.	northwest gale
Dec 23-29 1931	Violent storm. Entire coastal area affected. East Cliff Drive between Santa Maria Del Mar and Soquel Point cut by wave action and sections lost. Large quantities of sand eroded from Twin Lakes Beach. At Seacliff State Beach, concession building and bathing pavilion wrecked. Beach littered with debris brought down by storms. Giant breakers washed over pier at Capitola (20 feet above mean lower low water). Considerable damage to Casino.	winds first from southwest, then northwest
Dec 20-21 1932	Very rough on bay and waves breaking over breakwater under construction at Monterey.	winds from northwest
Dec 19 1935	Very heavy surf. Giant breakers demolished steps opposite Nichols Fishing Trip offices on wharf and damaged Stagnaro building.	...
Dec 10-11 1937	Coast Road closed at Waddell. Boats beached at Stillwater Cove.	southwest winds
Dec 9-10 1939	High waves. Breakers and high tide combined to flood lower East Cliff Drive area. Deep water wave height hindcast at 20 feet. At Seacliff State Beach, timber bulkhead destroyed and shoreward end of pier damaged.	southwest wind waves
Jan 8 1940	Casino at Capitola almost a complete wreck. Santa Cruz Casino damaged. East Cliff Drive between Santa Cruz and Capitola weakened. Piling broke loose from wharf. Flooding of a motor camp at Seabright. Debris and mud deposited up to entrance at Casa Del Rey Hotel. Boardwalk drenched.	.....
Feb 26-28 1940	Beach eroded and littered with logs. Hindcasted waves of 25 feet in height.	southwest wind, waves and swell
Dec 26-27 1940	Highway 1 closed after 800 feet of roadway washed away at Waddell from high seas. Timbers along boardwalk collapsed. Huge sections of East Cliff Drive at Schwann's Lagoon collapsed. Crux of local weather trouble was at Seacliff State Beach. Logs up to 10 feet were tossed onto road. An 80-foot section of pier washed out. Houses damaged. 80 feet of Seacliff State Beach	.....

Date	*Description and Damage*	*Direction or Type of Storm*
	lost. Two sections of sea cliff bulkhead ripped out. At Moss Landing houses were under a foot of water.	
Jan 8-13 1941	At Seacliff State Beach, about one-half of a timber bulkhead and 60 feet of shore end of pier destroyed. Beach eroded to bedrock.	waves and swell from southwest; crests level with deck of pier (+20 feet above mean lower low water)
Feb 11-13 1941	Large waves in bay. West Cliff Drive caves in. Residents in Seacliff State Beach cut off by slides.	.....
Feb 26-28 1941	Heavy winds, gigantic waves, breakers smashed Casino steps. West Cliff Drive closed due to cliff erosion from wave action. Hindcast wave height at 22 feet.	south-southwest and south- west wind waves and swell
Dec 24-25 1942	North winds and high surf beached four purse seiners at Monterey.	north winds
Jan 22 1943	High surf reported but no wave damage.	southwest winds
Dec 8-9 1943	Very strong northeast winds wrecked 40 fishing boats, piers and pilings in Monterey harbor.	northeast wind
Feb 1-2 1945	Southerly winds and heavy seas. No damage reported.	southerly winds
Mar 4 1946	North winds up to 40 knots. Two large purse seiners washed ashore.	north winds
Jan 28 1947	Northerly gale force winds; 43-foot fishing boat capsized and beached; 80-foot section of dike holding dredge spoil washed out in Monterey.	northerly gale
Apr 4 1947	Strong northerly winds with high surf in bay.	northerly winds
Feb 23 1948	Northwest winds up to 50 mph. Some boats beached in Monterey. Damage light.	northwest winds
Jan 2-3 1949	High winds and seas. Several boats adrift and one lost in Monterey.	.....
Oct 27-29 1950	Northerly gale winds accompanied by gigantic waves pounded Monterey Peninsula. Considerable shoreline erosion. Most damage caused by huge waves which swept up across Aptos Beach Drive at Rio Del Mar Beach. 15 foot combers carried fence posts smashing against residences. Beach club severely battered by waves at Rio Del Mar Beach with sea water and sand flooding many of the 33 homes along the beach. At Seacliff State Beach, 2 large pontoons were torn from their moorings. Homes along beach between Seacliff State Beach and New Brighton State Beach were not damaged as sea wall provided protection. At Santa Cruz waves were 10 to 15 feet high.	northerly gale
Dec 2 1951	Southerly winds up to 40 mph. High surf but no damage.	southerly winds

Date	*Description and Damage*	*Direction or Type of Storm*
Feb 23 1953	Northeast gale winds up to 60 mph drove 7 large fishing boats ashore in Monterey.	northeast winds
Nov 13 1953	Southerly winds. Pleasure Pier at Santa Cruz damaged. waves overtopped sea wall at Capitola. Beaches eroded. 14-foot waves.	southerly winds
Oct 7 1954	Foreshore of beaches from Santa Cruz to Rio Del Mar lowered. 3 to 5 foot scarp.	heavy ground swells from southwest
Feb 9-10 1960	Southerly winds up to 45 mph with gigantic waves. Rio Del Mar, Capitola and Seacliff State Beach took brunt of waves. At Capitola waves smashed beach restaurants and amusement concessions. At Rio Del Mar, 25 luxury homes along Beach Road were damaged by gigantic waves. At Seacliff State Beach, camping sites were destroyed, restrooms nearly destroyed. At times during the storm, the concrete ship disappeared completely. One wave took out the end of the concession buildings on wharf. Large areas of hardtop parking areas washed away.	southerly and westerly winds
Winter 1969	Storm waves attacked the Pajaro Dunes area. Erosion of the dunes occurred in certain areas and about 12 lots experienced severe erosion with stairs being undercut. Some automobile bodies were brought in for protection and placed at the toe of the scarp cut by the waves.	.....
Feb 11-15 1976	High waves washed completely over new sea wall at Seacliff State Beach, carrying debris back to cliff. Portions of sea wall undercut and caved in.	southerly gale
Jan 8-9 1978	Sea wall at Seacliff State Beach overtopped and logs and debris scattered across parking and camping area. Extensive damage to sea wall.	storm from southwest
Feb 1980	$1.1 million in damage at Seacliff State Beach. Storm destroyed entire lower beach portion of park, taking roads, parking for 324 cars, and a 2,672 foot sea wall.	southwest
Jan 28-30 1983	$740,000 in damage at Seacliff State Beach. 2,800 feet of new sea wall damaged. 700 feet totally destroyed; 11 RV sites destroyed; restroom heavily damaged; logs and debris washed back to cliff.	waves from southwest
Feb 3-7 1998	Extensive cliff erosion, beach sour, and economic losses.	waves from south and west

APPENDIX D

SCALE OF ACCEPTABLE RISKS FROM GEOLOGIC HAZARDS

ATTACHMENT 9

SCALE OF ACCEPTABLE RISKS FROM SEISMIC GEOLOGIC HAZARDS

Risk Level	Structure Types	Extra Project Cost Probably Required to Reduce Risk to an Acceptable Level
Extremely low[1]	Structures whose continued functioning is critical, or whose failure might be catastrophic: nuclear reactors, large dams, power intake systems, plants manufacturing or storing explosives or toxic materials.	No set percentage (whatever is required for maximum attainable safety).
Slightly higher than under "Extremely low" level.[1]	Structures whose use is critically needed after a disaster: important utility centers; hospitals; fire, police and emergency communication facilities; fire station; and critical transportation elements such as bridges and overpasses; also dams.	5 to 25 percent of project cost.[2]
Lowest possible risk to occupants of the structure.[3]	Structures of high occupancy, or whose use after a disaster would be particularly convenient: schools, churches, theaters, large hotels, and other high rise buildings housing large numbers of people, other places normally attracting large concentrations of people, civic buildings such as fire stations, secondary utility structures, extremely large commercial enterprises, most roads, alternative or non-critical bridges and overpasses.	5 to 15 percent of project cost.[4]
An "ordinary" level of risk to occupants of the structure.[1,5]	The vast majority of structures: most commercial and industrial buildings, small hotels and apartment buildings, and single family residences.	1 to 2 percent of project cost, in most cases (2 to 10 percent of project cost in a minority of cases).[4]

[1] Failure of a single structure may affect substantial populations.

[2] These additional percentages are based on the assumptions that the base cost is the total cost of the building or other facility when ready for occupancy. In addition, it is assumed that the structure would have been designed and built in accordance with current California practice. Moreover, the estimated additional cost presumes that structures in this acceptable risk category are to embody sufficient safety to remain functional following an earthquake.

[3] Failure of a single structure would affect primarily only the occupants.

[4] These additional percentages are based on the assumption that the base cost is the total cost of the building or facility when ready for occupancy. In addition, it is assumed that the structures would have been designed and built in accordance with current California practice. Moreover the estimated additional cost presumes that structures in this acceptable-risk category are to be sufficiently safe to give reasonable assurance of preventing injury or loss of life during and following an earthquake, but otherwise not necessarily to remain functional.

[5] "Ordinary risk": Resist minor earthquakes without damage; resist moderate earthquakes without structural damage, but with some non-structural damage; resist major earthquakes of the intensity or severity of the strongest experienced in California, without collapse, but with some structural damage as well as non-structural damage. In most structures it is expected that structural damage, even in a major earthquake, could be limited to repairable damage. (Structural Engineers Association of California)

Source: *Meeting the Earthquake*, Joint Committee on Seismic Safety of the California Legislature, Jan. 1974, p.9.

SCALE OF ACCEPTABLE RISKS FROM NON-SEISMIC GEOLOGIC HAZARDS*

Risk Level	Structure Type	Risk Characteristics
Extremely low risk	Structures whose continued functioning is critical, or whose failure might be catastrophic: nuclear reactors, large dams, power intake systems, plants manufacturing or storing explosives or toxic materials.	1. Failure affects substantial populations, risk nearly equals nearly zero.
Very low risk	Structures whose use is critically needed after a disaster: important utility centers; hospitals; fire, police and emergency communication facilities; fire station; and critical transportation elements such as bridges and overpasses; also dams.	1. Failure affects substantial populations. Risk slightly higher than 1 above.
Low risk	Structures of high occupancy, or whose use after a disaster would be particularly convenient: schools, churches, theaters, large hotels, and other high rise buildings housing large numbers of people, other places normally attracting large concentrations of people, civic buildings such as fire stations, secondary utility structures, extremely large commercial enterprises, most roads, alternative or non-critical bridges and overpasses.	1. Failure of a single structure would affect primarily only the occupants.
"Ordinary" risk	The vast majority of structures: most commercial and industrial buildings, small hotels and apartment buildings, and single family residences.	1. Failure only affects owners /occupants of a structure rather than a substantial population. 2. No significant potential for loss of life or serious physical injury. 3. Risk level is similar or comparable to other ordinary risks (including seismic risks) to citizens of coastal California. 4. No collapse of structures; structural damage limited to repairable damage in most cases. This degree of damage is unlikely as a result of storms with a repeat time of 50 years or less.
Moderate risk	Fences, driveways, non-habitable structures, detached retaining walls, sanitary landfills, recreation areas and open space.	1. Structure is not occupied or occupied infrequently. 2. Low probability of physical injury. 3. Moderate probability of collapse.

* Non-seismic geologic hazards include flooding, landslides, erosion, wave runup and sinkhole collapse

ROGERS E. JOHNSON & ASSOCIATES
CONSULTING ENGINEERING GEOLOGISTS
1729 SEABRIGHT AVENUE, SUITE D
SANTA CRUZ, CA 95062
BUS. (408) 425-1288
FAX. (408) 425-6539

GEOLOGIC REPORT

PROPOSED IMPROVEMENTS TO EAST CLIFF DRIVE

SANTA CRUZ HARBOR TO SCHWAN LAKE

SANTA CRUZ COUNTY, CALIFORNIA

REJA Job No. C95033-68

16 October 1995

ATTACHMENT 3

ROGERS E. JOHNSON & ASSOCIATES
CONSULTING ENGINEERING GEOLOGISTS
1729 SEABRIGHT AVENUE, SUITE D
SANTA CRUZ, CA 95062
BUS. (408) 425-1288
FAX. (408) 425-6539

16 October 1995

Job No. C95033-68

Mr. Carl Rom
Santa Cruz County Department of Public Works
701 Ocean Street
Santa Cruz, California 95060

Re: Proposed Improvements to East Cliff Drive
Santa Cruz Harbor to Schwan Lake
Santa Cruz County, California

Dear Mr. Rom:

Attached is our geologic report on the road alignment referenced above, which documents geologic and oceanographic conditions in the study area and addresses potential hazards to the proposed road improvement project, such as surf erosion, seismic shaking, and liquefaction. The companion report by Haro, Kasunich and Associates presents quantitative wave runup analyses for the beach adjacent to East Cliff Drive and gives specific engineering recommendations for mitigating the hazard to the road improvements posed by wave runup and scour. A detailed liquefaction analysis for the segment flanking Schwan Lake was beyond the scope of our combined services.

If you have any questions or comments regarding this report, please contact us at your earliest convenience.

Sincerely,

ROGERS E. JOHNSON AND ASSOCIATES

Alan O. Allwardt
R.G. No. 5520

Rogers E. Johnson
C.E.G. No. 1016

AOA/REJ/cjd

ATTACHMENT 3

TABLE OF CONTENTS

EXECUTIVE SUMMARY v
Purpose v
Findings v
Levels of Risk vi
Recommendations vii

INTRODUCTION 1

REGIONAL GEOLOGIC SETTING 1

SHORELINE HAZARDS IN MONTEREY BAY 3
Overview 3
Storm History of Monterey Bay, 1910-1983 5
Deep-Water Wave Conditions 9
Wave Runup Analysis 10
Human Intervention and Coastal Processes 13

AERIAL PHOTOGRAPHIC INTERPRETATION 15

FIELD INVESTIGATION 19
Geologic Setting 19
Subsurface Investigation 20
Subsurface Synthesis 26

SEISMICITY 29
Coseismic Slope Stability and Liquefaction 33

CONCLUSIONS 34

RECOMMENDATIONS 36

INVESTIGATION LIMITATIONS 37

REFERENCES 39

APPENDICES
Appendix 1: Storm History of Monterey Bay and the Central Coast, 1910-1983 . . . . . .
Appendix 2: Sketch Logs of Exploratory Test Pits . . . . .

TABLE
Table 1: Modified Mercalli Intensity Scale . . . . . .

ATTACHMENT 3

Table of Contents (contd.)

FIGURES

Figure 1: Plan View and Longitudinal Section from San Lorenzo Point to Soquel Point 2
Figure 2: Regional Geology 4
Figure 3: Offshore Wave Direction and Frequency 7
Figure 4: Wave Refraction in Monterey Bay, California . . 8
Figure 5: Schematic Cross Section Illustrating Wave Runup Terms 11
Figure 6: Beach Widths Before and After Construction of the Santa Cruz Yacht Harbor 14
Figure 7: Seacliff Erosion Before and After Construction of the Santa Cruz Yacht Harbor 16
Figure 8: Aerial Photographic Interpretation, Santa Cruz Harbor to Schwan Lake 18
Figure 9: Transverse Section X-X' 21
Figure 10: Transverse Section Y-Y' 22
Figure 11: Regional Earthquake Epicenters 31

PLATES

Plate 1: Geologic Site Plan . . . . . Pocket
Plate 2: Geologic Cross Sections . . . . . Pocket

ATTACHMENT 3

EXECUTIVE SUMMARY

Purpose

The stretch of East Cliff Drive between 5th Avenue and Schwan Lake is slated for improvements including widening of the roadway and addition of a bike/walkway. The attached geologic report and companion geotechnical report document the geologic and oceanographic conditions on the site, assess the hazards to the proposed improvements, and provide recommendations for mitigating those hazards.

Findings

The road alignment in question follows the edge of the beach between the Santa Cruz Harbor and Schwan Lake. The road in this area consists of two straight segments near beach level separated by a more elevated, pronounced S-turn. The two straight segments are constructed on fill embankments over beach and/or lagoonal deposits. The S-turn occupies a partial bench cut in the low, moderately steep coastal bluff, with a fill wedge on the outboard side. The coastal bluff consists of Purisima Formation overlain by partially stripped terrace deposits.

The beach is underlain by coastal deposits of variable thickness resting on Purisima bedrock. Between Woods Lagoon (now the harbor) and Schwan Lake, the buried bedrock surface is a wave-cut platform, and the beach deposits (and localized lagoonal deposits) are generally 15 feet thick or less. Seaward of Schwan Lake, however, the beach is underlain by at least 80 feet of Holocene beach and lagoonal deposits occupying the drowned and backfilled mouth of a Pleistocene drainage. A similar buried bedrock depression occupies the mouth of Woods Lagoon (the harbor), just west of the study area.

Levels of Risk

Construction of the Santa Cruz Harbor in the early 1960s disrupted the normal littoral flow of sand in northern Monterey Bay, leaving the downcoast beaches partially "starved" in the winter months. Although dredging of the harbor mouth has rectified this situation somewhat, many of the downcoast beaches still offer less protection for the shoreline during major storms than they did prior to construction of the harbor.

Aerial photographs of the study area taken in the 1980s show that wave runup and scour have encroached on East Cliff Drive in two locations: 1) along the seaward portion of the S-turn, near the foot of Assembly Avenue, and 2) along the embankment fronting Schwan Lake. The risk at these locations has been quantified by the project geotechnical engineers in their wave runup analysis. The geotechnical engineers have also analyzed wave runup for the straight segment of road between the harbor and the S-turn, where the risk is lower but still significant.

The only segment of road in the study area where the risk from wave runup and beach scour is low is the landward portion of the S-turn, approaching the intersection of East Cliff Drive with 7th Avenue. This area is in a "shadow" zone by virtue of the coastline geometry.

The study area is in a seismically active region with a moderate to high probability for strong seismic shaking during the design lifetime of the proposed road improvements. The road alignment across the mouth of Schwan Lake overlies Holocene coastal deposits more than 80 feet thick, some of which may be susceptible to liquefaction.

Recommendations

As we understand, the proposed road improvements will be implemented in three phases.

Phase 1 corresponds with the landward portion of the S-turn, where wave runup and scour do not pose a serious risk. The project geotechnical engineer has supplied design criteria for retaining walls along this stretch as necessary.

Phase 2 includes the straight segment of road immediately east of the harbor and the seaward portion of the S-turn, where the risk from wave runup and scour is moderate to high. The project geotechnical engineer has provided design criteria for various types of seawalls.

Phase 3 corresponds with the straight segment of road seaward of Schwan Lake, where the risk from wave runup and scour is high. The project geotechnical engineer has provided design criteria for various types of sea wall. Bear in mind, however, that a detailed liquefaction analysis for this area may be warranted and the results could have a bearing on the final design parameters.

All earthwork and structural design should accommodate the seismic-shaking parameters presented herein for the "design" earthquake.

INTRODUCTION

This report presents the results of our geologic investigation along East Cliff Drive from the Santa Cruz Harbor to Schwan Lake. Our investigation was undertaken in conjunction with Haro, Kasunich and Associates, geotechnical engineers, to: 1) document geologic and oceanographic conditions in the study area, 2) evaluate potential hazards to a road improvement project planned by the Santa Cruz County Department of Public Works, and 3) provide recommendations for mitigating the identified hazards.

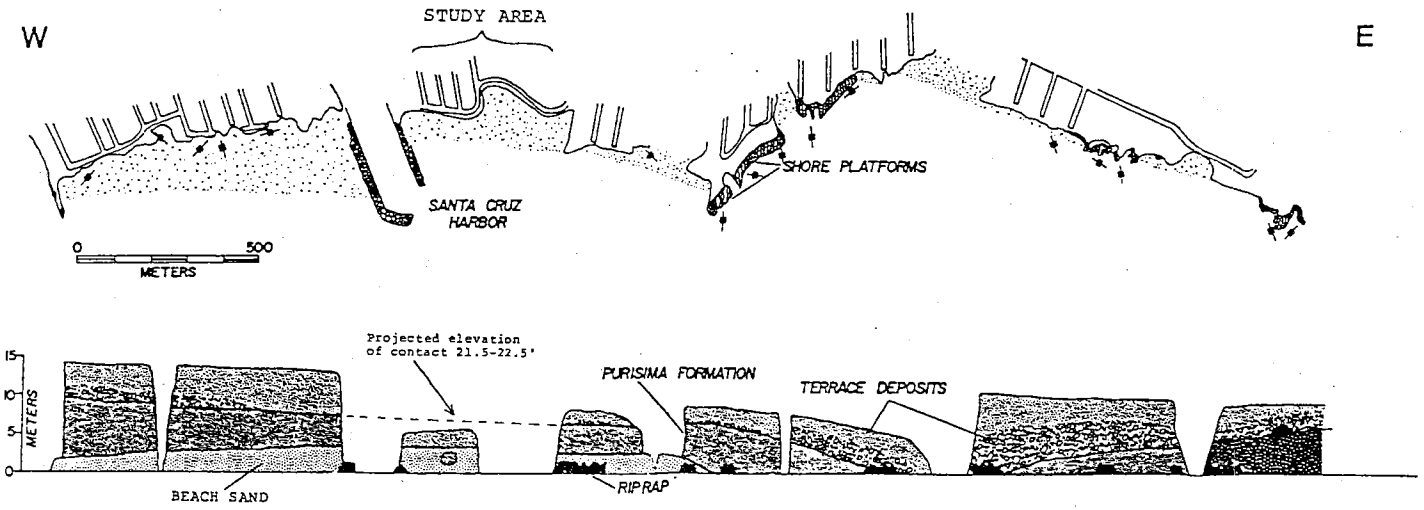
The scope of work performed for this investigation included: 1) review of existing published and unpublished literature relevant to the site and vicinity; 2) analysis of stereo-aerial photographs spanning the period 1931-1989; 3) excavation of eight backhoe test pits and eleven exploratory borings in conjunction with Haro, Kasunich and Associates; 4) compilation of a geologic site plan and several cross sections; 5) geologic inspection of the low coastal bluff along the road; 6) compilation and analysis of the resulting data; and 7) preparation of this report and accompanying illustrations. We have worked closely in this project with Haro, Kasunich and Associates and staff of the Santa Cruz County Department of Public Works.

REGIONAL GEOLOGIC SETTING

The study area is located in northern Monterey Bay along the coastline between San Lorenzo Point and Soquel Point, which trends roughly west to east and is characterized by a low seacliff interrupted by several coastal lagoons (Figure 1). This is one of many such cliffs in the Santa Cruz area exposing gently dipping, late Tertiary marine sedimentary rocks overlain by nearly horizontal, Quaternary terrace deposits of marine and eolian origin. The seismicity of the region is influenced primarily by the northwest-trending San Andreas fault situated northeast of the

PLAN VIEW AND LONGITUDINAL SECTION
FROM SAN LORENZO PT. TO SOQUEL PT.

Modified from Griggs and Johnson, 1979
Horizontal and vertical scales as shown



Note joint orientations

ATTACHMENT 3

Rogers Johnson & Associates

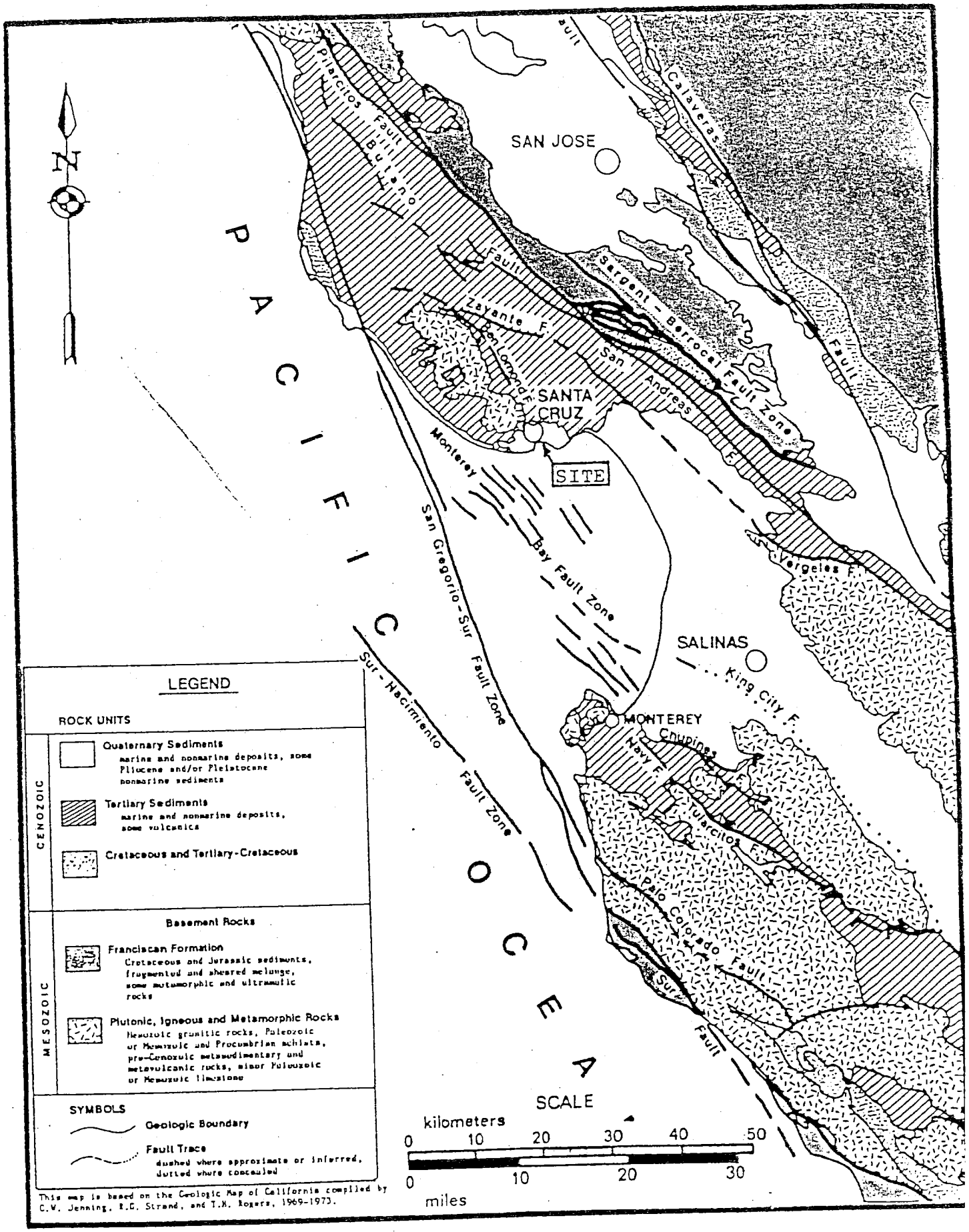
study area, and the San Gregorio fault located offshore in Monterey Bay (Figure 2; see also Hall et al., 1974 and Greene, 1977). The seismicity of the site will be discussed in more detail below.

The orientation of the coastline in northern Monterey Bay greatly influences the development of sandy beaches that protect the seacliffs against surf attack. From San Lorenzo Point to Soquel Point, for example, the west-to-east shoreline lies at a high angle to the dominant direction of approach for refracted waves, which is conducive to the formation of fairly wide beaches. In contrast, the southwest-to-northeast shoreline between Soquel Point and Capitola is nearly parallel to the approaching waves, causing rapid littoral drift that inhibits the formation of a continuous beach (Griggs, 1990). Instead, a series of pocket beaches have formed, Capitola Beach being the largest, which are very sensitive to seasonal changes and human intervention. At New Brighton State Beach the shoreline turns to a northwest-southeast orientation, which is again conducive to the formation of a wide, continuous beach. These oceanographic factors and their implications for coastal development will be discussed in more detail below.

SHORELINE HAZARDS IN MONTEREY BAY

Overview

Most of the northern end of Monterey Bay is flanked by prominent seacliffs 20 to 120 feet high, a clear indication of active surf erosion (in a geological time frame). From Santa Cruz to Capitola, where the beach is generally narrow and discontinuous, the documented rate of cliff retreat due to surf attack has averaged over one foot per year in some areas (Griggs and Johnson, 1979). Of



Rogers Johnson & Associates

course, this cliff retreat is not a steady process as the quoted rate might seem to imply, but rather occurs episodically every few seasons in response to large storms and/or when surf-cut notches at the base of the bluffs intercept prominent bedrock joints or other zones of structural weakness.

From New Brighton State Beach to La Selva Beach, the seacliff was formed in the same manner, but this fact has been less obvious to the layman because of the relatively wide and continuous beach at the foot of the bluff. Both public and private developments have taken place on the beach in this area simply because the hazard from surf attack lacks a certain degree of immediacy. Naturally the construction of permanent structures in this inherently impermanent setting has met with mixed success, depending on the engineering precautions that were taken in each case. The relevant oceanographic factors are discussed in more detail below.

Storm History of Monterey Bay, 1910-1983

Review of the storm history of Monterey Bay leads us to several immediate conclusions:

1) The number of large storms affecting Monterey Bay is relatively large.

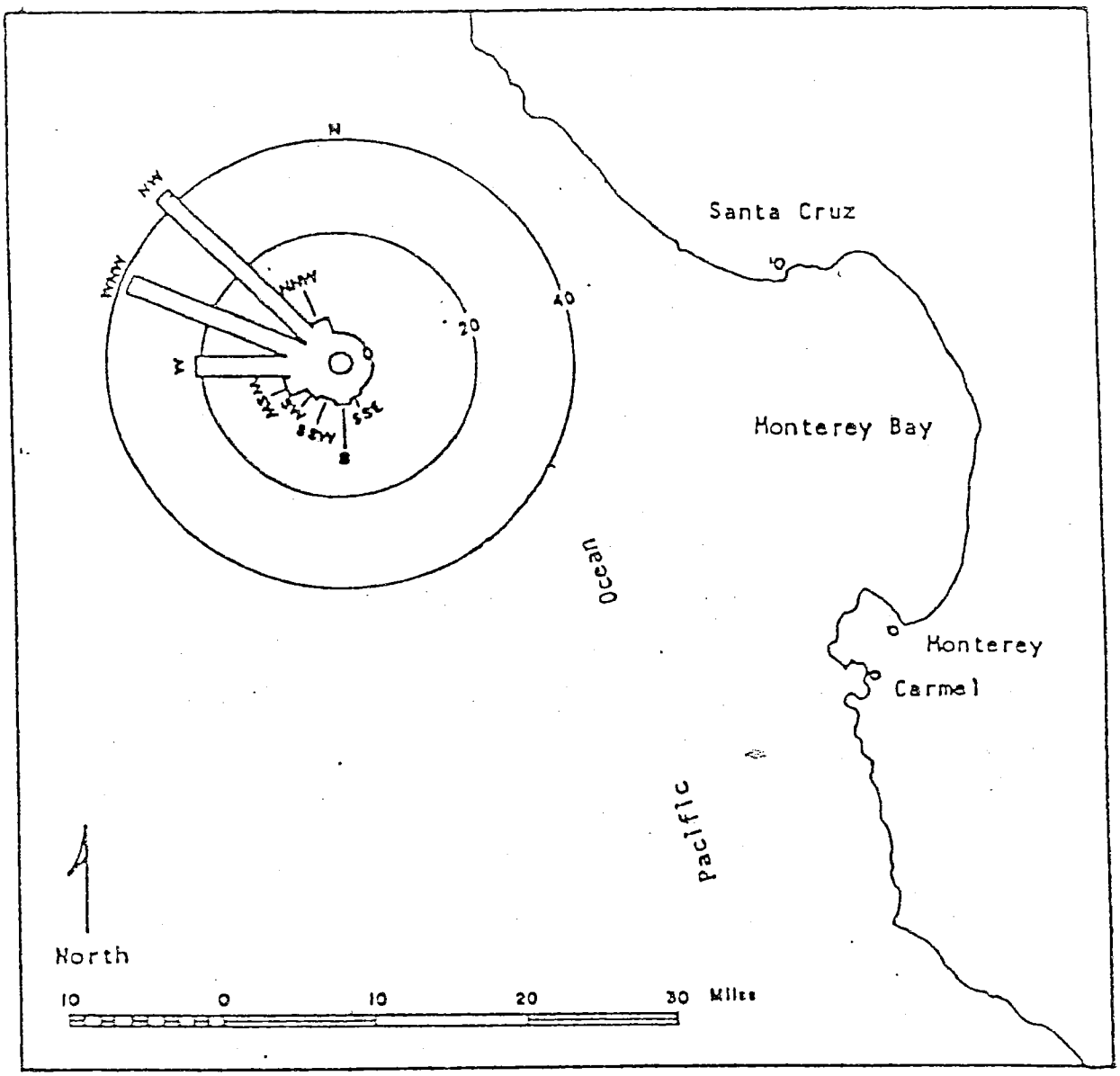
2) The storms which produced the greatest damage in the interior of the Bay often came from the west or southwest.

3) Structures directly exposed to wave action, or designed to protect ocean front properties from such action, have been regularly damaged or destroyed.

For the period of most detailed record, 1910-1960, there have been at least 45 storms of some significance (i.e., either high seas, strong winds, and/or damage to at least some portion of the Monterey Bay region). Thus, considering the 50 years of detailed records, this amounts to a major storm every 1.1 years on the average. Analysis of the record (Appendix 1) reveals that no major storms were recorded for some intervals as long as seven years (1916-1923), but in other cases, five significant storms occurred within a single year (1931). If we consider the entire period, 1910-1983, we have a major storm every 1.5 years on the average.

This historical record indicates that the northern one-half of Monterey Bay (Moss Landing to Santa Cruz) is most susceptible to damage from storms arriving from the west or southwest (Griggs and Johnson, 1983; Johnson and Associates, 1987). Waves from the northwest, which predominate along the central coast (Figure 3), undergo refraction or bending, which results in a significant energy loss prior to striking beaches along the interior of the Bay (Figure 4). Thus, although waves from the WNW and NW dominate along the coastline, their effect on the interior of the Bay appears to have been relatively small. In contrast, the storm waves approaching from the W, WSW and SW pass primarily over the deep water on their way to the shoreline within the Bay and lose little energy. These storms have produced the greatest recorded damage at the north end of the Bay.

Of the 45 major storms in the study period, 1910-1960, 20 have been listed as coming from the southwest or west; only 12 are described as arriving from the north or northwest (the remainder list no direction of approach). Of the 13 storms which have produced significant damage along the Bay's interior, only one is described



OFFSHORE WAVE DIRECTION & FREQUENCY

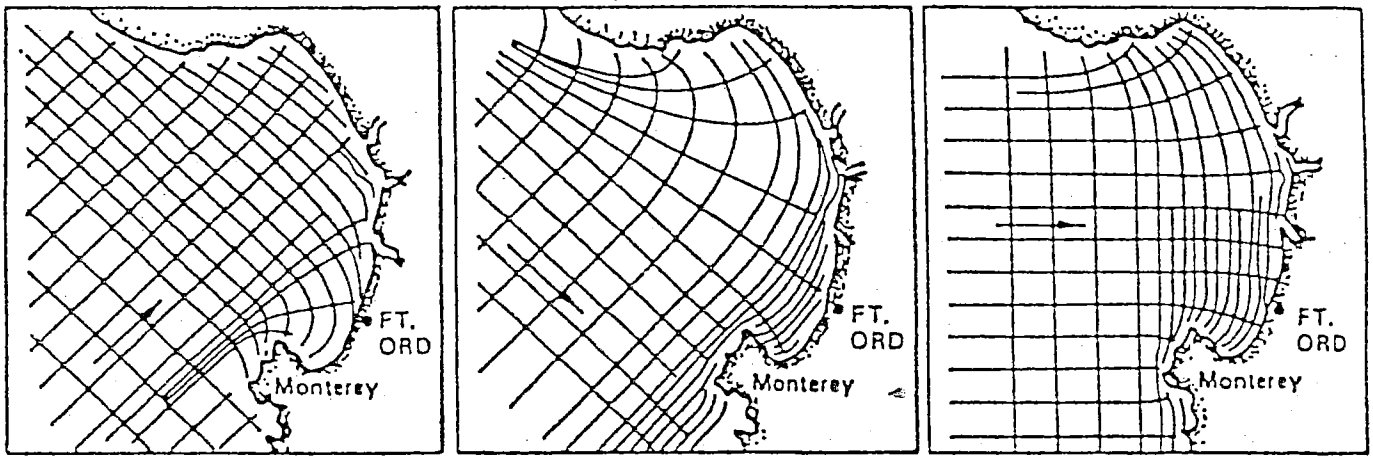
0 10 20 30 40 50

SCALE IN % OF OCCURENCE

SOURCE: NATIONAL MARINE CONSULTANTS, 1960

Rogers Johnson & Associates

ATTACHMENT 3



Wave refraction in Monterey Bay, California
(from Wiegel 1964)

as coming from the northwest; 11 arrived from the southwest, and for two of these, the direction was not listed. Thus, at least 85 percent of the storms which have caused damage approached from the south or southwest. Looking at the frequency of arrival of these storms, 13 have occurred in 69 years. In other words, damaging storms will strike the area every 5.3 years on the average. This does not mean that storms will actually occur every 5.3 years, of course.

The record of historical storm damage illuminates some other processes of relevance to the study area. The past damage to the Monterey Bay coastal area was often caused by the coupling or simultaneous occurrence of high tide and huge waves.

Deep-Water Wave Conditions

Wave data has been compiled from three different sources of numerous deep-water stations and also visual observations off Central California.

1) Ships' sea and swell reports summarized by the National Climatic Center and published by the U.S. Naval Weather Service Command as "Summary of Synoptic Meteorological Observation (SSMO)--North American Coastal Marine Areas--Pacific Coast".

2) "Wave Statistics for Seven Deep Water Stations along the California Coast", published by National Marine Consultants (1960).

3) "Deep-Water Wave Statistics for the California Coast", published by Meteorology International Incorporated (1977), based on hindcasts by the U.S. Fleet Numerical Weather Central.

As mentioned in the previous discussion of storms, the great majority of waves arrive from the northwest, but these must undergo significant energy loss through diffraction. Thus, waves from the southwest are normally of greater concern. Using hindcasting data from a station offshore from San Francisco (Nat. Mar. Cons., 1960), we can expect waves in excess of nine feet in height, on the average, 23 days of each year, and waves in excess of 15 feet three days each year. The storm record discussed earlier indicates storm waves ranging in height from 20 to 25 feet, arriving from the southwest, were recorded in 1939, 1940 and 1941. This data indicates that waves in excess of 10 to 15 feet are common in an average year, and waves in excess of 20 feet occur as well, although less frequently.

The potential impact of such storm waves on any given site can be quantified by wave runup analysis, as discussed in the next section.

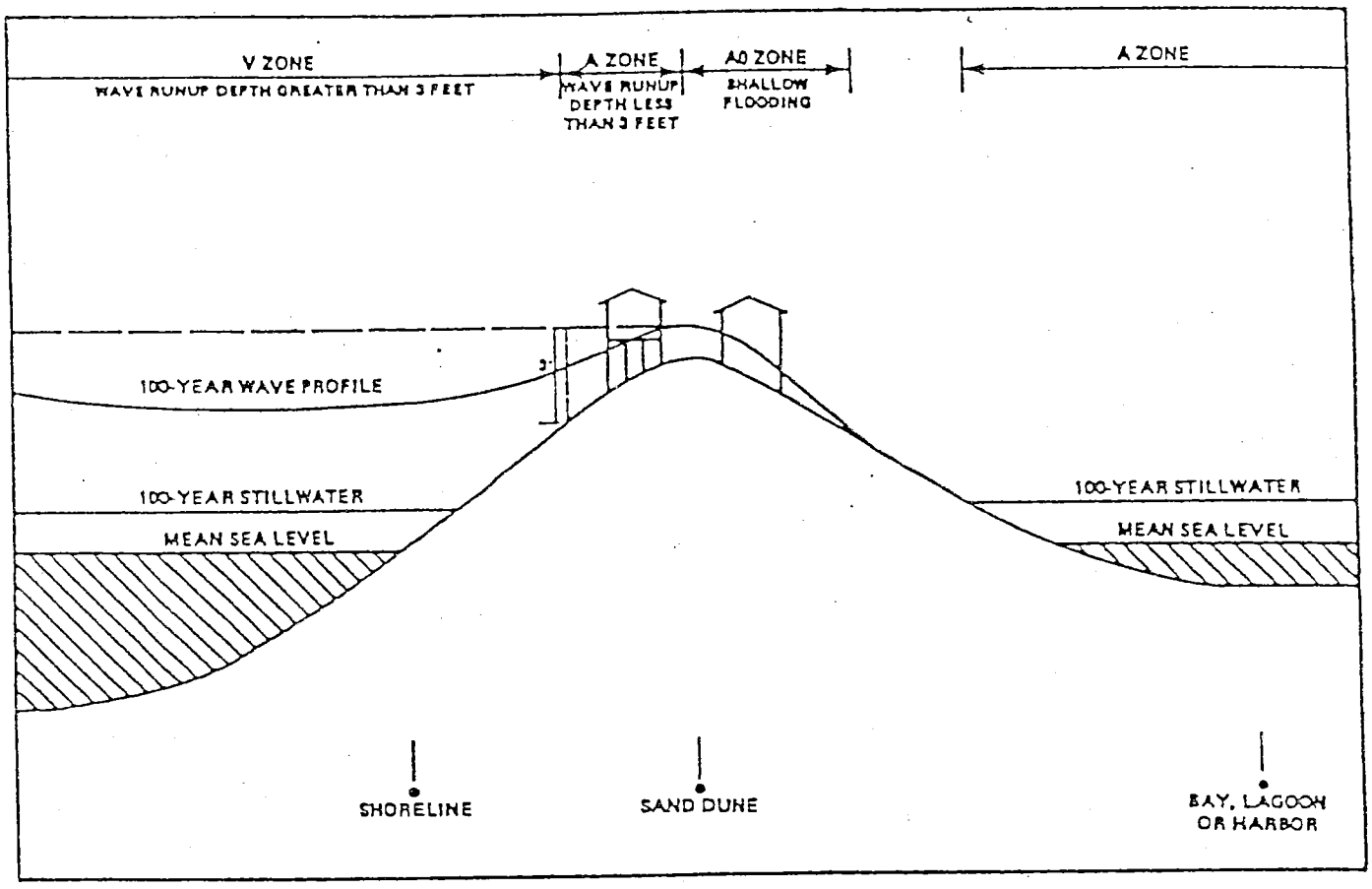
Wave Runup Analysis

Coastal flood hazards can be quantified to some degree by using wave runup analysis. This procedure is site specific, taking into account past storm frequencies, wave characteristics, bathymetry, and beach profile, as well as antecedent astronomical and meteorological conditions. Wave runup analysis can be explained in a qualitative way by reference to the generalized sketch in Figure 5.

ATTACHMENT

SCHEMATIC CROSS SECTION
ILLUSTRATING WAVE RUNUP TERMS

From FEMA, 1986



TYPICAL TRANSECT SCHEMATIC

The first step is to establish the expected "stillwater" elevation, representing the static water surface upon which the waves will be superimposed. Note that the stillwater elevation is higher than mean sea level for a number of reasons. The normal tidal range must be taken into account, obviously, because shoreline damage will be most severe during high tide. However, there are additional, less intuitive factors that tend to raise the stillwater elevation. Abnormally low barometric pressure and persistent onshore winds during storms, for instance, will both push up the water surface to some degree.

Stillwater elevations are expressed in probabilistic terms, much like storm frequencies. For design purposes, the Federal Emergency Management Agency (FEMA) and other governmental agencies have typically adopted the "100-year" conditions as a basis for their runup analyses. In this time frame, the slow but general rise of sea level must also be accommodated in the analysis (e.g., see Environmental Protection Agency, 1983; Hoffman, 1984).

With the stillwater elevation established, the next step is to superimpose the effects of storm waves on the shoreline, using computer models. These models typically use historical data for deep-water wave conditions and direction of approach combined with field data for bathymetry and beach profiles. Again, the results are expressed in probabilistic terms with the 100-year event as the benchmark. Along the relevant portions of East Cliff Drive, FEMA (1986) has not calculated 100-year wave runup elevations for any specific sites. For this reason, the project geotechnical engineer has completed detailed wave runup analyses for the beach adjacent to the study area, incorporating the shoreline configuration depicted on our geologic cross sections (Plate 2).

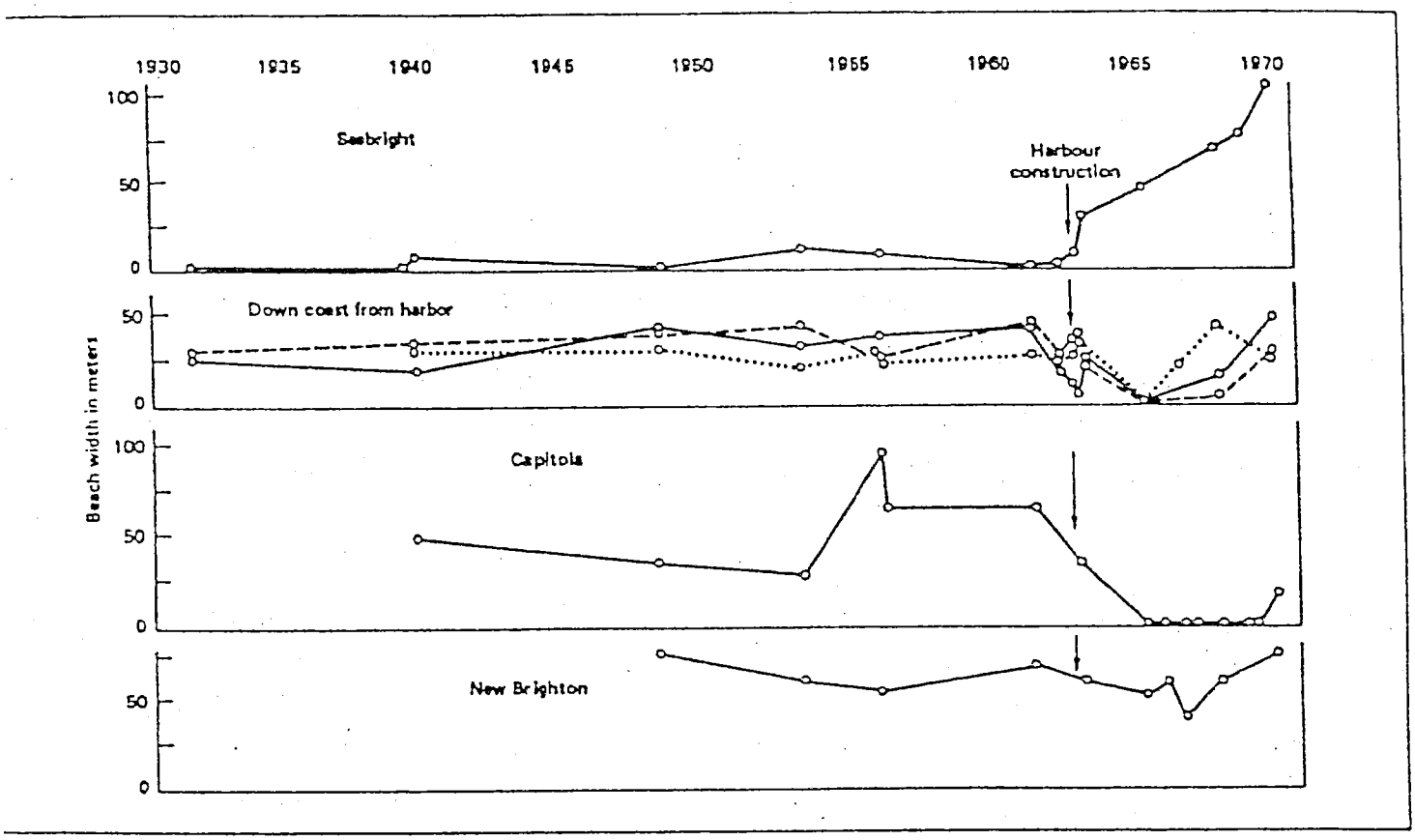
Human Intervention and Coastal Processes

Previous studies have shown that almost all of the annual sand supply for beaches in the Santa Cruz area can be attributed to littoral drift moving "downcoast" from north to south (see Griggs and Johnson, 1976, and references therein). Thus, any human intervention disrupting the normal littoral flow of sand would have a serious impact on these beaches. The construction of the Santa Cruz Yacht Harbor in 1962-1964 represented just such an event, as documented by Griggs and Johnson (1976). Their aerial photographic studies showed that the beach at Capitola, for example, averaged about 180 feet in width for the period 1932 to 1961, prior to construction of the yacht harbor. When the west jetty for the harbor was completed in late 1962, the annual littoral flow of sand totaling about 300,000 cubic yards was effectively cut off, causing the upcoast beaches to expand and the downcoast beaches to shrink (Figure 6). By 1965 the beach at Capitola had been reduced in width by almost 90 percent, to an average of only 20 feet. This beach remained depleted until 1970, when the city built a groin nearly 250 feet long at the downcoast end of the beach to help trap the diminished littoral supply and also brought in 2,000 truckloads of quarry sand as a supplement.

The beaches immediately downcoast from the harbor fared better, recovering somewhat after a few years as the buildup of sand on the upcoast side peaked and littoral drift began bypassing the jetties (Figure 6). However, some of the sand bypassing the jetties is now diverted into the deeper water of the bay and never actually reaches the downcoast beaches. In the winter months, furthermore, the harbor mouth traps up to 30 per cent of the entire annual littoral flow of sand (Griggs and Johnson, 1976). Although this

BEACH WIDTHS BEFORE AND AFTER CONSTRUCTION
OF THE SANTA CRUZ YACHT HARBOR

Griggs and Johnson, 1976



Chronologic changes in the widths of beaches upcoast and downcoast from the Santa Cruz harbor before and after harbor construction.

ATTACHMENT

sand is now dredged and reintroduced into the littoral drift system, the downcoast beaches are nevertheless deprived of a portion of this sand in the winter months when they need it the most.

With the downcoast beaches starved of sand by construction of the yacht harbor, the adjacent seacliffs are subjected to intensified surf attack and accelerated erosion. In 1963 and 1965 the U.S. Army Corps of Engineers installed riprap revetments along portions of the coastline to combat erosion, a measure that has met with mixed success. Griggs and Johnson (1976; 1970) established 60 stations along the coastline between San Lorenzo Point and New Brighton Beach and measured the rate of cliff top retreat at each, using maps and aerial photographs covering the period 1853-1973. Their results, shown in Figure 7, mirror the changes in the beaches shown in Figure 6.

Although the Griggs and Johnson study is valuable as background information for understanding coastal processes in northern Monterey Bay and the impact of human intervention, most of the data are not directly applicable to the study area. Furthermore, the Griggs and Johnson study ended more than twenty years ago, predating the period most relevant to our current investigation. Hence, we have conducted our own aerial photographic study, focusing on local changes to the beach and bluff since construction of the harbor (and especially during the storm years of the 1980s).

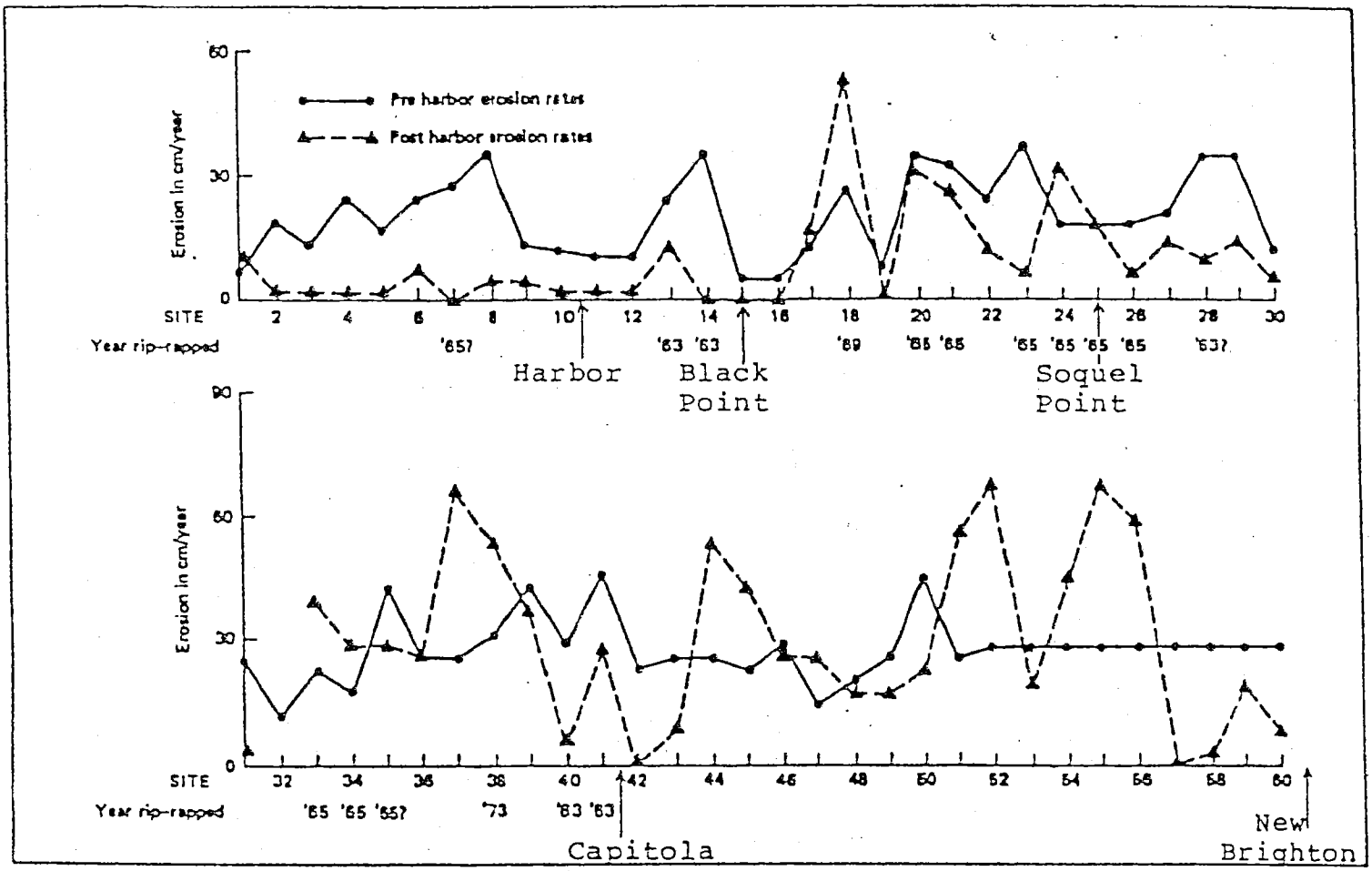
AERIAL PHOTOGRAPHIC INTERPRETATION

We have examined 13 sets of large-scale, stereo aerial photographs of the study area and vicinity, covering the period 1931 to 1989.

ATTACHMENT

SEACLIFF EROSION BEFORE AND AFTER CONSTRUCTION
OF THE SANTA CRUZ YACHT HARBOR

Griggs and Johnson, 1976



Comparison of average rates of cliff erosion before and after harbor construction at individual sites between San Lorenzo Point and New Brighton Beach.

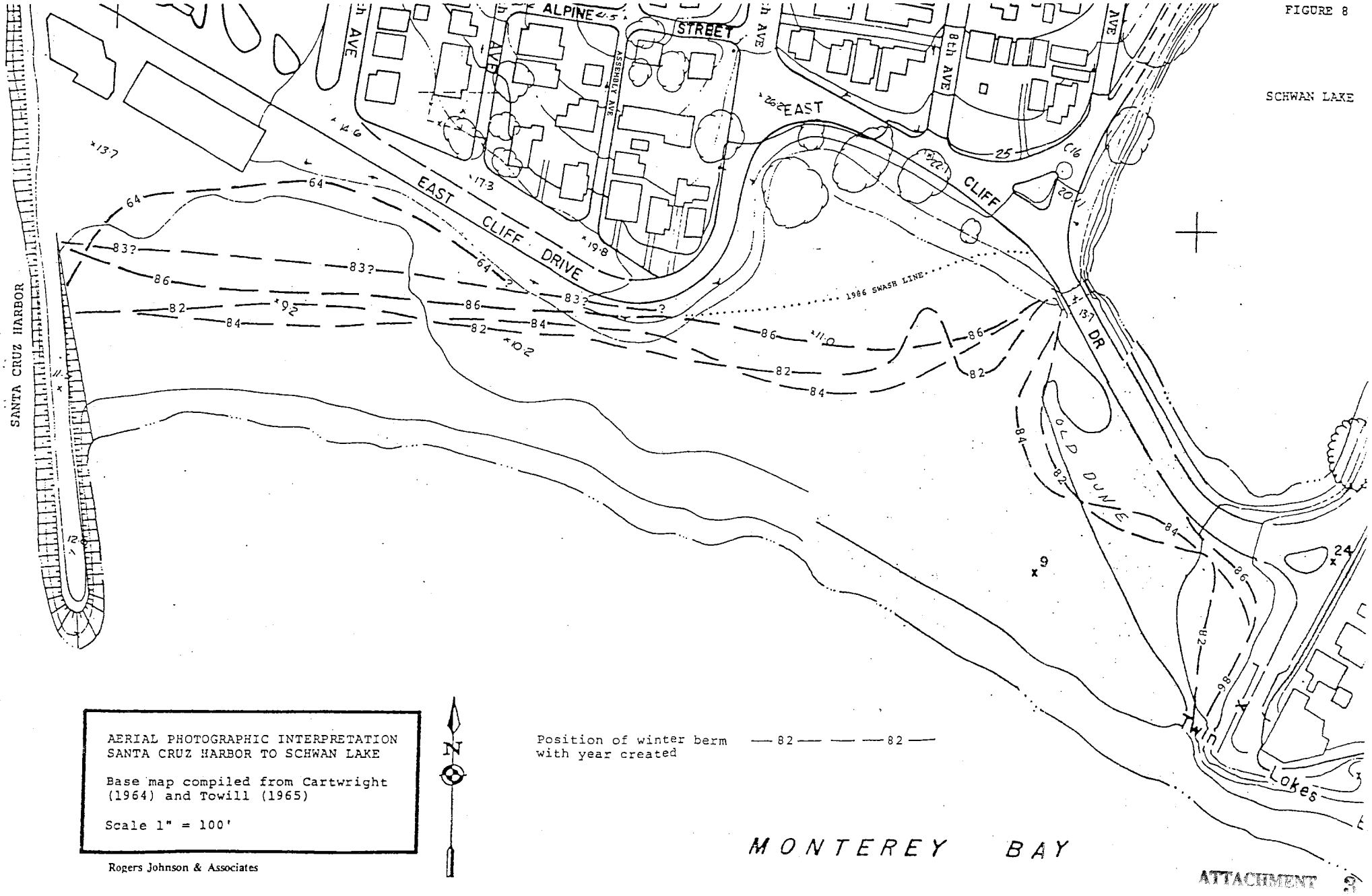
The photos taken prior to 1964 reveal seasonal and progressive changes to the beach, dune, and lagoon environments in the pre-harbor era. These older photos also show two significant alterations to East Cliff Drive that occurred between 1931 and 1948: the road alignment between 5th Avenue and 7th Avenue was straightened and moved seaward; and the wooden bridge across Schwan Lake was replaced by an embankment and restricted outlet for the lake.

The primary focus of our aerial photographic study, however, was beach and bluff erosion in the post-harbor era along the stretch of East Cliff Drive between the harbor and Schwan Lake. Figure 8 summarizes beach erosion for selected winters since the harbor was built. We can probably discount 1964 because the beach had not yet re-equilibrated following construction of the harbor jetties. The remaining data show a fairly consistent pattern, with wave runup and beach scour encroaching on East Cliff Drive primarily in two locations: 1) along the seaward portion of the prominent S-turn in the road (near its intersection with Assembly Avenue), and 2) along the embankment fronting Schwan Lake.

At the beginning of the S-turn, near Assembly Avenue, the worst storm erosion occurred in the winter of 1983, when the low bluff flanking the outboard shoulder of East Cliff Drive retreated approximately 20 feet (based on careful measurements of 1982 and 1984 aerial photographs). Riprap was subsequently emplaced at this bend in the road to prevent localized undermining of the roadbed. It is clear that the road alignment will be threatened in the future, but only during the largest storms: the bluff retreat along East Cliff Drive near the foot of Assembly Avenue in 1983 (20 feet) exceeded the cumulative retreat at this location for the entire period of 1931 to 1973 (14 feet; see Griggs and Johnson, 1979).

ATTACHMENT

FIGURE 8



ATTACHMENT 9

At the second location, near Schwan Lake, erosion of the old dune field seaward of East Cliff Drive has been progressive. By 1986 almost all of this dune field, along with the parking area built over it, had disappeared. Future wave runup during the largest storms will now impact the entire stretch of East Cliff Drive fronting Schwan Lake. (The hazard here to the road is certainly not new, however; see the entry for 26-27 December 1940 in Appendix 1).

Figure 8 shows that the shoreward portion of the S-turn in East Cliff Drive (near its intersection with 7th Avenue) is generally protected from surf attack by the geometry of the coastline. In 1986 the swash line reached the public bathrooms in this "shadow zone" but the berm representing significant beach scour lay considerably seaward. We will return to the geologic constraints on beach scour throughout the study area in our discussion of the geologic cross sections.

FIELD INVESTIGATION

Geologic Setting

The road alignment in question follows the edge of the beach between the Santa Cruz Harbor and Schwan Lake. From 5th Avenue (the edge of the harbor) to 9th Avenue (the edge of Schwan Lake) the beach is backed by a low, moderately steep coastal bluff consisting of Purisima Formation (Pliocene) overlain by partially stripped terrace deposits (Pleistocene). Figure 1 shows that the base of the terrace deposits should lie at an elevation of about 21.5 to 22.5 feet in the study area; we corroborated this supposition by examining bulldozer cuts on the corner lot near the S-turn (APN 27-182-04), where a house was demolished in September. The

ATTACHMENT 2

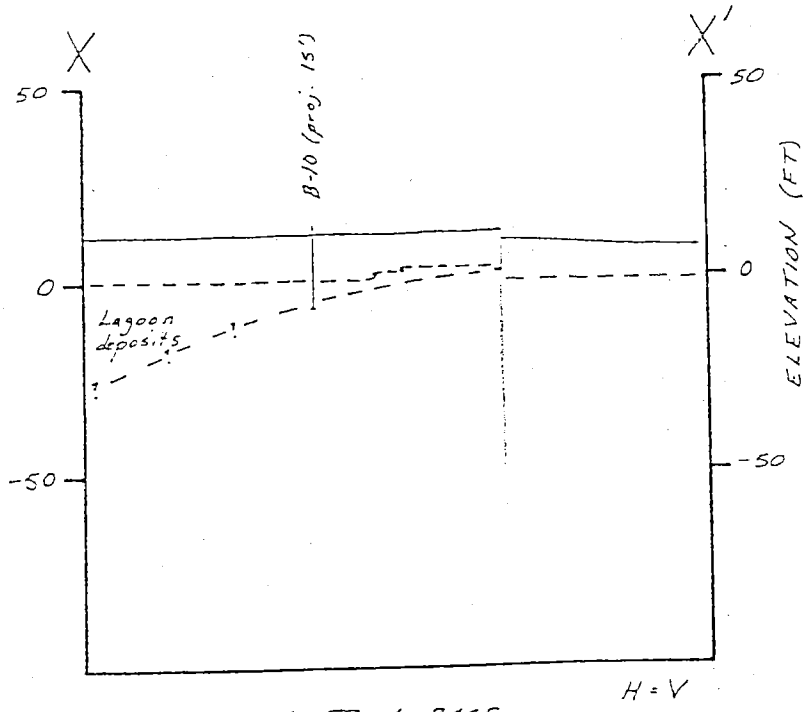
cuts at the back of the lot (elevation 24 to 29 feet) exposed soil and reddish brown, poorly consolidated, gravelly sands typical of the terrace deposits in the northern Monterey Bay area. In contrast, the bulldozer operator reported encountering "dense sandstone" beneath the floor of the dug-out garage at an elevation of 21 to 22 feet (personal communication), which probably represented the top of the Purisima. The roadbed for East Cliff Drive at this location is also between 21 and 22 feet in elevation. It appears, therefore, that the bench cut for the S-turn was created by scraping the terrace deposits off the denser Purisima bedrock below and dumping the spoils on the outboard edge to create a fill wedge. Exposures on the fill slope confirm that the fill material was derived from terrace deposits.

The beach is underlain by Holocene coastal deposits including beach sand and lagoonal sands and muds, which rest on Purisima Formation bedrock. As discussed later, the distribution of beach and lagoonal deposits is variable, as is their thickness. Briefly, between the modern lagoons the coastal deposits are generally 15 feet thick or less and the bedrock surface beneath them is a wave-cut platform. Seaward of the lagoons, however, the coastal deposits are more than 80 feet thick, filling the mouths of drowned Pleistocene drainages. These stratigraphic relationships are depicted on the cross sections (Plate 2) and transverse sections (Figures 9 and 10).

Subsurface Investigation

In conjunction with Haro, Kasunich and Associates, geotechnical engineers, we excavated eight backhoe test pits and eleven 6-inch diameter borings throughout the study area in July and August, 1995. Sketch logs of the test pits are presented in Appendix 2 of

FIGURE 9



TOPOGRAPHY FROM BASE

TP-1 = EXPLORATORY TE

B-5 = EXPLORATORY B

CONTACTS DASHED WHE

ROGERS JOHNSON & ASSOC.

ATTACHMENT 3

At the second location, near Schwan Lake, erosion of the old dune field seaward of East Cliff Drive has been progressive. By 1986 almost all of this dune field, along with the parking area built over it, had disappeared. Future wave runup during the largest storms will now impact the entire stretch of East Cliff Drive fronting Schwan Lake. (The hazard here to the road is certainly not new, however; see the entry for 26-27 December 1940 in Appendix 1).

Figure 8 shows that the shoreward portion of the S-turn in East Cliff Drive (near its intersection with 7th Avenue) is generally protected from surf attack by the geometry of the coastline. In 1986 the swash line reached the public bathrooms in this "shadow zone" but the berm representing significant beach scour lay considerably seaward. We will return to the geologic constraints on beach scour throughout the study area in our discussion of the geologic cross sections.

FIELD INVESTIGATION

Geologic Setting

The road alignment in question follows the edge of the beach between the Santa Cruz Harbor and Schwan Lake. From 5th Avenue (the edge of the harbor) to 9th Avenue (the edge of Schwan Lake) the beach is backed by a low, moderately steep coastal bluff consisting of Purisima Formation (Pliocene) overlain by partially stripped terrace deposits (Pleistocene). Figure 1 shows that the base of the terrace deposits should lie at an elevation of about 21.5 to 22.5 feet in the study area; we corroborated this supposition by examining bulldozer cuts on the corner lot near the S-turn (APN 27-182-04), where a house was demolished in September. The

ATTACHMENT 2

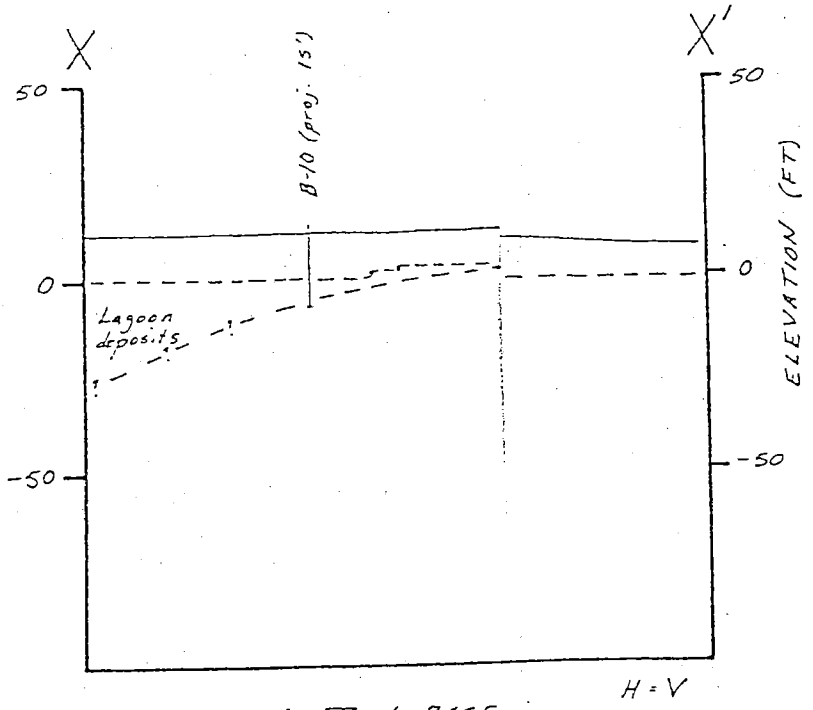
cuts at the back of the lot (elevation 24 to 29 feet) exposed soil and reddish brown, poorly consolidated, gravelly sands typical of the terrace deposits in the northern Monterey Bay area. In contrast, the bulldozer operator reported encountering "dense sandstone" beneath the floor of the dug-out garage at an elevation of 21 to 22 feet (personal communication), which probably represented the top of the Purisima. The roadbed for East Cliff Drive at this location is also between 21 and 22 feet in elevation. It appears, therefore, that the bench cut for the S-turn was created by scraping the terrace deposits off the denser Purisima bedrock below and dumping the spoils on the outboard edge to create a fill wedge. Exposures on the fill slope confirm that the fill material was derived from terrace deposits.

The beach is underlain by Holocene coastal deposits including beach sand and lagoonal sands and muds, which rest on Purisima Formation bedrock. As discussed later, the distribution of beach and lagoonal deposits is variable, as is their thickness. Briefly, between the modern lagoons the coastal deposits are generally 15 feet thick or less and the bedrock surface beneath them is a wave-cut platform. Seaward of the lagoons, however, the coastal deposits are more than 80 feet thick, filling the mouths of drowned Pleistocene drainages. These stratigraphic relationships are depicted on the cross sections (Plate 2) and transverse sections (Figures 9 and 10).

Subsurface Investigation

In conjunction with Haro, Kasunich and Associates, geotechnical engineers, we excavated eight backhoe test pits and eleven 6-inch diameter borings throughout the study area in July and August, 1995. Sketch logs of the test pits are presented in Appendix 2 of

ATTACHMENT



TOPOGRAPHY FROM BASE

TP-1 = EXPLORATORY TE

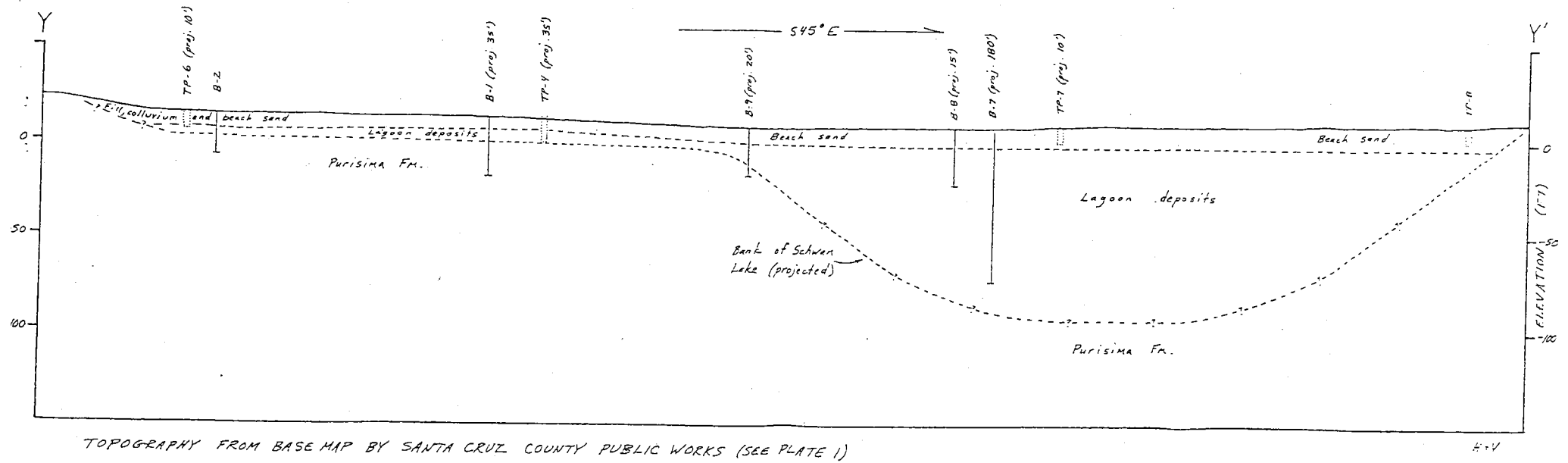
B-5 = EXPLORATORY B

CONTACTS DASHED WHER

ROGERS JOHNSON & ASSOC.

ATTACHMENT 9

TRANSVERSE SECTION
EAST CLIFF DRIVE ROAD ALIGNMENT
Santa Cruz Harbor to Schwan Lake
Scale 1" = 50' H=V



TOPOGRAPHY FROM BASE MAP BY SANTA CRUZ COUNTY PUBLIC WORKS (SEE PLATE 1)

TP-4 = EXPLORATORY TEST PIT
B-1 = EXPLORATORY BORING

CONTACTS DASHED WHERE APPROXIMATE, QUERIED WHERE UNCERTAIN

ROGERS JOHNSON & ASSOC.

ATTACHMENT 5

this geological report; logs of the borings are presented in the companion geotechnical report by Haro, Kasunich and Associates.

The borings and excavations (and limited outcrops) revealed the following earth materials. Their distributions are shown on the cross sections, which will be discussed individually later.

Fill: Fill is typically found beneath the existing roadbed of East Cliff Drive and its outboard shoulder, but its composition and configuration vary considerably along the length of the alignment. Beneath the low-lying straight segment of road between 5th Avenue and the S-turn, the fill consists of base rock and local borrow from the adjacent beach environment (aerial photographs from 1931 suggest that this segment of road was constructed in part on an old dune). These materials are visible where storm scour has undermined portions of the outboard shoulder.

Along the S-turn the outboard shoulder is underlain by fill derived from terrace deposits excavated from the bluff during construction of the partial bench cut for the road. This material is typically composed of weathered, reddish-brown, gravelly sand with a variable content of silt and clay binder.

The outboard shoulder of the S-turn is also locally armored by riprap near the intersection of East Cliff Drive and Assembly Avenue, where wave scour attacked the shoulder in 1983 (as discussed earlier). This riprap appears undersized and was probably installed on an emergency basis. Riprap also protects the parking area on the seaward side of East Cliff Drive near the intersection with 9th Avenue.

ATTACHMENT

Along the low-lying, straight segment of road fronting Schwan Lake, the roadbed is again constructed on an embankment composed largely of local borrow from the beach environment, as shown on undated, pre-1948 Public Works plans discovered by Ralph Norberg, civil engineer for the current project.

Colluvium: Colluvium underlies portions of the embankment along the outboard side of the S-turn, where it was deposited by slopewash at the base of the bluff. Like the fill wedge in this area, the colluvium has the lithologic character of its parent material, the terrace deposits exposed at the top of the bluff. However, the colluvium could be distinguished from the fill by the presence of a distinct soil profile developed on the former (e.g., in TP-6). The toe of the colluvium interfingers with the coastal deposits beneath the beach; the presence of the mature soil indicates that the colluvium is much older than the upper layers of beach sand, however.

Beach Sand: The beach sand in the study area consists largely of loose, fine to medium-grained sand with a "salt and pepper" appearance (typical of local beaches) due to its feldspathic composition with lesser amounts of dark mica and heavy minerals. Some horizons beneath the beach, however, were distinctive because of their unusual concentrations of coarse to very coarse sand, gravel, broken shells, and/or heavy mineral laminations. These horizons were noted in the test pits and borings because they represent lag deposits from storm events. The lag deposits were an important constraint for the geotechnical engineer's wave runup analysis and were thus included on the cross sections (see discussion below).

ATTACHMENT

Lagoonal Deposits: The lagoonal deposits encountered in the test pits and borings were distinguished by 1) their mottled, blue-green color and hydrogen sulfide odor, both indicative of a chemically reducing environment, and 2) the presence of marsh grass rootlets and (occasionally) the shells of tiny, fresh or brackish-water snails. The sediments themselves ranged from 1) fine to medium-grained sand very similar to beach sand, except for the chemical reduction "overprint," to 2) clayey sands or muds, which were sometimes interbedded with the cleaner sands. The coarser deposits were undoubtedly laid down by storms breaching the dune or beach ridge that normally blocked the mouth of the lagoon. Boring B-7, seaward of Schwan Lake and 80 feet deep, demonstrated that the alternation of muds and sands in the lagoonal environment persisted at this location for most of Holocene time.

The lagoonal deposits represent an important constraint for the wave runup analysis for one simple reason: their presence at any particular location and depth indicates that recent wave scour has been insufficient to erode them. This point will be discussed further in connection with the cross sections.

Terrace Deposits: As noted earlier, Pleistocene terrace deposits are exposed sporadically in the study area above the elevation of about 21.5 to 22.5 feet. In the recent bulldozer cuts on the corner lot adjacent to the S-turn, the terrace deposits consisted of weathered, reddish brown, silty sand and sand with pebbly and cobbly horizons. Where the original ground surface was undisturbed, these deposits were overprinted by a mature soil profile between 3 and 4 feet thick. The terrace deposits in this area normally rest with slight angular unconformity on the Purisima Formation bedrock (Pliocene), which is described below.

Purisima Formation: The Purisima bedrock encountered in one test pit and most of the borings consisted of dense but relatively unlithified, olive brown, fine to medium-grained sandstone. The Purisima sandstone was lithologically very similar to the overlying beach deposits but clearly distinct from them on the basis of color and density. The lack of lithification was notable, however, and explains how the bluff at the beginning of the S-turn could retreat 20 feet in a single winter (1983).

Subsurface Synthesis

Our synthesis of the subsurface data is presented in six cross sections at a scale of 1"=20' (Plate 2) and two transverse sections at a scale of 1"=50' (Figures 9 and 10), using topographic data furnished by surveyors for the Department of Public Works. The locations of these sections are shown on Plate 1, and each of them is explained below. Several of the sections on Plate 2 were used by the project geotechnical engineers in their wave runup analyses, as detailed in the companion geotechnical report.

Cross Section A-A': This section, located off 5th Avenue, depicts a thin veneer of beach sand on a wave-cut bedrock platform. Scour in the beach deposits (stippled pattern) was indicated in TP-1 by multiple shell horizons and a displaced riprap boulder at depth (see test pit logs, Appendix 2). Bedrock was encountered at 9 feet, separated from the beach sand by a half-foot of lagoonal deposits (not shown). The bedrock gradient seaward from TP-1 (about 2 percent) is based on the published, regional average for the inner wave-cut platform (Bradley and Griggs, 1976). The rise in the bedrock surface landward of TP-1 is conjectural but in some senses

irrelevant to our hazard assessment because the Purisima sandstone in this area is unlithified and consequently prone to wave scour.

Cross Section B-B′: This section was located at the beginning of the S-turn in East Cliff Drive, near the foot of Assembly Avenue. The beach deposits were 15 feet thick or less, with scour indicated by gravels, shell layers, and/or heavy mineral concentrations in TP-2 and B-6. Depth to bedrock was established in B-6 and the regional platform gradient was applied. Note that the landward projection of the bedrock surface passes just beneath TP-2, where 20 feet of horizontal bedrock scour apparently occurred in 1983 (as deduced from aerial photographs). The subsurface configuration of the emergency riprap is conjectural but somewhat constrained by outcrops in the road shoulder and by several small, displaced boulders encountered in TP-2.

Cross Section C-C′: This section extended seaward from the recessed portion of the S-turn. TP-6 revealed fill, colluvium, and lagoonal deposits at the base of the bluff. Buried beneath the beach, about 3 feet of lagoonal deposits rest on the bedrock surface in B-2 and B-3 but not, apparently, at TP-3. At various times in the historic past, an arm of Schwan Lake has extended westward toward the sites of B-2 and B-3 (e.g., 1931 aerial photographs). Consequently, it is not difficult to envision a more extensive lagoonal arm in the distant past, as implied by C-C′. It is conceivable, moreover, that these lagoonal deposits once extended farther seaward than shown and were subsequently scoured away. This scenario is consistent with the distribution of lag deposits shown on the section and also supports the "shadow zone" postulated for the recessed portion of the S-turn (see Aerial Photographic Interpretation, above). In any event, we can safely

ATTACHMENT

conclude that the depth of recent scour between B-2 and B-3 is constrained by the presence of the lagoonal deposits.

Depth to bedrock (generally 10 to 15 feet) was established in B-2, B-3 and B-4, yielding a seaward platform gradient for C-C' similar to the published regional average employed on A-A' and B-B'.

Cross Section D-D': This section off the foot of 8th Avenue shows up to 7 feet of lagoonal deposits buried beneath the beach. Depth to bedrock was established in B-1 and the regional platform gradient was applied. The total thickness of coastal deposits above the bedrock platform is generally 15 feet or less. The landward termination of the coastal deposits, as shown on the section, is conjectural.

Depth of wave scour along D-D' is constrained by 1) the buried lagoonal deposits landward of B-9, and 2) the bedrock platform seaward of B-9. The most probable zones of wave scour lie within the stippled pattern, representing the projected upper and lower limits of the lag deposits encountered in B-1, B-9, TP-4 and TP-5.

Cross Section E-E': This section lies seaward of Schwan Lake, where bedrock is buried by more than 80 feet of beach and lagoonal deposits dating back to the rise in sea level at the end of the Pleistocene ice ages. The alternation of muddy and sandy intervals in B-7 is only approximate, since sampling below the water table was not possible with the drill rig employed.

Depth of wave scour between B-7 and B-8 is constrained by the top of the buried lagoonal deposits. The most probable zones of wave scour lie within the stippled pattern, representing the projected

ATTACHMENT 8

considered to be the most active fault within the region (Figure 11). The 1989 Loma Prieta earthquake probably relieved some stress along the segment of the San Andreas fault closest to the study area, called the southern Santa Cruz Mountains segment. However, the assumed 100-year economic lifetime for coastal developments is sufficiently long to allow stress on this segment to build up again and trigger a repeat of the Loma Prieta event. Therefore, using estimates from The Working Group on California Earthquake Probabilities (1990), the "design earthquake" for the subject site is a magnitude 7.0 earthquake centered on the southern Santa Cruz Mountains segment of the San Andreas fault. A magnitude 7.0 earthquake on the San Francisco Peninsula segment of the San Andreas (Working Group, 1990) or a magnitude 7.7 earthquake on the San Gregorio (Wesnousky, 1986) could also produce strong shaking at the site.

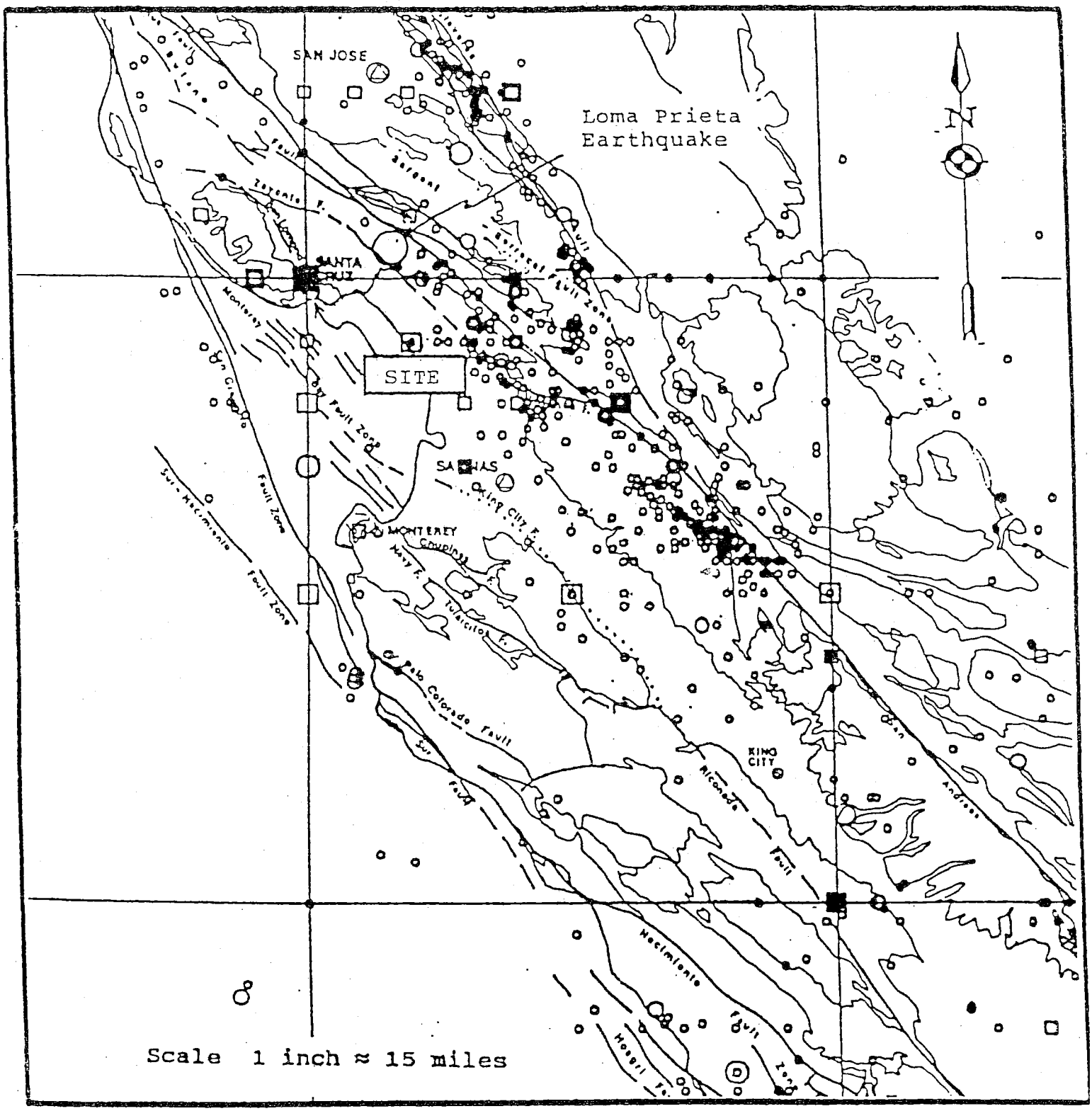
Ground shaking from a magnitude 7.0 earthquake 11 miles from the site would have a Modified Mercalli Intensity of approximately VII to VIII+ (Table 1), with a mean peak horizontal ground acceleration (MPHGA) of about 0.35 gravity (Seed and Idriss, 1982) and repeatable high ground accelerations (RHGA) of about 0.25 gravity, rounded to the nearest 0.05g (Ploessel and Slossen, 1974). The duration of ground shaking from this design event would be about 16 seconds (Dobry and others, 1978).

No active or potentially active faults have been mapped near the site. The bedrock faults exposed in the seacliffs between Santa Cruz and Capitola do not disrupt the wave-cut platform below the terrace deposits. This surface is at least 85,000 years old (Weber, 1990).

ATTACHMENT 3

FIGURE 11

REGIONAL EARTHQUAKE EPICENTERS



Intensities

III-V □

VI-VIII □

IX-XII □

EARTHQUAKE EPICENTERS PLOTTED BY NATIONAL GEOPHYSICAL DATA CENTER/NOAA, BOULDER, COLORADO

Magnitudes

3.5-4.9 ∘

5.0-6.0 ○

6.1-7.0 ○

>7.0 ○

ATTACHMENT

TABLE 1

MODIFIED MERCALLI INTENSITY SCALE

General Comparison Between Earthquake Magnitude and the Earthquake Effects Due to Ground Shaking

EARTHQUAKE CATEGORY	RICHTER MAGNITUDE	MODIFIED MERCALLI INTENSITY SCALE* (After Housner, 1970)	DAMAGE TO STRUCTURE
Minor	2.0	I - Detected only by sensitive instruments.	No damage
		II - Felt by few persons at rest, especially on upper floors; delicate suspended objects may swing.	
	3.0	III - Felt noticeably indoors, but not always recognized as an earthquake; standing cars rock slightly, vibration like passing truck.	
	4.0	IV - Felt indoors by many, outdoors by a few; at night some awaken; dishes, windows, doors disturbed; cars rock noticeably.	Architectural damage
		V - Felt by most people; some breakage of dishes, windows and plaster; disturbance of tall objects.	
	5.0	VI - Felt by all; many are frightened and run outdoors; falling plaster and chimneys; damage small.	
Moderate 5.3			
	6.0	VII - Everybody runs outdoors; damage to buildings varies depending on quality of construction; noticed by drivers of cars.	
Major 6.9		VIII - Panel walls thrown out of frames; fall of walls, monuments, chimneys; sand and mud ejected; drivers of cars disturbed.	Structural damage
	7.0	IX - Buildings shifted off foundations, cracked, thrown out of plumb; ground cracked, underground pipes broken; serious damage to reservoirs and embankments.	
Great 7.7		X - Most masonry and frame structures destroyed; ground cracked; rail bent slightly; landslides.	
	8.0	XI - Few structures remain standing; bridges destroyed; fissures in ground; pipes broken; landslides; rails bent.	Near total destruction
		XII - Damage total; waves seen on ground surface; lines of sight and level distorted; objects thrown into the air; large rock masses displaced.	

*The intensity is a subject measure of the effect of the ground shaking, and is not an engineering measure of the ground acceleration.

ATTACHMENT

Coseismic Slope Stability and Liquefaction

Both the seismic setting and the site-specific geology influence the stability of the seacliffs in this area. As previously mentioned, the study area will be subjected to strong ground shaking in the event of a large magnitude earthquake centered on the nearby San Andreas or San Gregorio faults.

Review of the local newspaper coverage (Youd and Hoose, 1978), and the Carnegie Commission Report (Lawson et al., 1908) of the 1906 earthquake disclosed no documented accounts of large-scale seacliff failure in Santa Cruz County due to the earthquake, though there was much sloughing of "earth" from the bluffs near Capitola (Lawson et al., 1908, p. 272). This apparently involved portions of the poorly consolidated terrace deposits that were shaken loose during the earthquake.

Another seismically generated failure occurred on the steep coastal bluff along Opal Cliffs Drive on 24 April 1984 (Morgan Hill earthquake, Magnitude 5.8-6.2), resulting in about six feet of localized retreat. This amount of coseismic bluff retreat is similar to that which occurs during storm-generated bluff retreat. We are not aware of bluff retreat at the subject property as a result of the Morgan Hill earthquake.

The 1989 Loma Prieta earthquake generated numerous localized coastal bluff failures in Santa Cruz County, including soil sloughing, rockfalls, blufftop fissuring, and shallow translational landslides (Sydnor et al., 1990).

ATTACHMENT 8

Dupré (1975) has mapped the river mouths and coastal lagoons in the Santa Cruz area as having a high potential for liquefaction. Historical accounts indicate that ground failures due to liquefaction during the 1906 earthquake were common in the lower San Lorenzo River flood plain (e.g., Youd and Hoose, 1978). Although no such occurrences were reported from the mouth of Schwan Lake, borings B-7 and B-8 show sandy strata at depth that could be susceptible to liquefaction (see Cross Section E-E' and Transverse Section Y-Y'). A detailed liquefaction analysis for this area may be warranted.

CONCLUSIONS

The stretch of East Cliff Drive between 5th Avenue and Schwan Lake is slated for improvements including widening of the roadway and addition of a bike/walkway. This geologic report and the companion geotechnical report document the geologic and oceanographic conditions on the site, assess the hazards to the proposed improvements, and provide recommendations for mitigating those hazards.

The road alignment in question follows the edge of the beach between the Santa Cruz Harbor and Schwan Lake. The road in this area consists of two straight segments near beach level separated by a more elevated, pronounced S-turn. The two straight segments are constructed on fill embankments over beach and/or lagoonal deposits. The S-turn occupies a partial bench cut in the low, moderately steep coastal bluff, with a fill wedge on the outboard side. The coastal bluff consists of Purisima Formation overlain by partially stripped terrace deposits.

The beach is underlain by coastal deposits of variable thickness resting on Purisima bedrock. Between Woods Lagoon (now the harbor) and Schwan Lake, the buried bedrock surface is a wave-cut platform, and the beach deposits (and localized lagoonal deposits) are generally 15 feet thick or less. Seaward of Schwan Lake, however, the beach is underlain by at least 80 feet of Holocene beach and lagoonal deposits occupying the drowned and backfilled mouth of a Pleistocene drainage. A similar buried bedrock depression occupies the mouth of Woods Lagoon (the harbor), just west of the study area.

Construction of the Santa Cruz Harbor in the early 1960s disrupted the normal littoral flow of sand in northern Monterey Bay, leaving the downcoast beaches partially "starved" in the winter months. Although dredging of the harbor mouth has rectified this situation somewhat, many of the downcoast beaches still offer less protection for the shoreline during major storms than they did prior to construction of the harbor.

Aerial photographs of the study area taken in the 1980s show that wave runup and scour have encroached on East Cliff Drive in two locations: 1) along the seaward portion of the S-turn, near the foot of Assembly Avenue, and 2) along the embankment fronting Schwan Lake. The risk at these locations has been quantified by the project geotechnical engineers in their wave runup analysis. The geotechnical engineers have also analyzed wave runup for the straight segment of road between the harbor and the S-turn, where the risk is lower but still significant.

The only segment of road in the study area where the risk from wave runup and beach scour is low is the landward portion of the S-turn,

approaching the intersection of East Cliff Drive with 7th Avenue. This area is in a "shadow" zone by virtue of the coastline geometry.

The study area is in a seismically active region with a moderate to high probability for strong seismic shaking during the design lifetime of the proposed road improvements. The road alignment across the mouth of Schwan Lake overlies Holocene coastal deposits more than 80 feet thick, some of which may be susceptible to liquefaction.

RECOMMENDATIONS

As we understand, the proposed road improvements will be implemented in three phases.

Phase 1 corresponds with the landward portion of the S-turn, where wave runup and scour do not pose a serious risk. The project geotechnical engineer has supplied design criteria for retaining walls along this stretch as necessary.

Phase 2 includes the straight segment of road immediately east of the harbor and the seaward portion of the S-turn, where the risk from wave runup and scour is moderate to high. The project geotechnical engineer has provided design criteria for various types of seawalls.

Phase 3 corresponds with the straight segment of road seaward of Schwan Lake, where the risk from wave runup and scour is high. The project geotechnical engineer has provided design criteria for various types of sea wall. Bear in mind, however, that a detailed

ATTACHMENT

liquefaction analysis for this area may be warranted and the results could have a bearing on the final design parameters.

All earthwork and structural design should accommodate the seismic-shaking parameters presented herein for the "design" earthquake: MPHGA 0.35g; RHGA 0.25g; duration approximately 16 seconds.

We request the opportunity to review all forthcoming engineering plans for conformity with our geological findings and recommendations.

INVESTIGATION LIMITATIONS

1) The conclusions and recommendations contained herein are based on probability and in no way imply that the road alignment will not possibly be subjected to ground failure, seismic shaking or coastal erosion by wave inundation and/or impact causing significant damage. The report does suggest that constructing the road improvements in compliance with the recommendations contained herein is an acceptable risk over the 100-year design period stipulated by the California Coastal Commission.

2) This report is issued with the understanding that it is the responsibility of the owner or his representative or agent to ensure that the recommendations contained herein are brought to the attention of the project engineer, are incorporated into the plans and specifications for the project, and that the necessary steps are taken to ensure that the contractor and subcontractors carry out such recommendations in the field.

ATTACHMENT 3

3) If any unexpected variations in soil conditions or if any undesirable conditions are encountered during construction, Rogers E. Johnson and Associates should be notified so that supplemental recommendations can be given.

Sincerely,

ROGERS E. JOHNSON & ASSOCIATES

Alan O. Allwardt
R.G. No. 5520

Rogers E. Johnson
C.E.G. No. 1016

AOA/REJ/cjd

ATTACHMENT 3

REFERENCES

Aerial Photographs

1 April 1931, Frames [C-1437] B32 and 33, black and white, nominal scale 1:12,000, City of Santa Cruz.

25 April 1948, Frames CDF5-4 61 and 62, black and white, nominal scale 1:10,000, California Division of Forestry.

25 August 1953, Frames [CCL] SC 44 and 45, black and white, nominal scale 1:10,000, Beach Erosion Board, Washington, D.C.

6 December 1961, Frames SC 1-34 and 35, black and white, nominal scale 1:10,000, U.S. Army Corps of Engineers.

13 June 1964, Frames 1-1 and 2, black and white, nominal scale 1:6,000, California Recreation Board #3.

11 May 1965, Frames SC 1-36 and 37, black and white, nominal scale 1:10,000, U.S. Army Corps of Engineers.

14 October 1975, Frames SCZCO 2-62 and 63, black and white, nominal scale 1:12,000, Santa Cruz County Planning Department.

5 October 1976, Frames DNOD-AFU-C 171 and 172, color, nominal scale 1:12,000, California Department of Navigation and Ocean Development.

8 January 1982, Frames JSC 9-1 and 2, black and white, nominal scale 1:20,000, U.S. Geological Survey.

13 October 1982, Frames AV-2192-08 10 and 11, black and white, nominal scale 1:6,000, City of Santa Cruz.

12 April 1984, Frames MONTEREY 93 and 94, color, nominal scale 1:12,000, U.S. Army Corps of Engineers, Los Angeles District.

16 March 1986, Frames CDBW-APU-C 226 and 227, color, nominal scale 1:12,000, California Department of Boating and Waterways.

18 October 1989, Frames SANTA CRUZ-B 22174 and 22175, black and white, nominal scale 1:7,200, Air Flight Service (Santa Clara).

Maps and Reports

Bixby, H.C., Jr., 1962, Storms causing harbor and shoreline damage through wind and waves -- Monterey, California. Naval Post-graduate School, Monterey, California, unpublished Master's thesis.

Brabb, E.E., 1989, Geologic map of Santa Cruz County, California, U. S. Geological Survey Miscellaneous Investigations Series Map I-1905, scale 1:62,500.

Bradley, W.C., 1957, Origin of marine-terrace deposits in the Santa Cruz area, California, Bulletin of the Geological Society of America, v. 68, p. 421-444.

Bradley, W.C., and Griggs, G.B., 1976, Form, genesis, and deformation of central California wave-cut platforms, Geological Society of America Bulletin, v. 87, p. 433-449.

California Coastal Commission, 1978, Wave damage along the California Coast, December 1977 - March 1978, Published San Francisco, California.

Dobry, R., Idriss, I.M., and Ng, E., 1978, Duration characteristics of horizontal components of strong motion earthquake records, Bulletin of the Seismological Society of America, v. 68, p. 1487-1520.

Dupré, W.R., 1975, Geology and liquefaction potential of Quaternary deposits in Santa Cruz County, California, U. S. Geological Survey Miscellaneous Field Studies Map MF-648, 2 sheets, scale 1:62,500.

Environmental Protection Agency, 1983, Projecting sea level rise, methodology, estimates to the year 2100 and research needs, stock 055-000-00236-3, document EPA 230-09-007.

Federal Emergency Management Agency (FEMA), 1986, Flood Insurance Study, Santa Cruz County, California, Unincorporated Areas; 2 volumes plus Floodway Boundary and Flood Insurance Rate Maps (FIRM).

Fulton-Bennett, K., and Griggs, G.B., 1986, Coastal Protection Structures and their Effectiveness, California Department of Boating and Waterways/Marine Sciences Institute, University of California at Santa Cruz, 48 p.

Greene, H.G., 1977, Geology of the Monterey Bay region, California, U. S. Geological Survey Open-File Report 77-718, 347 p., 9 plates, scale 1:200,000.

Griggs, G.B., 1990, Coastal erosion and protection, northern Monterey Bay, in Griggs, G.B. and Weber, G.E., eds., Coastal Geologic Hazards and Coastal Tectonics, Association of Engineering Geologists Field Trip Guide, p. 1-49.

Griggs, G.B., and Johnson, R.E., 1976, Effects of the Santa Cruz Harbor on coastal processes of northern Monterey Bay, California, Environmental Geology, v. 1, p. 299-312.

Griggs, G.B., and Johnson, R.E., 1979, Coastline erosion: Santa Cruz County, California Geology, v. 32, p. 67-76.

Griggs, G.B., and Johnson, R.E., 1983, Impact of 1983 storms on the coastline, northern Monterey Bay and Santa Cruz County, California, California Geology, v. 36, p. 163-174.

Hall, N.T., Sarna-Wojcicki, A.M., and Dupré, W.R., 1974, Faults and their potential hazards in Santa Cruz County, California, U. S. Geological Survey Miscellaneous Field Studies Map MF-626, 3 sheets, scale 1:62,500.

Hoffman, J.S., 1984, Estimates of future sea level rise, in Barth, M.C., Titus, J.G., and Ruckelshaus, W.D., eds., Greenhouse Effect and Sea Level Rise, Van Nostrand Reinhold Company, New York, p. 79-105.

Jennings, C.W. et al., 1975, Fault map of California, California Division of Mines and Geology, California Geologic Data Map Series, map no. 1.

Jennings, C.W. et al., 1977, Geologic map of California, California Division of Mines and Geology, California Geologic Data Map Series, map no. 2.

Johnson, Rogers E. & Associates, 1987, Marina Dunes Shoreline Recession Study, unpublished report.

Lawson, A.C. et al., 1908, The California Earthquake of April 18, 1906, Report of the State Earthquake Investigation Commission, Carnegie Institute of Washington, Publication 87, 2 v., 600 p.

Meteorology International Incorporated, 1977, Deep water wave statistics for the California coast, published by California Department of Boating and Waterways.

National Marine Consultants, 1960, Wave statistics for seven deep water stations along the California coast, prepared for U.S. Army Corps of Engineers, Los Angeles and San Francisco districts, 20 p.

Ploessel, M.R., and Slossen, J.E., 1974, Repeatable high ground accelerations from earthquakes, California Geology, v. 27, p. 195-199.

Seed, H.B., and Idriss, I.M., 1982, Ground motion and soil liquefaction during earthquakes (Engineering Monographs on Earthquake Criteria, Structural Design and Strong Motion Records, v. 5), Earthquake Engineering Research Institute, Berkeley, California.

Sydnor, R.H., Griggs, G.B., Weber, G.E., McCarthy, R.J., and Plant, N., 1990, Coastal bluff landslides in Santa Cruz County resulting from the Loma Prieta earthquake of 17 October 1989, in McNutt, S.R., and Sydnor, R.H. (editors), The Loma Prieta (Santa Cruz Mountains), California Earthquake of 17 October 1989, California Division of Mines and Geology Special Publication, 104, p. 67-82.

U.S. Army Corps of Engineers, 1958, Santa Cruz County, California, Beach Erosion Control Study, U.S. Government Printing Office, Washington, D.C., 91 p.

U.S. Army Corps of Engineers, San Francisco District, 1969, City of Capitola, Beach Erosion Study, Santa Cruz County, California, Detailed Project Report, unpublished report dated November 1969.

Weber, G.E., 1990, Pleistocene marine terraces and neotectonics of the San Gregorio fault zone in Santa Cruz and San Mateo counties, California in Griggs, G.B., and Weber, G.E., (editors), Coastal Engineering and Coastal Tectonics, Association of Engineering Geologists Field Trip Guide, part 2, p. 1-97.

Wesnousky, S.G., 1986, Earthquakes, Quaternary faults, and seismic hazard in California, Journal of Geophysical Research, v. 91, p. 12587-12631.

Wiegel, R.L., 1964, Oceanographical Engineering, Prentice-Hall, Englewood Cliffs, New Jersey.

Working Group on California Earthquake Probabilities, 1990, Probabilities of large earthquakes in the San Francisco Bay region, California, U. S. Geological Survey Circular 1053, 51 p.

Yanev, P., 1974, Peace of Mind in Earthquake Country, Chronicle Books, San Francisco, 304 p.

Youd, T.L., and Hoose, S.N., 1978, Historic ground failures in northern California triggered by earthquakes, U. S. Geological Survey Professional Paper 993, 177 p.

APPENDIX 1

Storm History of Monterey Bay and the Centeral Coast, 1910-1983

ATTACHMENT

STORM HISTORY OF MONTEREY BAY AND THE CENTRAL COAST, 1910-1983

(Compiled from U. S. Army Corps of Engineers, 1958; Bixby, 1962; California Coastal Commission, 1978; Griggs and Johnson, 1983; Santa Cruz Sentinel and Watsonville Register-Pajaronian)

Date	Damage - Description	Direction/ Type of Storm
21 March 1910	Heavy storm off coast, mountainous seas. No damage.	---
22 Nov. 1910	Bay was very rough and surf was running high. No ships able to enter or leave Monterey harbor. No damage.	---
23 Feb. 1911	Mountainous waves reported along the beach north of Monterey. No damage.	---
4-11 Oct. 1912	Strong northwest wind and heavy swell. Several wharves at Monterey damaged and boats beached. Heavy surf.	---
Dec. 1912	Watsonville Wharf damaged, waves dashed up to Casino building; heaviest seas in history of Monterey Bay.	---
29-30 Apr. 1915	Heavy surf and strong winds. Considerable damage to structure and boats.	---
26 Nov. 1915	Large and powerful waves breaking over wharves at Monterey. No damage.	---
27 Jan. 1916	Southwest gale. Steamship pier at Moss Landing destroyed by tremendous swells.	"southwest gale"
29 Nov. to 1 Dec. 1923	Northeast gale swept 15 boats ashore at Monterey. Heavy seas outside harbor. Freighter beached at Santa Cruz.	"northeast gale"
11-15 Feb. 1926	Southerly gale winds and wave damage all along California coast. Pier damaged at Moss Landing. High tide and waves destroyed bath house at Santa Cruz, concession building lost practically all of underpinnings. Downtown Capitola flooded. Venetian Court apartments undercut. High waves washed completely over 2000' of new seawall at Seacliff, carrying debris back to cliff. Portions of seawall undercut and caved in. Beach road washed almost entirely away. Seawall at Swanton Beach partially destroyed. Seaside Company's bandstand collapsed. Breaker broke into and destroyed Ideal Fish Restaurant.	"southerly gale"

Date	Damage - Description	Direction/ Type of Storm
25 Oct. 1926	Heavy swells running into Bay. Giant combers rolled shoreward carrying bay waters almost up to high line of last February's storm. Swept up to Casino.	---
8-9 Dec. 1926	Heavy swells washed one boat ashore at Monterey. No significant damage.	---
14-16 Feb. 1927	At the time reported to be most violent storm in history of Pacific coast. During high tide, breakers rolled clear to the esplanade. Dashed against Casino. Concrete seawall at Seacliff Beach destroyed.	"heavy southwester"
4 Oct. 1927	Huge breakers reported along Central California coast. No damage reported.	---
30 Dec. 1928	Powerful surges in Monterey harbor causing damage to freighter attempting to moor.	---
3 Jan. 1931	Piling of Municipal Pier loosened. Boarding in front of Casino damaged.	heavy southwest swell
4 Feb. 1931	Damage at Santa Cruz Casino building. High breakers and ground swells, waves reached bottom of wharf, 14 to 20 feet above mean lower low water.	---
20 Feb. 1931	North winds of gale intensity. Several small boats wrecked.	north winds
20-21 Nov. 1931	Strong winds and heavy seas beached numerous small boats at Monterey. No damage to Santa Cruz wharf.	northwest gale
23-29 Dec. 1931	Violent storm. Entire coastal area affected. East Cliff Drive between Santa Maria del Mar and Soquel Point cut by wave action and sections lost. Large quantities of sand eroded from Twin Lakes Beach. At Seacliff concession building and bathing pavilion wrecked. Beach littered with debris brought down by storms. Giant breakers washed over pier at Capitola (20 feet above mean lower low water). Considerable damage to Casino.	winds first from southwest, then northwest
20-21 Dec. 1932	Very rough on bay and waves breaking over breakwater under construction at Monterey.	winds from northwest

Date	Damage - Description	Direction/ Type of Storm
19 Dec. 1935	Very heavy surf. Giant breakers demolished steps opposite Nichols Fishing Trip offices on wharf and damaged Stagnaro landing.	---
10-11 Dec. 1937	Coast Road closed at Waddell. Boats beached at Stillwater Cove.	southwest winds
9-10 Dec. 1939	High waves. Breakers and high tide combined to flood lower East Cliff Drive area. Deep water wave height hindcast at 20 feet. At Seacliff Beach, timber bulkhead destroyed and shoreward end of pier damaged.	southwest wind, waves
8 Jan. 1940	Casino at Capitola almost a complete wreck. Santa Cruz Casino damaged. East Cliff Drive between Santa Cruz and Capitola weakened. Piling broke loose from wharf. Flooding of a motor camp at Seabright. Debris and mud deposited up to entrance at Casa Del Rey Hotel. Boardwalk drenched.	---
26-28 Feb. 1940	Beaches eroded and littered with logs. Hindcasted waves of 25 feet in height.	southwest wind, waves and swell
26-27 Dec. 1940	Highway 1 closed after 800 feet of roadway washed away at Waddell from high seas. Timbers along boardwalk collapsed. Huge sections of East Cliff Drive at Schwann's Lagoon collapsed. Crux of local weather trouble was at Seacliff. Logs up to 10 feet were tossed onto road. 80-foot section of pier washed out. Houses damaged. 80 feet of Seacliff State Park lost.Two sections of Seacliff bulkhead ripped out. At Moss Landing, houses were under a foot of water.	---
8-13 Jan. 1941	At Seacliff Beach, about half of a timber bulkhead and 60 feet of shore end of pier destroyed. Beach eroded to bedrock.	waves and swell from southwest; crests level w/ deck of pier (+20 ft. above mean lower low water)
11-13 Feb. 1941	Large waves in bay. West Cliff Drive caves in. Residents in Seacliff Park cut off by slides.	---
26-28 Feb. 1941	Heavy winds, gigantic waves, breakers smashed Casino steps. West Cliff Drive closed due to cliff erosion from wave action. Hindcast wave height at 22 feet.	south-southwest and southwest wind waves and swell

Date	Damage - Description	Direction/ Type of Storm
13 Nov. 1953	Southerly winds. Pleasure pier at Santa Cruz damaged; waves overtopped seawall at Capitola. Beaches eroded. 14 foot waves.	southerly winds
7 Oct. 1954	Foreshore of beaches from Santa Cruz to Rio del Mar lowered. 3 to 5 foot scarp.	heavy ground swells from southwest
9-10 Feb. 1960	Southerly winds up to 45 mph with gigantic waves. Rio del Mar, Capitola and Seacliff took brunt of waves. At Capitola waves smashed beach restaurants and amusement concessions. Rio del Mar: 25 luxury homes along Beach Road damaged by gigantic waves. Seacliff Beach State Park: camping sites destroyed, restroom nearly destroyed. At times during the storm, the concrete ship disappeared completely. One wave took out end of concession buildings on wharf. Large areas of hardtop parking areas washed away.	southerly and westerly winds
Winter 1969	Storm waves attacked the Pajaro Dunes area. Erosion of the dunes occurred in certain areas and about 12 lots experienced severe erosion with stairs being undercut. Some automobile bodies were brought in for protection and placed at the toe of the scarp cut by the waves.	---
11-15 Feb. 1976	High waves washed completely over new seawall at Seacliff, carrying debris back to cliff. Portions of seawall undercut and caved in.	southerly gale
8-9 Jan. 1978	Seawall at Seacliff overtopped and logs and debris scattered across parking and camping area. Extensive damage to seawall.	storm from southwest
Feb. 1980	$1.1 million in damage at Seacliff. Storm destroyed entire lower beach portion of park, taking roads, parking lots for 324 cars and a 2672 foot seawall.	southwest
28-30 Jan. 1983	$740,000 in damage at Seacliff. 2800 feet of new seawall damaged. 700 feet totally destroyed; 11 RV sites destroyed, restroom heavily damaged, logs and debris washed back to cliff.	waves from southwest

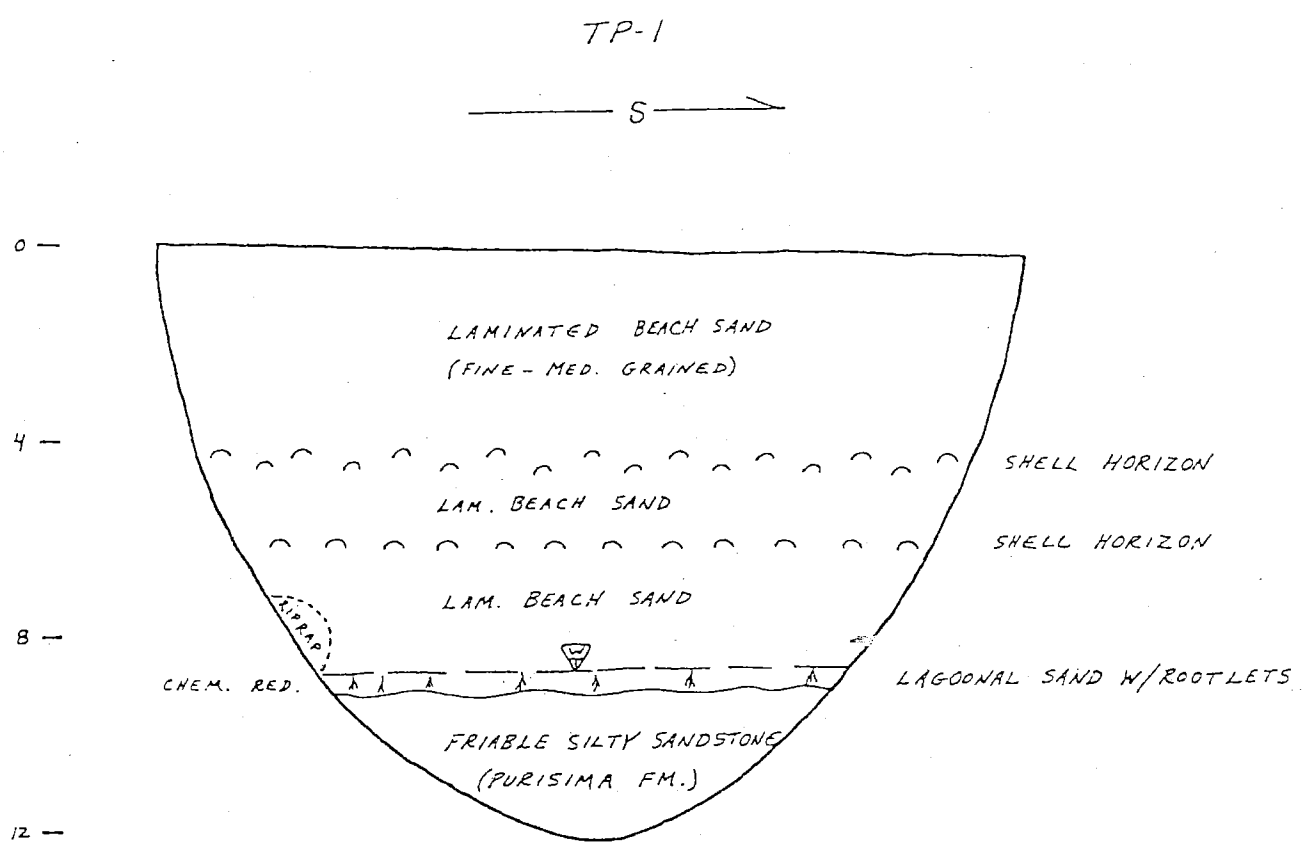
APPENDIX 2

Sketch Logs of Exploratory Test Pits

ATTACHMENT 3

SKETCH LOG OF EXPLORATORY TEST PIT

Scale 1" = 4' H=V



ELEVATION OF TEST PIT ~ 11.5 FEET AT HEADWALL
WATER TABLE PERCHED ON LAGOONAL SAND

East Cliff Drive
See Plate 1 for location

Logged by AOA 7/19/95

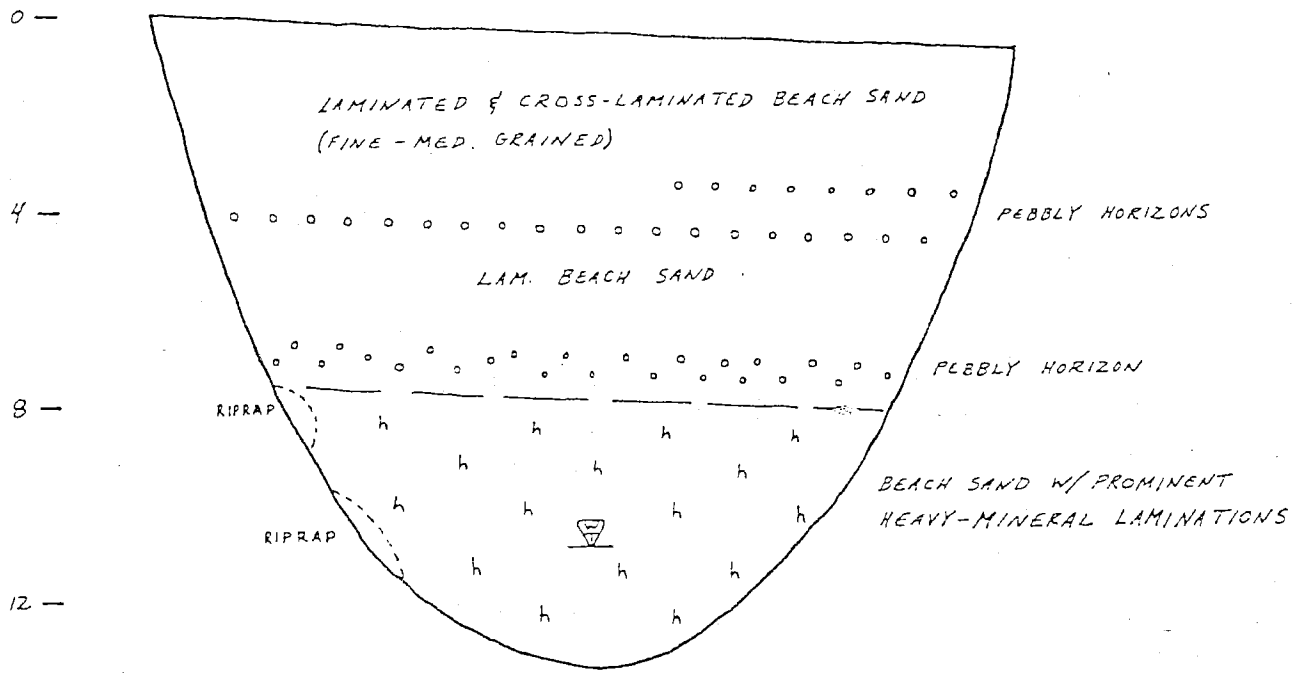
ATTACHMENT 3

SKETCH LOG OF EXPLORATORY TEST PIT

Scale 1" = 4' H=V

TP-2

S



ELEVATION OF TEST PIT ~ 14 FEET AT HEADWALL

East Cliff Drive
See Plate 1 for location

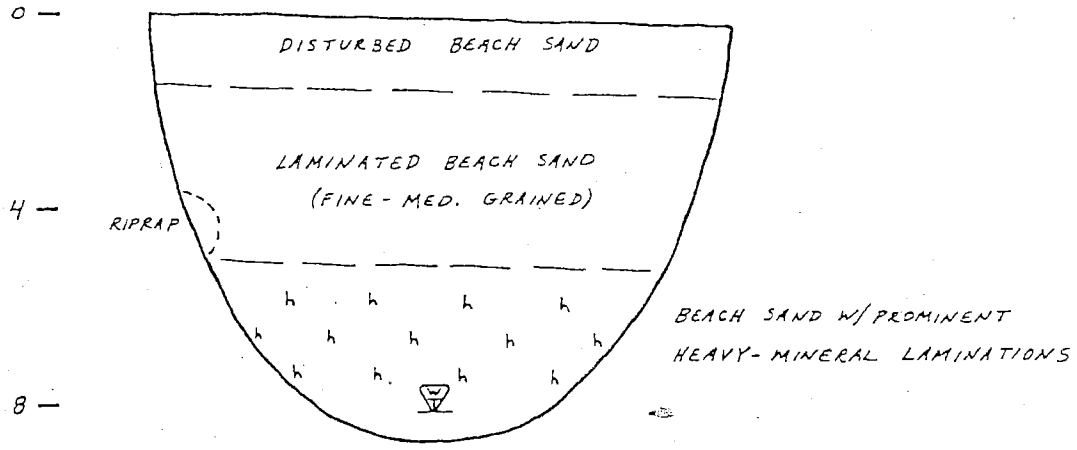
Logged by AOA 7/19/95

SKETCH LOG OF EXPLORATORY TEST PIT

Scale 1" = 4' H=V

TP-3

SE



ELEVATION OF TEST PIT ~ 10.5 FEET AT HEADWALL

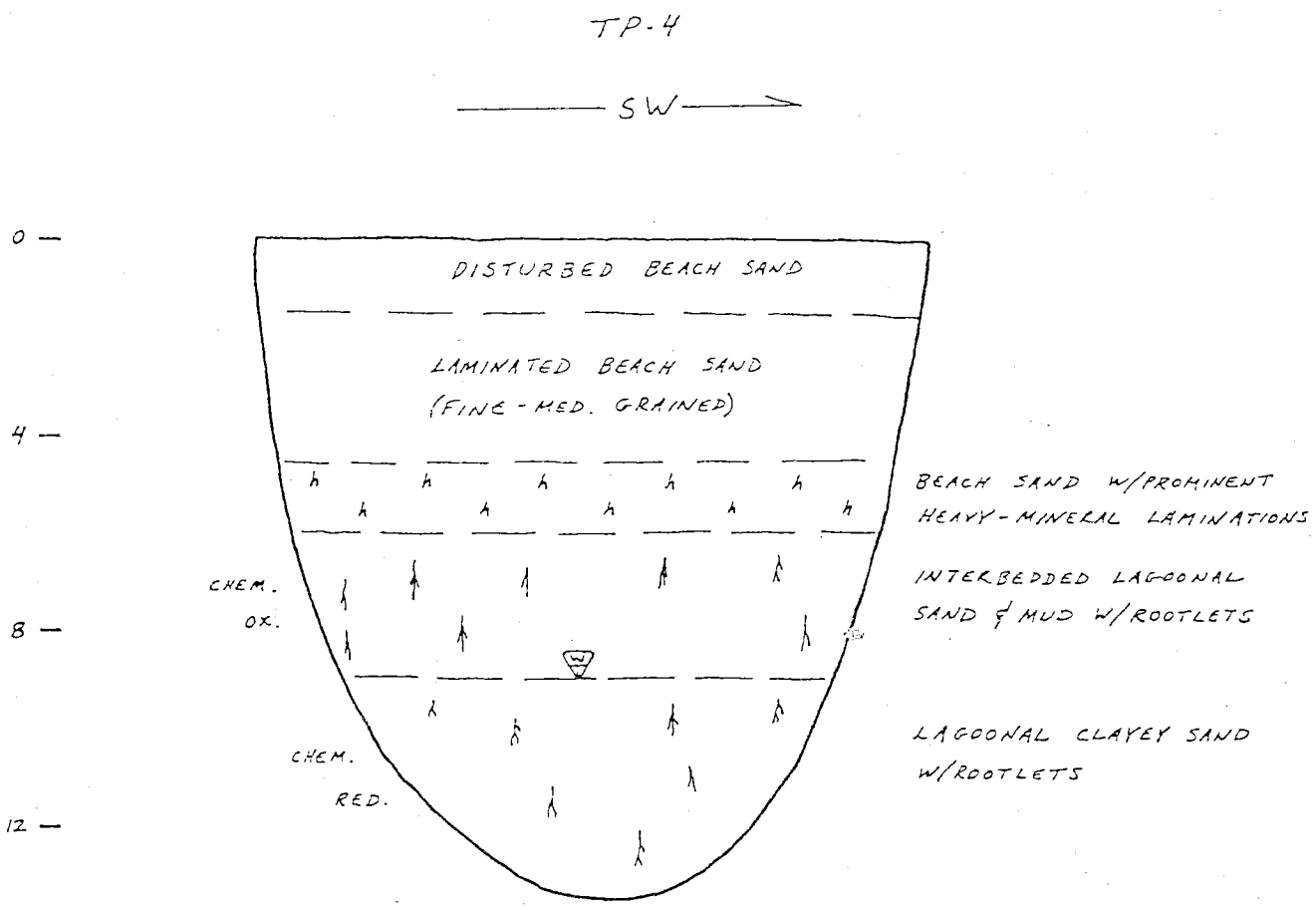
East Cliff Drive
See Plate 1 for location

Logged by AOA 7/19/95

ATTACHMENT 2

SKETCH LOG OF EXPLORATORY TEST PIT

Scale 1" = 4' H=V



ELEVATION OF TEST PIT ~ 11 FEET AT HEADWALL
WATER TABLE PERCHED ON LAGOONAL CLAYEY SAND

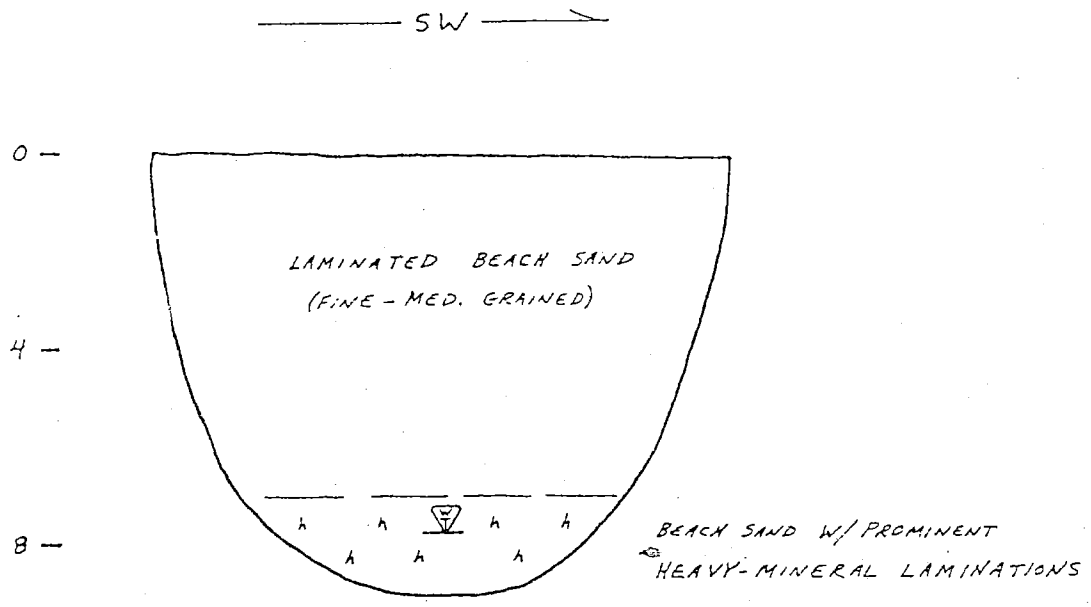
East Cliff Drive
See Plate 1 for location

Logged by AOA 7/19/95

SKETCH LOG OF EXPLORATORY TEST PIT

Scale 1" = 4' H=V

TP-5



ELEVATION OF TEST PIT ~ 10 FEET AT HEADWALL

East Cliff Drive
See Plate 1 for location

Logged by AOA 7/19/95

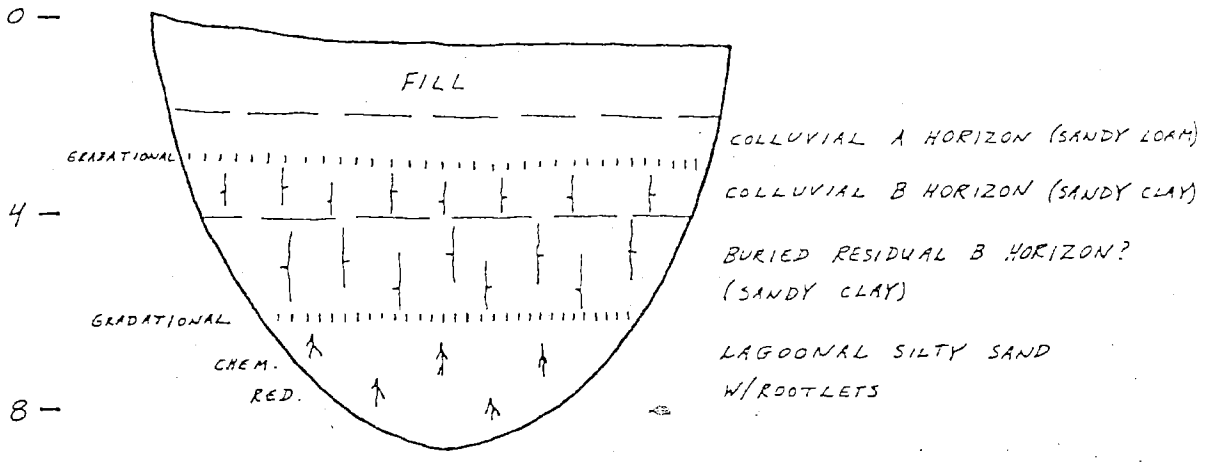
ATTACHMENT 9

SKETCH LOG OF EXPLORATORY TEST PIT

Scale 1" = 4' H=V

TP-6

SW



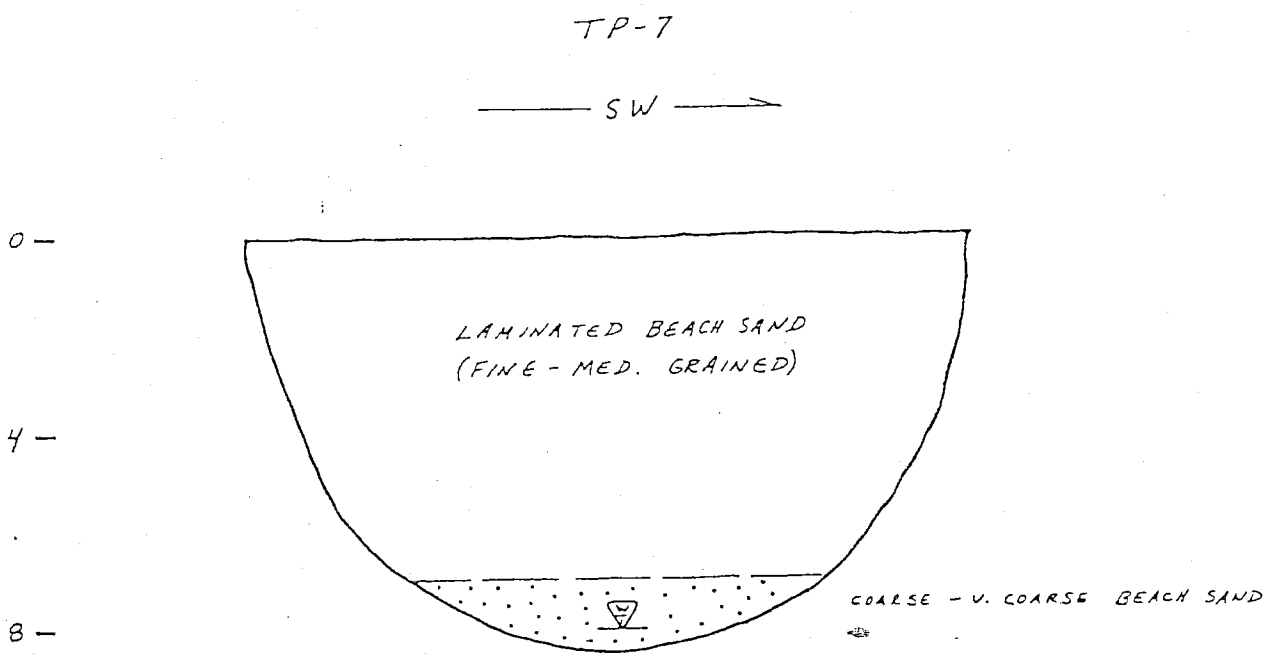
ELEVATION OF TEST PIT ~ 13.5 FEET AT HEADWALL

East Cliff Drive
See Plate 1 for location

Logged by AOA 7/19/95

SKETCH LOG OF EXPLORATORY TEST PIT

Scale 1" = 4' H=V



ELEVATION OF TEST PIT ~ 8 FEET AT HEADWALL

East Cliff Drive
See Plate 1 for location

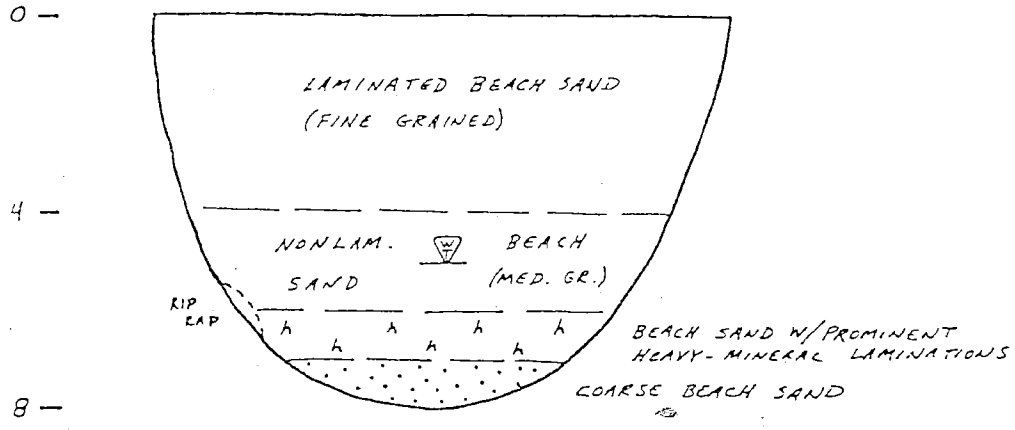
Logged by AOA 7/19/95

SKETCH LOG OF EXPLORATORY TEST PIT

Scale 1" = 4' H=V

TP-8

SW



ELEVATION OF TEST PIT ~7 FEET

East Cliff Drive
See Plate 1 for location

Logged by AOA 7/19/95

UPDATE
GEOTECHNICAL and COASTAL ENGINEERING INVESTIGATION
For the
Twin Lakes Beachfront Project
Santa Cruz Harbor to Schwan Lake
Santa Cruz County, California

Prepared for the
Santa Cruz County Redevelopment Agency
Santa Cruz, California

Prepared By
HARO, KASUNICH AND ASSOCIATES, INC
Geotechnical & Coastal Engineers
Project No. SC9809
June 2009
Revised August 2009

ATTACHMENT 4

Project No. SC9809
5 June 2009
Revised 27 August 2009

SANTA CRUZ COUNTY REDEVELOPMENT AGENCY
701 Ocean Street, Room 510
Santa Cruz, California 95060-4000

Attention: Mr. Jim Davies, Project Manager

Subject: Update Geotechnical and Coastal Engineering Investigation

Reference: Twin Lakes Beachfront Project
Santa Cruz Harbor to Schwan Lake
Santa Cruz County, California

Dear Mr. Davies:

In accordance with your authorization, we have performed an Update Geotechnical and Coastal Engineering Investigation for the proposed Twin Lakes Beachfront Project along East Cliff Drive, from 5th Avenue adjacent the Santa Cruz Harbor to Schwan Lake in Santa Cruz County, California. This report provides an update and supplemental analyses to our 6 December 1995 Geotechnical and Coastal Engineering Investigation - East Cliff Drive Improvements – Santa Cruz Harbor to Schwan Lake prepared for the Santa Cruz County Department of Public Works.

The Santa Cruz County Redevelopment Agency is proposing to enhance public access to the project site area by widening East Cliff Drive from about 5th Avenue to about the existing outfall at Schwan Lake near 9th Avenue. A pedestrian path, a bicycle path and parking areas are proposed along the seaward perimeter of East Cliff Drive.

Our update investigation was performed in conjunction with the engineering geology firm of Rogers E. Johnson & Associates. The Update Geology Investigation is dated 4 June 2009. Working with the project engineering geologists we explored the soil and bedrock profile beneath Twin Lakes State Beach to enhance the 1995 geologic map and cross sections in order to develop accurate winter scour beach platform profiles along the toe of the proposed project alignment.

Using the May 2009 Rogers E. Johnson & Associates Road and Beach Profiles, our firm performed wave runup analyses to evaluate the potential effect of the

116 EAST LAKE AVENUE • WATSONVILLE, CALIFORNIA 95076 • (831) 722-4175 • FAX (831) 722-3202

project upon the existing landward improvements and to develop wave pressures for preliminary structural engineering design of new shoreline protection structures to stabilize the low elevation coastal bluff along the project alignment and protect the proposed improvements from wave action erosion.

Our coastal engineering analyses were conducted using four design storm Stillwater Levels representing: current sea level; and future sea level rise rates of 5mm/yr (1.7 feet), 10 mm/yr (3.3 feet) and 15 mm/yr (5.0 feet) for the next 100 years. The rate of sea level rise is widely thought to be exponential rather than linear and this is illustrated in the graphs of sea level rise presented by the 2007 Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC). Due to the exponential acceleration of sea level rise that is occurring, sea level rise during the next 50 years is likely to be less than half of the total sea level rise during the next 100 years

Armoring the proposed project alignment with an erosion resistant shoreline protection system will preserve the existing configuration of East Cliff Drive, protect proposed improvements and substantially reduce coastal flooding of the existing residences along the landward perimeter of the project alignment.

The effects of anticipated sea level rise upon the relatively low elevation project alignment will be dramatic. As sea level rises, the water column depth adjacent the project site increases allowing larger waves to break closer to the seaward perimeter of the project alignment. Larger breaking waves will increase wave action erosion, wave forces on shoreline protection structures and wave runup overtopping of shoreline barriers. For presentation of our wave force analyses or wave pressure calculations, we used the sea level rise rate of 10 mm/yr for the next 100 years. From an economic perspective, it may not be feasible to construct shoreline protection structures to accommodate the upper ranges of the estimated sea level rise over the next 100 years. An alternative approach may be to design the project for less than 100 years and maintain the project alignment seawalls and revetments as needed.

The wave runup analysis included with this update report was based upon the existing measured winter scour platform elevations. As sea level rises, the winter scour platform, whether lagoon deposits or sandstone bedrock, will become exposed more often and erode/abrade. As the elevation of the winter scour platform is lowered the water column adjacent the proposed improvements becomes deeper and the effects of wave runup will increase. As the winter scour platform deepens, seawall conventional spread footings embedded into bedrock will become exposed as will the keyways of any project site revetments. Once a project design life has been established based on projected sea level rise, the

down wearing of the winter scour platform should be estimated by the project engineering geologists and utilized by the project structural engineers to design foundation elements. The final project design should also include the increase in wave impact pressures to the project shoreline protection structures associated with the increased water column depth and wave runup due to the down wearing of the winter scour platform.

The results of our update coastal and geotechnical engineering investigation are included in the body and Appendix of this report.

If you have any questions concerning the data or conclusions presented in this report, please call our office.

Respectfully submitted,

HARO, KASUNICH AND ASSOCIATES, INC

Rick L. Parks, GE
Senior Geotechnical and Coastal Engineer

RLP/dk
Copies: 6 to Addressee w/digital copy on CD
1 to Rogers E. Johnson & Associates
Attn: Greg Easton, CEG

Project No. SC9809
5 June 2009
Revised 27 August 2009

TABLE OF CONTENTS

TRANSMITTAL LETTER

COASTAL AND GEOTECHNICAL INVESTIGATION
Executive Summary 1
Project Setting 2
Methodology 3
Rate of Sea Level Rise Update 4
Shoreline Protection Structures 6
End of 5th Avenue Turnaround to near 6th Avenue 6
6th to 8th Avenue 7
8th Avenue to 9th Avenue 9
9th Avenue to 11th Avenue 10
Purpose and Scope 13
Site Description 16
Project Description 16
Field Exploration 17
Subsurface Conditions 19
Groundwater 20
Project Site Seismicity 21
Liquefaction Hazards and Analysis 22
General 22
Summary of Liquefaction Analysis 23
2007 California Building Code Site Class 25
FEMA - Flood Insurance Rate Maps 26
Wave Runup Analysis 27
Design Storm Stillwater Level 30
Astronomical Tide 31
Atmospheric Storm Surge 32
Wave Setup 33
Future Sea Level Rise 34
Current Conditions Design Storm Stillwater Level (SWL) Summary 36
100 Year Design Storm SWL Summary with 5mm/yr Sea Level Rise 37
100 Year Design Storm SWL Summary with 10mm/yr Sea Level Rise 37
100 Year Design Storm SWL Summary with 15mm/yr Sea Level Rise 37
Nearshore and Shoreline Barrier Configuration 38
Beach Roughness 38
Design Wave Period 38
Results of Wave Runup Analysis 39
Revetment Quarrystone Sizing Analyses 41
Supplemental Design Criteria 43
Plan Review, Construction Observation and Testing 45
Investigation Limitations 45

ATTACHMENT 4

TABLE OF CONTENTS CONTINUED

APPENDIX A
Site Vicinity Map
Exploratory Test Pit Locations Color Plate
CPT Probe Locations Color Plate
CPT Testing Description
CPT Soil Profile Logs

APPENDIX B
Wave Runup Analysis Results
Key to Wave Runup Tables
Wave Runup Results Tables and Output Data Sheets:
RJA Section A-A'
RJA Section B-B"
RJA Section E-E'
RJA Section F-F'
RJA Section H-H'
Goda Formula Schematic - Vertical Walls

APPENDIX C
RJA Section A-A' - Short Wall Landward of Stillwater Level
RJA Section B-B' Vertical Wall - Toe at -1 ft NGVD29
RJA Section E-E' Vertical Wall - Toe at -1 ft NGVD29
Goda Formula Schematic - Vertical Walls

APPENDIX D
FEMA Firmettes
Map #06087C0334D
Map #06087C0353D

APPENDIX E
Twin Lakes Beachfront Project:
CGS - Ground Motion Page
CPT -1 Liquefaction Analysis - 2009
CPT -2 Liquefaction Analysis - 2009
O'Neill Yacht Building - 2222 East Cliff Drive:
Boring Site Plan
Boring Log B-3
B-3 Liquefaction Analysis - 2003

TABLE OF CONTENTS CONTINUED

APPENDIX F
Quarrystone Sizing Analyses
1.5:1 (H:V) Revetment Slope- Rock Sizes
2:1 (H:V) Revetment Slope- Rock Sizes
1.5:1 (H:V) Revetment Slope- Generalized Wave Runup
2:1 (H:V) Revetment Slope- Generalized Wave Runup

Project No. SC9809
5 June 2009
Revised 27 August 2009

COASTAL/GEOTECHNICAL INVESTIGATION

Executive Summary

This report presents the results of our Update Coastal and Geotechnical Investigation for the proposed Twin Lakes Beachfront Project situated along the seaward perimeter of East Cliff Drive between 5th Avenue, adjacent the Santa Cruz Harbor and Schwan Lake in Santa Cruz County, California; see the Site Vicinity Map included in the Appendix of this report.

The Santa Cruz County Redevelopment Agency is proposing to enhance public access to the Santa Cruz Harbor, Twin Lakes State Beach and the Monterey Bay Sanctuary by widening East Cliff Drive from about 5th Avenue to about the existing Schwan Lake outfall near 9th Avenue. A pedestrian path, a bicycle path and parking areas are proposed along the seaward perimeter of East Cliff Drive.

This report provides an update and supplemental analyses to our 6 December 1995 Geotechnical and Coastal Engineering Investigation - East Cliff Drive Improvements – Santa Cruz Harbor to Schwan Lake prepared for the Santa Cruz County Department of Public Works.

Our update investigation was performed in conjunction with the engineering geology firm of Rogers E. Johnson & Associates. The Update Geology

ATTACHMENT 4

Investigation is dated 4 June 2009 with their original report for the project site dated 16 October 1995.

Working with the project engineering geologists we explored the soil and bedrock profile beneath Twin Lakes State Beach to enhance the 1995 geologic map and cross sections in order to develop accurate winter scour beach platform profiles along the toe of the proposed project alignment.

Project Setting

The proposed Twin Lakes Beachfront project alignment is situated between two deep infilled drainage ravines, one below the Santa Cruz Harbor and the other underlying Schwan Lake; with sandstone bedrock at relatively shallow elevations between 6th Avenue to about 8th Avenue. During long duration winter storms, such as the El Niño winters of 1982-83 and 1997-98, the accreted beach sand is stripped from the bulk of Twin Lakes State Beach down to the winter scour platform. At the project site the winter scour platform consists of either: sandstone bedrock at about Mean Sea Level (0 feet NGVD29) or higher along the central portion of the project alignment; or lagoon/slough deposits at the two, deep infilled ravines at the upcoast and downcoast ends of the project alignment. During our 1995, solid stem auger, drill rig exploration of the project site, we drilled to about 80 feet below beach grade at the mouth of the Schwan Lake with no bedrock encountered. In 2003, at the O'Neill Yacht Building adjacent the upcoast boundary of the project alignment, we drilled to about 125 feet below

sidewalk grade between the O'Neill Yacht Building and the Crow's Nest Restaurant using a mud rotary drill with no bedrock encountered. At about the midpoint of the seaward perimeter of the O'Neill Yacht Building, we encountered bedrock at about 60 feet below sidewalk grade indicating the steep rise of the incised bedrock ravine or canyon wall, adjacent the upcoast end of the project alignment.

Methodology

To update the 1995 geology and geotechnical/coastal engineering reports, our initial task was to explore the subsurface soil and bedrock profile beneath Twin Lakes State Beach to enhance the 1995 geologic map and cross sections in order to develop accurate winter scour beach platform profiles along the toe of the proposed project alignment. We utilized a rubber track mounted Cone Penetrometer Testing (CPT) rig and a steel track mounted excavator to determine the depth below beach grade to the winter scour platform along seven beach profiles or cross sections. The exploration site elevations were then tied to the National Geodetic Vertical Datum of 1929 (NGVD29). The Site Geologic Map plates dated 14 and 22 May 2009; the Beach and Road Profiles plates dated 15 May 2009 and the Logs of Test Pits plate dated 14 May 2009 are included in the Updated Geologic Investigation dated 4 June 2009. The Site Geologic Map shows: the 2009 field exploration CPT and test pit locations as well as the 1995 solid stem auger drill rig borings and test pit locations; areas of shallow bedrock exposed during the 1997-98 El Niño winter beach scour

conditions; the seaward perimeter of the proposed project improvements; and other geologic and topographic features. The Beach and Road Profiles show the proposed seaward alignment and elevation of project improvements as well as the elevation of the winter scour platform at the cross section locations.

Our firm then utilized the mapped winter scour platform profile at five of the seven cross section locations to model the wave runup conditions along the project site alignment. A second component of wave runup modeling and analysis is the Stillwater Level (SWL) or the elevation of the surface of the ocean if all wave action was absent.

Rate of Sea Level Rise Update

The most significant difference between our 1995 wave runup models and our 2009 wave runup models is the very significant increase of the current estimates of the rate of sea level rise in the next 100 years. Our wave runup analysis performed in 1995 includes one (1) foot of sea level rise in 100 years. For our 2009 wave runup analysis modeling, we utilized a range of sea level rise rates for the next 100 years: 5 mm/yr; 10 mm/yr; and 15 mm/yr. At other recent Monterey Bay Projects we have been instructed by the California Coastal Commission to evaluate project sites using 100 year sea level rise rates of 10 mm/yr and 15 mm/yr which equates to an increase in Mean Sea Level of 3.3 feet and 5.0 feet. For a 100 year design of the project shoreline protection structures, we recommend the sea level rise rate of 10mm/yr or 3.3 feet of sea level rise be

used for a design Stillwater Level of 10.6 feet NGVD29. A 100 year sea level rise rate of 10mm/yr represents the middle of the range of sea level rises rates endorsed by the March 2009 International Scientific Congress on Climate Change.

Sea level rise and the associated rise in the Stillwater Level elevation will have a tremendous impact upon wave runup, coastal flooding and shoreline erosion at the project site. As the Stillwater Level rises, the water column above the winter scour platform deepens allowing larger waves to encroach closer to East Cliff Drive with greater runup and wave impact force potential.

As sea level rises and the surf zone moves landward, the entire project alignment will be susceptible to wave action and erosion. Unless the seaward perimeter of the project alignment is hardened or armored to mitigate wave action, East Cliff Drive will be undermined. Our project design rate of sea level rise of 10 mm/yr in the next 100 years or about 3.3 feet above present day Mean Sea Level is considered very significant. If the project alignment is hardened so that the project alignment configuration is protected from erosion and abrasion, incoming waves will be forced to break seaward of the alignment during winter scour conditions. If the project is not constructed, the existing seaward perimeter of East Cliff Drive will be eroded by wave action and recede landward allowing waves to break closer and closer to the underlying existing utilities. If the roadway permitted to erode, both public access and utilities will be lost.

The Rogers E. Johnson and Associates Site Geologic Map plates dated 14 May and 22 May 2009 and the 15 May 2009 Road and Beach Profiles show the proposed seaward extent of the project improvements, the elevation of the adjacent edge of pavement and the depth to the winter scour platform.

Shoreline Protection Structures

End of 5th Avenue /Turnaround to near 6th Avenue

At the upcoast end of the project alignment adjacent the East Cliff Drive entrance to the Santa Cruz Harbor, the traffic circle or roundabout is situated upon fill soils, beach sand, and lagoon deposits based upon our 1995 exploratory Boring B-10 which terminated at about elevation -10 feet NGVD29 with no bedrock encountered. These near surface soils are susceptible to wave erosion and settlement due to seismic shaking. Two alternatives are available to support improvements along the seaward perimeter of the roundabout to near the upcoast perimeter of 6th Avenue. One alternative is to support the roadway and shoulder widening upon 3 feet of onsite sands compacted to at least 95 percent relative compaction. The new roadway and shoulder would be susceptible to wave erosion and probably settle in about the same manner as the rest of the roundabout area during severe seismic shaking. The roadway area would need to be repaired or replaced after severe wave erosion which might occur every 5 to 15 years, most often corresponding to El Niño winters.

A second alternative would be to protect the widened roundabout area from coastal erosion utilizing a quarrystone revetment. Harbor channel dredged sand could be used to cover the quarrystone revetment for most of the calendar year.

6th to 8th Avenue

As delineated on the Rogers E. Johnson and Associates Site Geologic Map plates dated 14 May and 22 May 2009 and the 15 May 2009 Road and Beach Profiles, relatively shallow sandstone bedrock is present along the seaward perimeter of the project alignment from near the upcoast perimeter of 6th Avenue to about the centerline of 8th Avenue. As shown on the geologic profiles, the vertical distance between bedrock beach platform and the elevation of the proposed improvements is on the order of 20 feet for this section of the project alignment. Due to the elevation difference between the measured winter scour platform and the seaward limit of the proposed improvements and in order to limit encroachment of the shoreline protection structures onto the State beach, we anticipate vertical walls will be needed to support the seaward perimeter of the project improvements from near the upcoast perimeter of 6th Avenue to about the centerline of 8th Avenue. To prevent the project site improvements from being undermined by wave action, the toe of the structures supporting the seaward perimeter of the proposed improvements should be embedded into the winter scour bedrock beach platform. With the top of the bedrock beach platform at or above about -1 feet NGVD29 (Tide Book elevation equal to about +2 feet MLLW) at the seaward perimeter of this section of the proposed alignment, we

recommend conventional spread footings embedded into sandstone bedrock supporting vertical or near vertical seawalls be utilized. In some areas of this section of the project alignment the vertical walls will need to be backfilled in order to support the proposed improvements. The wall system must be designed to resist wave impact pressures as well as act as retaining walls. With significant sea level rise, wave impact pressures will dictate seawall foundation design. Wave pressure may be more than compacted backfills can resist. A possible vertical wall design using conventional spread footings embedded into bedrock would be a vertical concrete wall with counterforts along the landward perimeter. Counterforts consist of footings excavated into the bedrock, perpendicular to the wall alignment with formed concrete braces extending from the footings to the landward side of the structural concrete wall. The seaward face of the wall would need to be covered with a simulated facing to match the existing bluff materials or the sand beach. An alternative to the near vertical seawall design where shallow bedrock is present would be a large footprint, steeply sloping grouted quarrystone wall. For reference, we were recently involved in the design and construction of a 20 feet high, grouted quarrystone seawall with a foundation width of 16 feet, a 3 feet deep keyway into bedrock and a slope face of 1:12 (H:V). Utilizing pumped sand from the Santa Cruz Port District dredging operations, the elevation of the backshore or back beach could be raised to hide the vertical walls along the project alignment for most of the calendar year.

From about the downcoast perimeter of the 7th Avenue Pump House to the about the centerline of 8th Avenue, an alternative to vertical walls would be a moderately sloped, large footprint, engineered fill slope with an erosion resistant facing. A suitable erosion resistant facing with respect to anticipated sea level rise would be a 2 layer quarrystone revetment atop woven geotextile fabric with the toe of the revetment embedded into the winter scour bedrock beach platform. The steepest gradient the revetment slope should be built to is 1.5:1 (H:V). A 20 feet high slope would encroach 30 feet onto the public beach beyond the seaward perimeter of the proposed improvements. Utilizing pumped sand from the Santa Cruz Port District dredging operations, the elevation of the backshore or back beach could be raised to hide the quarrystones along the project alignment for most of the calendar year.

8th Avenue to 9th Avenue

As shown on the Geologic Profiles E-E' and F-F', the winter scour bedrock beach platform along the seaward perimeter of the proposed project alignment falls in elevation from about 0 feet NGVD29 at 8th Avenue to about -5 feet NGVD29 at 9th Avenue. Either a vertical seawall supported by deep piers embedded into bedrock beach platform or a quarrystone revetment with a deep keyway embedded into bedrock beach platform could be used to support the seaward perimeter of this section of the project alignment. Based on our experience, excavation and construction of revetment keyways on sand beaches below about -5 to -6 feet NGVD29 is problematic due the working below the lowest low tide

level and the continuous slumping of the excavation sidewalls below the waterline.

9th Avenue to 11th Avenue

From about the centerline of 9th Avenue to near the remnant of 11th Avenue on the downcoast side of Schwan Lake, an engineered quarrystone revetment is the best solution to protect the proposed improvements overlying lagoon deposits atop deep bedrock. As shown on the Geologic Profiles G-G' and H-H' and delineated on the soil probe log for the 2009 CPT-1 as well as the 1995 exploratory boring B-7, the mouth of Schwan Lake and the adjacent East Cliff Drive overlie a deep ravine incised into the sandstone bedrock. The deep ravine was cut when sea level was several hundred feet lower than current sea level. The ravine infilled with slough or lagoon deposits as sea level rose. The lagoon deposits consist of soft, peaty silts and clays interbedded with loose sands and silts. The top or surface of the lagoon deposits represents the winter scour platform with the thickness of overlying beach sand dependant upon the season and recent storm activity. At Geologic Profile H-H', the top of the lagoon deposits/winter scour platform was found to at about -5 feet NGVD29 during our 2009 field exploration. The lagoon deposits are subject to wave action erosion during long duration winter storms albeit at a slower rate than the accreted beach sand. The lagoon deposits are subject to long term settlement or consolidation due to surcharge loading as well as liquefaction due to severe seismic shaking. The lagoon deposits are too deep to economically penetrate with pier or piles in

order to support rigid structures such as vertical concrete seawalls or grouted quarrystone seawalls. A quarrystone revetment has the ability to settle and still maintain a portion of its ability to function as a shoreline protection structure. Slumped revetments can be restacked with additional quarrystones added as needed to maintain the revetment design height and slope.

The rate of sea level rise is widely thought to be exponential rather than linear and this is illustrated in the graphs of sea level rise presented by the 2007 Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC). Due to the exponential acceleration of sea level rise that is occurring, sea level rise during the next 50 years is likely to be less than half of the total sea level rise during the next 100 years

Armoring the proposed project alignment with an erosion resistant shoreline protection system will preserve the existing configuration of East Cliff Drive, protect the existing public utilities underling East Cliff Drive and protect the proposed project alignment improvements.

The effects of anticipated sea level rise upon the relatively low elevation project alignment will be dramatic. As sea level rises, the water column depth adjacent the project site increases allowing larger waves to break closer to the seaward perimeter of the project alignment. Larger breaking waves will increase wave action erosion, wave forces on shoreline protection structures and wave runup

overtopping of shoreline barriers. For presentation of our wave force analyses or wave pressure calculations, we used the sea level rise rate of 10 mm/yr for the next 100 years. From an economic perspective, it may not be feasible to construct shoreline protection structures to accommodate the upper ranges of the estimated sea level rise over the next 100 years. An alternative approach may be to design the project for less than 100 years and maintain the project alignment seawalls and revetments as needed.

The wave runup analysis included with this update report was based upon the existing measured winter scour platform elevations. As sea level rises, the winter scour platform, whether lagoon deposits or sandstone bedrock, will become exposed more often and erode/abrade. As the elevation of the winter scour platform is lowered the water column adjacent the proposed improvements becomes deeper and the effects of wave runup will increase. As the winter scour platform deepens, seawall conventional spread footings embedded into bedrock will become exposed as will the keyways of any project site revetments. Once a project design life has been established based on projected sea level rise, the down wearing of the winter scour platform should be estimated by the project engineering geologists and utilized by the project structural engineers to design foundation elements. The final project design should also include the increase in wave impact pressure to vertical walls associated with increased runup and appropriate quarrystone sizing for the design breaking wave heights.

Purpose and Scope

The purpose of our update investigation was to address the geotechnical and coastal engineering aspects of the 18 September 2008 Memorandum by the Santa Cruz County Planning Department for the project. The specific scope of our services was as follows:

1. Review of available coastal, geotechnical and geologic studies of the project site as well as current coastal engineering design manuals pertinent to the analysis and design. These include:

   Geotechnical and Coastal Engineering Investigation - East Cliff Drive Improvements – Santa Cruz Harbor to Schwan Lake by our firm dated 6 December 1995;

   Geologic Report – Proposed Improvements to East Cliff Drive – Santa Cruz Harbor to Schwan Lake by Rogers E. Johnson & Associates dated 16 October 1995;

   Wave Runup/Wave Force Analysis – Proposed West Jetty Lighthouse by our firm dated 10 April 2001:

   Geotechnical Investigation for O'Neill Yacht Building – 2222 East Cliff Drive by our firm dated 3 October 2003;

   Shore Protection Manual, (SPM) US Army Corps of Engineers, 1984;

   Coastal Construction Manual (CCM), FEMA 55, Edition 3, August 2005;

   Coastal Engineering Manual, (CEM) EM 1110-2-1100, US Army Corps of Engineers, August 2008;

   Coastal Engineering Manual (CEM-PE) Professional Edition 2.01, Veri-Tech, Inc, 2004;

   Comparison of California Tides, Storm Surges, and Mean Sea Level During the El Niño Winters of 1982-83 and 1997-98 by Richard E. Flick, Shore and Beach July 1998;

   Wave Forces on Inclined and Vertical Wall Structures, ASCE, 1995;

Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States, Subsection D.4.5 – Wave Setup, Runup and Overtopping, FEMA January 2005;

Wave Setup – FEMA Coastal Flood Hazard Analysis and Mapping Guidelines Focused Study Report, FEMA February 2005;

FEMA Flood Rate Insurance Maps (FIRM) #06087C0334D and #06087C0353D dated 2 March 2006;

Guidelines and Specifications for Flood Hazard Mapping Partners (GSFHMP), Subsection D.2.8 – Wave Runup and Overtopping, FEMA February 2007; and

Nautical Chart – Monterey Bay NOAA, May 1998.

2. Meetings with Santa Cruz County Redevelopment Agency staff prior to initiating field exploration.
3. Obtain an encroachment permit from California State Parks for field exploration upon Twin Lakes State Beach.
4. Utility locates at potential exploration sites with Underground Service Alerts (USA) and the Santa Cruz Port District.
5. Supplemental field exploration of the Twin Lakes Beach subsurface conditions to delineate the winter scour platform at the site for wave runup calculations as well to determine engineering parameters needed for liquefaction analyses at the project. A track mounted Cone Penetrometer Testing (CPT) unit was utilized to conduct six (6) probes to depths ranging from 11 to 61 feet below grade. A track mounted excavator was used to dig seven (7) exploratory pits.

6. Level surveys by our firm to determine NGVD29 datum elevations at the field exploration locations.
7. Meetings with project engineering geologists.
8. Wave runup analyses and project base flood elevations utilizing current estimates of sea level rise for the next 100 years and the winter scour beach platform profiles developed by the project engineering geologists for (5) sections along the project alignment
9. Wave force analyses for vertical structures at three (3) sections along the project alignment.
10. Liquefaction analyses of two (2) CPT profiles with sand and lagoon deposits overlying deep bedrock.
11. Quarrystone sizing for repair of the existing revetment at downcoast end of project alignment and/or construction of a new revetment the upcoast end of the project alignment adjacent the 5th Avenue/East Cliff Drive intersection roundabout.
12. Seismic surcharge loading of seawalls/retaining walls and determination of 2007 CBC Site Classes for the project alignment.
13. Submittal of a report presenting the results and conclusions of our update geotechnical and coastal engineering investigation fieldwork and analyses as well as our recommendations for the design and construction of the proposed project shoreline protection system.

Site Description

The Twin Lakes Beachfront project alignment is situated along the seaward perimeter of East Cliff Drive between 5th Avenue, adjacent the Santa Cruz Harbor and Schwan Lake in Santa Cruz County, California; see the Site Vicinity Map included in the Appendix of this report. The project area investigated during our update investigation consists of primarily the backshore or back beach area of Twin Lakes State Beach. For a detailed description of the site geology and physical characteristics of the project site, see the Rogers E. Johnson & Associates Update Geology Investigation dated 4 June 2009

Project Description

The Santa Cruz County Redevelopment Agency is proposing to enhance public access to the Santa Cruz Harbor, Twin Lakes State Beach and the Monterey Bay Sanctuary by widening East Cliff Drive from about 5th Avenue to about the existing Schwan Lake outfall near 9th Avenue. A pedestrian path, a bicycle path and parking areas are proposed along the seaward perimeter of East Cliff Drive. It is also our understanding a future component of the project may be the widening of the existing seaward roadway shoulder of East Cliff Drive as it crosses the mouth of Schwan Lake to accommodate a pedestrian path. The seaward configuration of the proposed project is delineated on the Rogers E. Johnson & Associates Geologic Map plates dated 14 and 22 may 2009.

Field Exploration

Subsurface conditions were investigated on 2 March 2009 using a rubber track mounted, Cone Penetrometer Testing (CPT) rig and on 12 March 2009 using a steel track mounted excavator.

The CPT probe configuration incorporated a piezocone for the measurement of dynamic (CPTu) pore pressure. Cone penetrometer testing allows continuous testing of the soil profile by pushing the penetrometer cone end into the underlying soil and measuring both the resistance to penetration of the tip and the frictional sliding resistance of the side or sleeve of the cone. Soil behavior type and stratigraphic interpretation are based on the relationship between cone end tip resistance, side wall friction and dynamic pore pressure. Cone end resistance is correlated to Standard Penetration Testing N_{60} blowcounts utilizing algorithms based on cross-calibration of CPTu/SPT data in a wide variety of soil types, penetration resistances and depths. A description of cone penetrometer testing methods is included in the Appendix of this report. The CPT Soil Profile Logs in the Appendix of this report outline the soil profile and the correlated Standard Penetration Testing - N_{60} blowcounts at each of the six test probe locations.

A total of 6 cone penetrometer test (CPT) probes were completed at the project site to depths ranging from 11 to 61 feet below existing grades. The approximate locations of the CPT probes are indicated on the CPT Probe Locations Color

Plate in the Appendix of this report. Differential elevations were measured on the day of the field exploration between the existing beach grade at the CPT probe locations and temporary benchmarks set by our firm. We later returned to the site to tie our temporary benchmarks to Public Works Department elevations along the alignment to convert out field data elevations to the NGVD29 datum. Beach sand grade elevations at the time of our CPT exploration were as follows:

2 March 2009
CPT Exploration Beach Grade Elevations

CPT Location	Beach Grade Elevation * feet NGVD29
CPT-1	5.8 ft
CPT-2	5.9 ft
CPT-3	9.6 ft
CPT-4	11.7 ft
CPT-5	5.4 ft
CPT-6	10.1 ft

* - Zero (0) feet on the CPT logs

A steel track mounted excavator was utilized at seven locations along the back beach of the project alignment to dig exploratory test pits to determine the subsurface soil profile at the base of the short coastal bluff adjacent East Cliff Drive or the quarrystone revetment configuration at the base of the quarrystone revetment on the seaward side of East Cliff Drive crossing the mouth of Schwan Lake. The project engineering geologists logged the exploratory pits with differential elevations measured on the day of the field exploration between the geologic features of the seven test pits and temporary benchmarks set by our firm. We later returned to the site to tie our temporary benchmarks to Public Works Department elevations along the alignment to convert the test pit field data elevations to the NGVD29 datum. The project engineering geologists then

utilized the data from the CPT probes and excavator test pits to construct the updated beach profile sections with the elevations in the NGVD29 datum. The Log of Test-Pits dated 14 May 2009 is included in the Rogers E. Johnson & Associates Updated Geologic Investigation dated 4 June 2009. Beach sand grade elevations at the time of our excavator test pit field exploration were as follows:

12 March 2009
Excavator Test Pit Beach Grade Elevations

Test Pit Location	Beach Grade Elevation[1] feet NGVD29
TP-1	7.7 ft
TP-2	7.8 ft
TP-3	8.6 ft
TP-4	9.3 ft
TP-5	13.4 ft
TP-6	15.7 ft
TP-7	17.9 ft

Subsurface Conditions

In general, the proposed Twin Lakes Beachfront project alignment is situated between two deep infilled drainage ravines, one below the Santa Cruz Harbor and the other underlying Schwan Lake; with sandstone bedrock at relatively shallow elevations between 6th Avenue to about 8th Avenue. During long duration winter storms, such as the El Niño winters of 1982-83 and 19997-98, the accreted beach sand is stripped from the bulk of Twin Lakes State Beach down to its winter scour platform. At the project site the winter scour platform consists of either: sandstone bedrock at about Mean Sea Level (0 feet NVGV29) or higher

along the central portion of the project alignment; or lagoon/slough deposits at the two, deep infilled ravines at the upcoast and downcoast end of the project alignment. During our 1995, solid stem auger, drill rig exploration of the project site, we drilled to about 80 feet below beach grade at the mouth of the Schwan Lake with no bedrock encountered. In 2003, at the O'Neill Yacht Building adjacent the upcoast boundary of the project alignment, we drilled to about 125 feet below sidewalk grade between the O'Neill Yacht Building and the Crow's Nest Restaurant using a mud rotary drill with no bedrock encountered. At about the midpoint of the seaward perimeter of the O'Neill Yacht Building, we encountered bedrock at about 60 feet below sidewalk grade indicating the steep rise of the incised bedrock ravine or canyon wall, adjacent the upcoast end of the project alignment.

The beach sands above the winter scour platform were found to be in a loose to medium dense configuration near existing beach grade with very loose to loose sands at depth. The lagoon deposits were found to very soft to soft.

Groundwater

The depth to groundwater along the project site alignment is dependant upon the tide cycle and sea state. In general, for construction feasibility purposes groundwater elevation will be at about +2 feet NGVD29 or about Mean High Tide.

ATTACHMENT

It should be noted that groundwater levels may fluctuate due to variations in rainfall, tidal cycle, sea state or other factors not evident during our investigation.

Project Site Seismicity

The following is a general discussion of seismicity in the project area. Detailed studies of geologic hazards are in the Update Geology Investigation dated 4 June 2009.

The proposed project lies about 10 miles southwest of the San Andreas Fault zone. This is a major fault zone of active displacement which extends from the Gulf of California to the vicinity of Point Arena, where the fault leaves the California coastline. Between these points, the fault is about 700 miles long. The fault zone is a break or series of breaks along the earth's crust, where shearing movement has taken place. This fault movement is primarily horizontal.

The largest historic earthquake in Northern California occurred on 18 April 1906 (M8.3+). The 17 October 1989 Loma Prieta earthquake is considered to have been associated with the San Andreas Fault system. This event was the second largest earthquake in Northern California last century.

Liquefaction Hazards and Analysis

General

Liquefaction is the seismically induced settlement of loose, saturated sands. Severe seismic shaking can also cause the dry settlement of loose sands above the water table.

The liquefaction process typically occurs at depths less than 50 feet below the ground surface. Liquefaction can occur at deeper intervals, given the right conditions, however ground manifestations have been found to be relatively minor.

Liquefaction can lead to several types of ground failure, depending on slope conditions and the geologic and hydrologic setting. The four most common types of ground failure are: 1) lateral spreads, 2) flow failures, 3) ground oscillation and 4) loss of bearing strength. Based upon project site topography, ground oscillation and the loss of bearing strength are the most likely effects of severe seismic shaking to occur at the project site. Loss of bearing strength can either be: an area wide event, settling as a unit with little differential settlement within the immediate vicinity of the infilled drainage ravines; or void space, caused by sand boils, can be developed beneath a limited section of the project alignment creating a situation where differential settlement within and along quarrystone revetments and adjacent landward improvements can occur.

Summary of Liquefaction Analysis

To assess the liquefaction potential of the project site as well as the potential for dry settlement of the sands above the water table during severe seismic shaking, a quantitative liquefaction analysis was conducted using methodology outlined in the Proceedings of the National Center for Earthquake Engineering Research (NCEER) Workshop on Evaluation of Liquefaction Resistance of Soils-Technical Report- NCEER-97-0022, 1997 and the computer program LiquefyPro4 (CivilTech 2004).

A design earthquake of 7.9 Maximum Moment Magnitude (M_w) was used to evaluate liquefaction at the project site. Input ground motion for the liquefaction analysis was generated from the California Geologic Survey Probabilistic Seismic Hazards Mapping Ground Motion Page. Peak ground acceleration (pga) of 0.446g was derived for an alluvium type site category. A copy of the project site Ground Motion Page is included in the Appendix of this report.

Groundwater was modeled at grade or about 5.8 feet NGVD29 for two of the 2009 field exploration profiles, CPT-1 and CPT-2.

To evaluate liquefaction potential, the computer program LiquefyPro4 initially calculated the cyclic stress ratio (CSR) or seismic demand placed on the project site soil profile utilizing the input the design acceleration. The CSR is a function of the ratio of total to effective overburden stress and the peak ground acceleration, multiplied by stress reduction and weighing factors. The CSR seismic demand is resisted by the cyclic resistance ratio (CRR), which is the

ATTACHMENT 4

capacity of the soil profile to resist earthquake loading and liquefaction. The CRR was derived from project site normalized CPT tip resistance with the fines contents of the two soil profiles estimated using the CPT sleeve friction to tip resistance ratios.

A factor of safety was determined at 6 inch intervals throughout the recorded soil columns at CPT-1 and CPT-2 by dividing the cyclic resistance ratio (CRR) by the cyclic stress ratio (CSR). The CSR represents the seismic demand placed on the soil profile interval and the CRR represents the capacity of the soil profile interval to resist liquefaction. When a factor of safety less than one is determined, liquefaction is likely. When a factor of safety equal to one is determined, a state of equilibrium is assumed. When a factor of safety greater than one is determined, the probability of liquefaction decreases.

The liquefaction analysis output data sheets for CPT-1 and CPT-2 are included in the Appendix of this report. As shown on the output data sheets, liquefaction at the project site is likely to occur during the design earthquake with a peak ground acceleration of 0.446g. The output sheets also show the corresponding amounts of dry soil and saturated soil settlement for each model.

The following table summarizes the 2009 liquefaction analysis results:

2 March 2009
Liquefaction Analysis Results
Twin Lakes Beach CPT Probes

CPT Probe Location	Liquefaction Analysis Water Depth	Base of Liquefaction Zone F.S. ≤ 1 Feet NGVD	Seismic Settlement (saturated)
CPT-1	At grade 5.8 ft NGVD	-18 ft NGVD	1.89 inches
CPT-2	At grade 5.9 feet NGVD	-27 feet NGVD	1.86 inches

The results of our 2009 liquefaction analyses of CPT-1 and CPT-2 are included in the Liquefaction section of the Appendix of this report.

In 2003 our firm investigated the sol profile and liquefaction potential beneath the existing O'Neill Yacht Building at 2222 East Cliff Drive, adjacent the upcoast end of the project alignment. The results of our 2003 liquefaction analysis near the 5th Avenue roundabout are as follows:

18 September 2003
Liquefaction Analysis Results
O'Neill Yacht Building – Downcoast End[1]
Mud Rotary Drill Rig – Boring 3

Boring Location	Liquefaction Analysis Water Depth	Base of Liquefaction Zone F.S. ≤ 1 Feet NGVD	Total Seismic Settlement (dry and saturated)
B-3	9 feet below sidewalk grade 5 ft NGVD	- 20 ft NGVD	3.3 inches

1 – Boring site grade elevation = 14 feet NGVD

The O'Neill Yacht Building Boring Site Plan, Log of B-3 and the B-3 liquefaction output data sheet is included in the Liquefaction section of the Appendix of this report.

2007 California Building Code Site Class

The project site alignment is underlain with two distinct soil profiles, liquefiable alluvial deposits at the upcoast and downcoast ends with shallow sandstone

bedrock below loose to medium dense sans in the central portion of the project from about 6th Avenue to 8th Avenue.

If required for the structural engineering design of the project, the shallow bedrock section of the project alignment should be assigned the Site Class D per Section 1613.5.2 of the 2007 California Building Code (CBC)

Adjacent the 5th Avenue traffic roundabout and from about 8th Avenue to across the mouth of Schwan Lake, the site soils consist of saturated, loose sands atop lagoon deposits overlying deep bedrock. In accordance with Section 1613.5.2 of the 2007 California Building Code (CBC) and Section 20.3.1 of the 2006 ASCE Minimum Design Loads for Buildings and Other Structures, we determined the soils beneath the upcoast and downcoast ends of the project site are liquefiable under seismic loading. Provided the fundamental period of vibration of any proposed applicable project alignment structure is equal to or less than 0.5 seconds the upcoast and downcoast ends of the project site should be assigned the Site Class E.

FEMA - Flood Insurance Rate Maps

Two FEMA - Flood Insurance Rate Maps (FIRM), #06087C0334D and #06087C0353D dated 2 March 2006 show inland or terrestrial flooding elevations for Woods Lagoon/Santa Cruz Harbor and Schwan Lake. Coastal flood zones with wave action have not been evaluated for the project site alignment by FEMA.

We have included the FEMA software generated FIRMettes with the Woods Lagoon/Santa Cruz Harbor and Schwan Lake areas in the FEMA FIRMettes section of the Appendix of this report.

Wave Runup Analysis

Wave runup is the uprush of water from wave action on a shoreline barrier intercepting the Stillwater Level. The Stillwater Level (SWL) is defined as the elevation that the surface of the ocean would assume if all wave action was absent. Shoreline barriers include broad sand beaches, steep bluffs and dunes as well as manmade features such as revetments and seawalls. The water wedge generally thins and slows during its excursion up the barrier, as residual forward momentum in wave motion near the shore is fully dissipated or reflected. The notable characteristic of the wave runup process for this project is the water runup elevation or the vertical height above the Stillwater Level to which potential runup would reach. When the blufftop is lower in elevation than the potential runup elevation, the blufftop is overtopped. For blufftops with level or negative landward slopes, a general rule used by FEMA limits the wave runup elevation to 3 feet above the maximum ground elevation (GSFHMP).

The proposed Twin Lakes Beachfront Project is exposed to the Pacific Ocean, which borders the site to the south and southwest. During severe coastal storms, large surf runs up the winter scour profile impacting the blufftoe or proposed shoreline protection structure. A portion of each incoming large wave

will travel up the bluff face or wall face to a height or elevation dependent upon many factors.

To establish our coastal engineering parameters for the project site we modeled the wave runup analysis with atmospheric and storm wave parameters similar to those recorded during the very destructive El Niño winter storm of 1982-83. The primary reason the 1982-83 storm season was so devastating was the long duration of severe wave impact and runup. For a period of about six weeks, back to back winter storm waves impacted the local coastline: scouring away any accreted beach deposits from the bedrock beach platform; running up the bluff face; and overtopping lower elevation bluff tops. The project site was modeled under severe storm conditions at both current sea level and with 100 years of anticipated sea level rise.

To evaluate the potential for wave runup to impact the project site, we first worked with the project engineering geologists to develop winter scour beach platform profiles or sections at the project site; see the Rogers E. Johnson 15 May 2009 Road and Beach Profiles dated 15 May 2009.

The most severe wave condition for design of the project site shoreline protection system is the combination of: the predicted extreme water depth or design storm Stillwater Level; the scouring of any beach deposits exposing the winter scour or bedrock beach platform allowing the maximum water depth at the toe of the

structure producing a maximum incident or breaking wave height; and the wave period that produces waves which would break directly on the structure.

The breaking height of shallow water waves (H_b) is dependent upon water depth with a generalized ratio of breaking wave height to water depth (breaker depth index) of 0.78 for near level beach slopes to a maximum theoretical ratio of 1.56 for steep beach slopes with long period waves. For example, a wave traveling along a near level beach platform in 10 feet of water would generate a maximum depth limited breaking wave height of approximately 7.8 feet. The practice of using water depth at or near the structure to determine incident or breaking wave parameters is termed Depth Limited Methodology. To account for the travel distance of large beakers, we recommend computing design incident wave height a distance of $5H_b$ from the structure where H_b is equal to project site breaker index multiplied by the water depth at the toe of the structure (D_s).

For our 100 year design storm wave runup analyses we utilized: Stillwater Levels of 7.3 feet NGVD29, 9.0 feet NGVD29, 10.6 feet NGVD29 and 12.3 feet NGVD29; a depth of water corresponding the our measured winter scour platform elevations; and Figure II-4-2 of the 2004 (CEM-PE) to calculate breaker depth indices for determination of project design breaking wave heights.

Wave runup calculations are based on a variety of theoretical and laboratory work, as well as empirical observations. Most laboratory measurements have

been made in relatively small wave tanks. Specific model studies have not been made for the Twin Lakes State Beach area shoreline; however, existing information, experimental work, and empirical observations allow us to calculate approximate runup elevations.

To calculate wave runup at the referenced site, several factors and conditions must be defined. These are:

1. Design Storm Stillwater Level;
2. Nearshore and coastal bluff configuration;
3. Beach slope roughness;
4. Design wave height; and
5. Design wave period.

Following is a discussion of these conditions and the results of our wave runup analysis.

Design Storm Stillwater Level

Stillwater level is the elevation that the surface of the ocean would assume if all wave action was absent. This super elevation of the assumed static water surface is due to a combination of: astronomical high tide; storm surge; wave setup; and for project design life calculations, long term sea level rise.

Astronomical Tide

A mixed semi-diurnal tide characterizes the California coast, which means simply that we experience two daily high tides, of unequal heights; and two low tides, also of unequal heights. Normally, tidal heights are stated in feet, relative to elevation datum Mean Lower Low Water (MLLW). Mean Sea Level (MSL) is defined as the local mean sea level and should not be confused with the National Geodetic Vertical Datum (NGVD 29) or Sea Level Datum of 1929. NGVD 29 is a fixed datum adopted as a standard geodetic reference for heights where Mean Sea Level was held fixed as observed at 26 stations in the U.S. and Canada. NGVD for the Monterey Bay area was adjusted in 1961 and revised in 1986. As outlined by the National Oceanic and Atmospheric Administration (NOAA) National Ocean Service, 5 November 1986, Local Mean Sea Level (MSL) at Monterey Harbor is 2.85 feet MLLW, a local difference of 0.03 feet between MSL and NGVD. The highest observed water level at Monterey Harbor was 8.12 feet MLLW on 27 January 1983. The highest observed total water level at the San Francisco NOAA tide gauge was 9.0 MLLW on 27 January 1983 which included 2.0 feet of storm surge. The average tide level is about +3.0 MLLW. Tides above 6 feet MLLW occur about 13 percent of the time. The important consideration here is not simply the tidal elevation, but also the coincidence of high astronomical tides with severe storm conditions, particularly those associated with El Niño storms which include long duration high winds, low barometric pressure and extreme waves.

The probability of high tides occurring with severe storm conditions is reasonably high and must therefore be considered in determining Stillwater Level.

Atmospheric Storm Surge

An important factor that influences the height of the Stillwater Level is storm surge. Storm surge is attributed to pressure setup and wind setup. Pressure setup is the rise in the water surface elevation due to low atmospheric pressure. Large areas of low barometric pressure associated with storm events allow sea level to rise above normal levels. Winds associated with coastal storms create a surge which increases sea levels above their normal high tidal range. During large storm events, on-shore winds push water toward shore where water "mounds", raising sea level.

Storm surge is usually calculated from tide gauge data which is gathered in a manner that eliminates the effects of wave induced setup and surges. As outlined in the July 1998 Shore and Beach article Comparison of California Tides, Storm Surges, and Mean Sea Level During the El Niño Winters of 1982-83 and 1997-98 storm surge rarely exceeds 2.0 along the central California coastline.

We utilized 2.0 feet of atmospheric storm surge in our calculation of the design storm Stillwater Level for both the current conditions and with 50 years of sea level rise.

Wave Setup

Wave setup is the additional elevation of the water level within the surf zone caused by wave action alone. Breaking waves dissipate energy and transfer momentum to the water column. This transfer of momentum is equivalent to a shore directed "push" on the water column that causes a tilt of the water surface. Seaward of the surf zone, the water level is lowered slightly with a rise in the water level throughout the surf zone. For a wave of a constant height and period the transfer of momentum would be steady and wave setup would be static. Static wave setup is included in the USACE Automated Coastal Engineering System (ACES) wave runup programs. Static or steady state wave setup calculations are based on bottom slope and incident wave steepness. As an example, for a site setting with a breaker depth index or ratio of breaking wave height to water depth of 0.8; about 15% of the incident breaking wave water depth could be anticipated for the static wave setup component of the total wave runup.

When a wave system contains more then one wave component or when two wave systems of different generation origins simultaneously impact the shoreline, also known as irregular waves, the wave setup consists of a steady or static component and an oscillating component. The oscillating component is termed dynamic wave setup.

Recent FEMA publications have outlined the need for the dynamic component of wave setup to be included in coastal flooding investigations as well as the need to develop standardized methodology to determine dynamic wave setup. This is of particular interest on the Pacific coast where severe coastal storms are characterized by long period wave systems impacting the relatively narrow Pacific Coast continental shelf.

To account for the probable occurrence of dynamic wave setup during severe coastal storms at the project site we have included 1.2 feet of dynamic wave setup in our design storm Stillwater Level calculations representing about 10% of the incident breaking wave water depth for the 100 year Stillwater Level design storm using a sea level rise of 10mm/yr.

Future Sea Level Rise

The earth is in a warming phase and sea level is rising. Measurements from tide gauge stations around the world show that the global sea level has risen by almost 20cm since 1880. Since 1993, global sea level has been measured accurately from satellites; since 1993 figures have shown sea level rising at a rate of 3.2cm per decade indicating a non-linear increase in the rate of sea level rise.

The two main causes of this rise are extra water entering the ocean from melting land ice and the expansion of ocean water as it gets warmer. Both are inevitable physical consequences of global warming. Considerable uncertainty exists regarding the rate of global warming due to climate-carbon cycle feedbacks, ice sheet dynamics and future earth temperatures.

A rising sea level is an adverse condition for the project site whether or not the current proposed project is constructed or not. Rising sea level will result in more frequent wave impact, higher wave forces and more frequent overtopping of the shoreline protection structure.

Rising sea level results in future higher wave runup and greater wave impact because it raises the Stillwater Level allowing larger breaking waves to impact the project site blufftoe. Higher wave energy will cause greater and more frequent overtopping of the blufftop retaining wall at the relatively low elevation project site. Sea level rise is a linear addition to the design storm Stillwater Level and the height of the water column adjacent the project alignment. As the height/depth of the water column adjacent the project alignment increases so does the potential for increase wave runup.

To quantify projected sea level rise as a component of our wave runup and wave force analyses, we utilized three sources:

1. The 2007 Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC);
2. The March 2009 International Scientific Congress on Climate Change concluding seal level may be rising twice as much as was predicted in the 2007 IPCC Fourth Assessment Report in line with Prof. Stefan Rahmstorf's 2007 estimates that 1.6 feet (0.5 meters) to 4.6 feet (1.4 meters) of sea level rise will occur by 2100 (2007 to 2100 = 93 years); and
3. Interaction with the California Coastal Commission (CCC) on recent Monterey Bay coastal projects where the CCC asked that future sea level rise rates of 10 mm/yr and 15 mm/yr are evaluated. A rate of 5 mm/yr represents 1.7 feet in 100 years, and is consistent with the most liberal estimate by Rahmstorf (2007). A rate of 10 mm/yr represents 3.3 feet in 100 years, and is the middle of the range selected by Rahmstorf. A rate of 15 mm/yr represents about 5.0 feet in 100 years, and is consistent with the most conservative estimate by Rahmstorf (2007).

We utilized the following Stillwater Levels for our wave runup analyses:

Current Conditions Design Storm Stillwater Level (SWL) Summary

Extreme high tide	4.1 feet NGVD 29
Atmospheric storm surge	2.0 feet

Nearshore and Shoreline Barrier Configuration

The configuration and slope of the nearshore winter scour or bedrock beach platform and the shoreline barrier are important conditions controlling wave runup along the proposed project alignment.

Beach Roughness

Our wave runup analysis included an assessment of roughness correction factors for the nearshore winter scour platform and shoreline protection surface materials.

Design Wave Period

We used a design wave period of 16 seconds to develop our project wave runup model. Localized storms and the resulting wind swell produce relatively short wave periods in the range of 3 to 10 seconds. Long period waves of 10 to 25 seconds are typical of distant storm waves arriving over relatively undisturbed or storm free local waters. In general the largest breaking wave at the project site will be long period waves.

The design wave period of 16 seconds represents the upper limit of the averaged dominant wave periods recorded at the NOAA Half Moon Bay Buoy – Station 46012 during the winter storm season months of December, January and February from November 1980 to December 2001.

Results of Wave Runup Analysis

Our project site wave runup analysis was performed using the 2004 Coastal Engineering Manual (CEM-PE) Professional Edition 2.01 by Veri-Tech, Inc. The CEM-PE was prepared in conjunction with the US Army Corps of Engineers Coastal and Hydraulics Laboratory in corporate the Automated Coastal Engineering Software (ACES) programs.

Our wave runup analyses was based on depth limited methodology where the design breaking wave is determine from site parameters as opposed to a probabilistic approach using deepwater wave heights. Based upon past events, we anticipate the most dramatic coastal erosion and wave runup to occur during El Niño type winters when long duration storms strip the sand from the winter scour platform allowing incoming waves to break in front of or upon the proposed shoreline protection structures.

Wave runup calculations are based on a two slope model configuration. The nearshore slope gradient determines the breaker index which converts the water column depth at the toe of the structure to an incident breaking wave height. The incident breaking wave then travels up the shoreline barrier or structure slope gradient until all forward momentum is dissipated.

To generate coastal engineering design criteria for the project we evaluated the seaward perimeter of the proposed project alignment with respect to the elevation

of the winter scour platform. Vertical walls appear to be necessary along most of the project alignment form 6th Avenue to 8th Avenue in order span between the existing roadway grade elevations and sandstone bedrock at elevations around 0 feet NGVD29 and minimize the seaward encroachment of the shoreline protection structures.

Wave runup at the Rogers E Johnson & Associates (RJA) Section A-A' was evaluated using Composite Slope methodology and Equation VI-5-3 of the CEM-PE. To determine potential wave impact pressures for vertical wall placed landward of the Stillwater Level we utilized methodology from the 1984 Shore Protection Manual; see the RJA Section A-A' in the Wave Runup Analysis and Wave Pressure sections of the Appendix of this report.

To model the height of the reflected or standing wave formed at the seaward side of vertical walls where the toe of the wall is seaward of the Stillwater Level as well as the associated wave impact pressures, we used the Goda Formula method form the CEM-PE; see RJA Sections B-B' and E-E' in the Wave Runup Analysis and Wave Pressure sections of the Appendix.

RJA Sections F-F' and H-H' model quarrystone revetments at four Stillwater levels and a range of breaking wave heights, see RJA Sections B-B' and E-E' in the Wave Runup Analysis section of the Appendix.

The calculated elevation of coastal flooding and the landward extent of overtopping, where applicable, are also outlined in the Wave Runup Analysis section of the Appendix.

A comparison of estimated wave runup on revetment slope gradients of 1.5:1 (H:V) as opposed to 2:1 (H:V) is presented in the Quarrystone Sizing Analyses section of the Appendix.

Revetment Quarrystone Sizing Analyses

Quarrystone rock sizing for project site revetments was performed using the 2004 CEM-PE, specifically the Hudson Equation for Riprap Armor Stability and depth limited breaking wave methodology; see the Quarrystone Sizing Analyses section in the Appendix of this report. We evaluated two slope gradient profiles, 1.5:1 (H:V) and 2:1 (H:V), with four Stillwater Levels to develop rock sizing for a wide range of potential water column depths fronting project site revetments.

Based on our wave runup analyses, existing and future revetments at the project site will be overtopped and as such we recommend the same median rock size be utilized in both the toe and the body of any new or significantly repaired revetment. No more than 25% of imported rock shall weigh less than the median weight (W_{50}). All new and repaired revetments should be embedded or keyed at least 3 feet into the winter scour platform or to the design project scour elevation, which ever is deeper. The largest rock imported to the site should be reserved for

the keyway to buttress the body of the revetment above. A summary of our calculated quarrystone sizing with W_{50} (weight of median armor unit) and D_{n50} (Equivalent cube length of median rock) versus project Stillwater Levels with associated breaking wave heights ($H_s = H_b = H_i$) is as follows:

RJA Section H – H'
Top of Winter Scour Platform at -5 ft NGVD
2-Layer Quarrystone Revetment at 1.5:1 (H:V)

Stillwater Level (SWL) feet NGVD29	Breaking or Incident Wave Height feet	Calculated Median Rock Size Toe to Top of Revetment Tons	Comparative Wave Runup feet NGVD29
7.3 ft	11.3 ft	8.4 tons	17.3 ft
9.0 ft	12.8 ft	13.2 tons	-
10.6 ft	14.1 ft	17.3 tons	-
12.3 ft	15.6 ft	23.9 tons	-

RJA Section H – H'
Top of Winter Scour Platform at -5 ft NGVD
2-Layer Quarrystone Revetment at 2:1 (H:V)

Stillwater Level (SWL) feet NGVD29	Breaking or Incident Wave Height Feet	Calculated Median Rock Size Toe to Top of Revetment Tons	Comparative Wave Runup feet NGVD29
7.3 ft	11.3 ft	6.8 tons	18.8 ft
9.0 ft	12.8 ft	10.0 tons	-
10.6 ft	14.1 ft	13.3 tons	-
12.3 ft	15.6 ft	17.9tons	-

As shown above and illustrated in the models presented in the Quarrystone Sizing Analyses section in the Appendix of this report, median rock sizes become very large with increasing Stillwater Levels. From a practical perspective, 6 to 10 ton, hard rock quarrystones are about the upper limit of readily available quarrystones for repair or construction of project site revetments. As sea level rises, larger quarrystones are needed for revetment stability. Per current California Coastal

Commission requirements, quarrystone revetments must be sloped at 1.5:1(H:V) or steeper to minimize beach encroachment. As shown above reducing the revetment slope gradient to 2:1(H:V) reduces minimum rock size.

Another option for revetment stability with sea level rise to utilize man made armor units with relatively high stability coefficients such as tribars (K_D=9) or the relatively new Core-Loc (K_D=13) compared to randomly placed angular quarrystones with a stability coefficient of K_D=2. The stability coefficient is utilized in a linear manner in the denominator of the Hudson Equation for Riprap Armor Stability so a significant increase in the stability coefficient substantially reduces the minimum rock size needed revetment stability.

Supplemental Design Criteria

Vertical seawalls also act as retaining walls. The seawall/retaining walls at the project site will be subject to overtopping and should be designed for saturated backfill conditions. The following active earth pressures and seismic surcharge loads should be used for the design of the project:

For cantilever type retaining walls (triangular loading condition):

Undrained = 84 pcf-efw

For at-rest conditions (triangular loading condition):

Undrained = 92 pcf-efw

For restrained type retaining walls (rectangular loading condition):

Undrained = 55 psf · H (ft)

The project seawall/retaining wall system wall should be designed to include a seismic surcharge equivalent to 16 H/ft acting at 0.6 H where H is the height of the active zone.

The project site vertical seawall/retaining wall system should be designed for wave impact loading; see the Wave Pressure Calculations section in the Appendix of this report.

A seawall/retaining wall backfill passive pressure value of 300 pcf-efw may be used for engineered fill soils compacted to at least 90 percent relative compaction (ASTM 1557 – current) or undisturbed terrace deposits.

The wave runup analysis included with this update report was based upon the existing measured winter scour platform elevations. As sea level rises, the winter scour platform, whether lagoon deposits or sandstone bedrock, will become exposed more often and erode/abrade. As the elevation of the winter scour platform is lowered, the water column, adjacent the proposed improvements becomes deeper and the effects of wave runup will increase. As the winter scour platform deepens, toe of the seawall conventional spread footings embedded into bedrock will become exposed as will the keyways of any project site revetments. Once a project design life has been established based on projected sea level rise, the down wearing of the winter scour platform should be projected by the project engineering geologists and utilized by the project

ATTACHMENT 4

structural engineers to design the project. The final project design should also include the increase in wave impact pressure to vertical walls associated with increased runup and appropriate quarrystone sizing for the design breaking wave heights.

Plan Review, Construction Observation and Testing

The recommendations presented in this report section are contingent upon our: review of the project civil and structural engineering plan set for conformance to our geotechnical and coastal engineering recommendations; observation of the geotechnical related aspects of the project such as the excavation of seawall foundation elements; and observation and relative compaction testing of retaining wall/seawall backfill soils

Investigation Limitations

Our work is based on presently accepted geotechnical and coastal engineering practices and standards; our conclusions do not imply that the site is free from geologic hazards or that the site will not be subject to coastal erosion, ground failure, or inundation. The report does suggest that compliance with the recommendations will reduce potential coastal and geologic hazards to an acceptable risk.

APPENDIX A

Site Vicinity Map

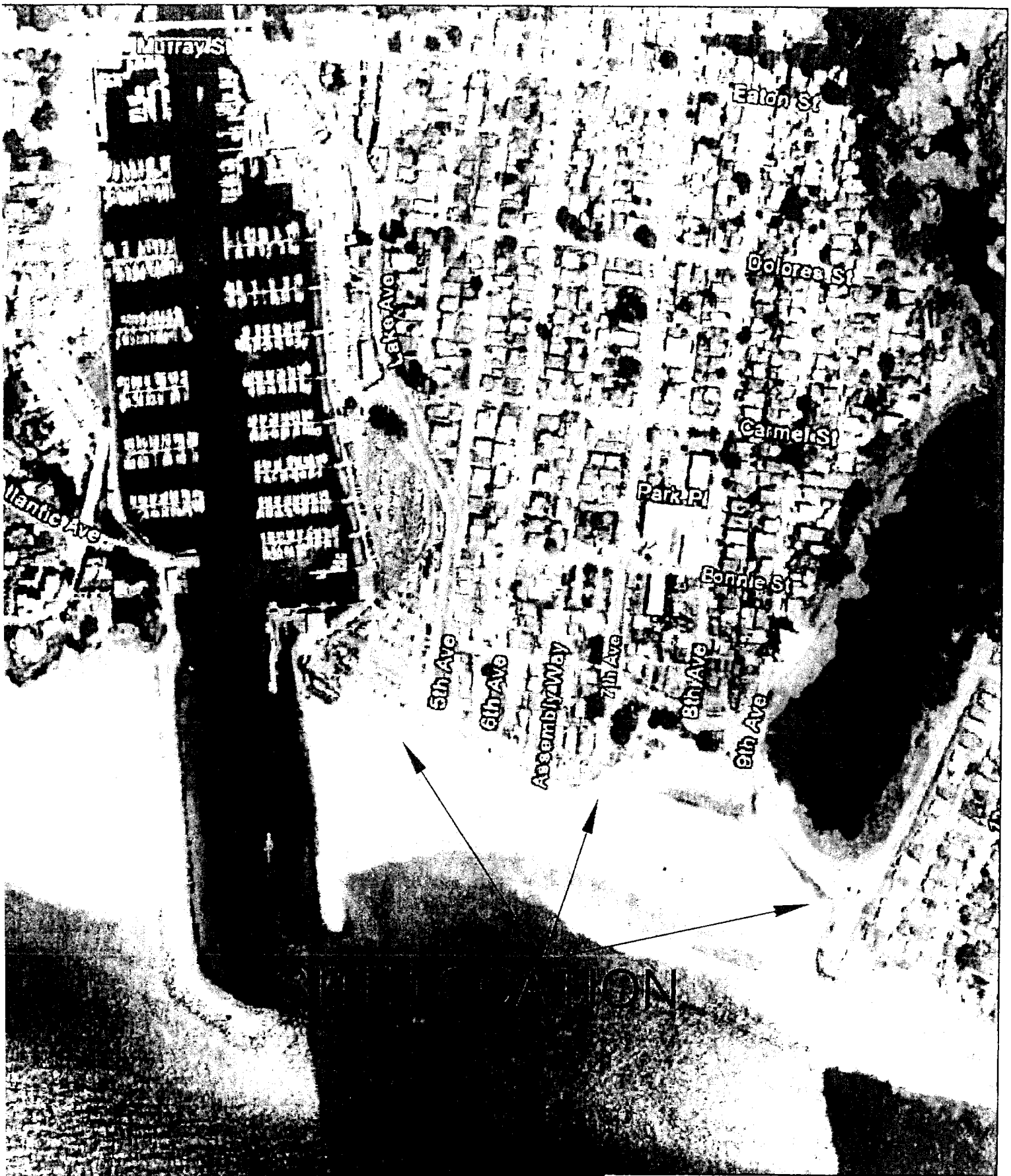
Exploratory Test Pit Locations Color Plate

CPT Probe Locations Color Plate

CPT Testing Description

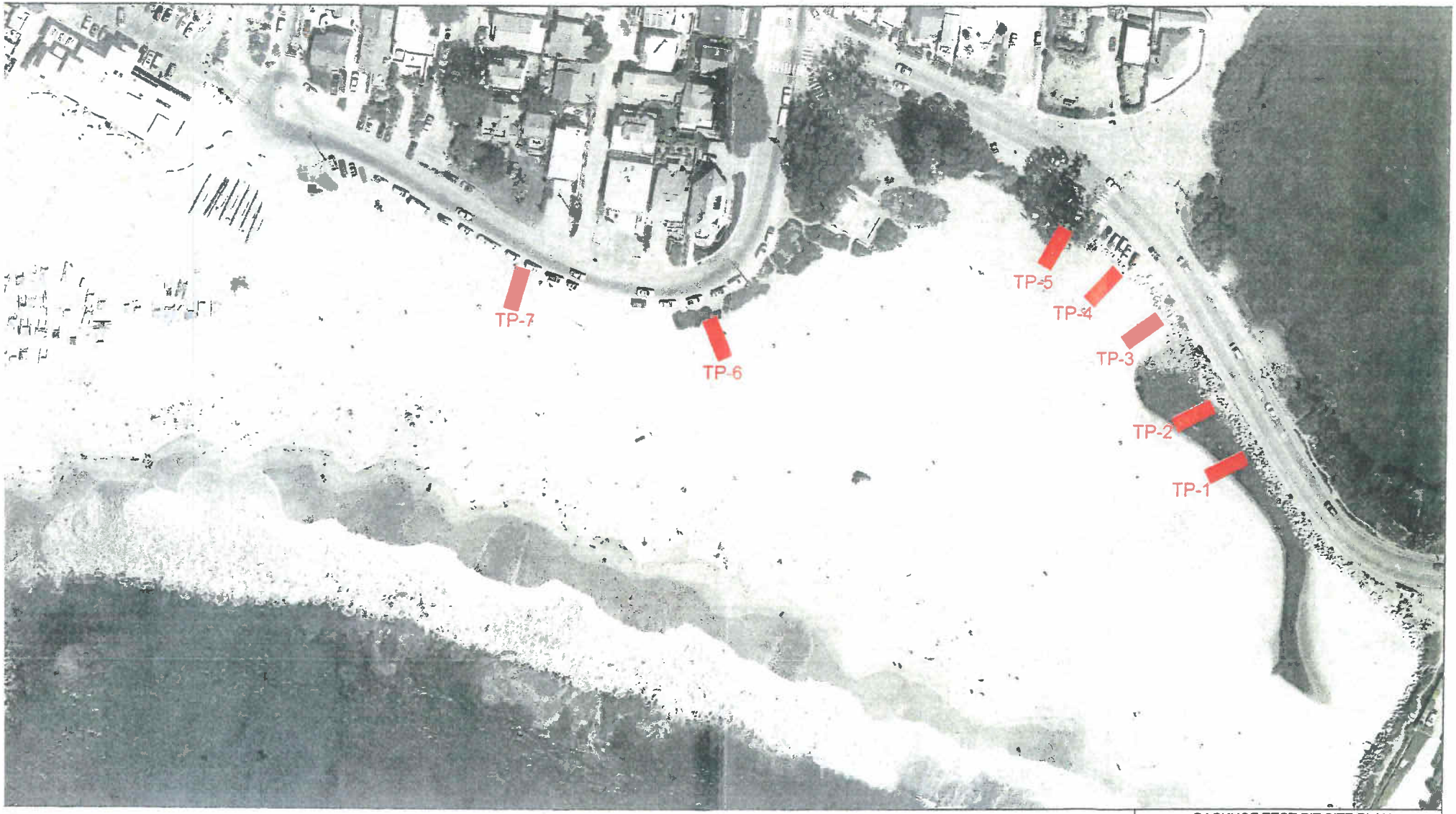
CPT Soil Profile Logs

ATTACHMENT 4



SITE VICINITY MAP
Twin Lakes Beachfront Project
Santa Cruz Harbor to Schwan Lake
Santa Cruz County, California

SCALE: NO SCALE	Image From Google Earth, July 2003
DRAWN BY: JD	
DATE: June 2009	HARO, KASUNICH & ASSOCIATES, INC.
REVISED:	GEOTECHNICAL AND COASTAL ENGINEERS
JOB NO: SC9809	116 E. LAKE AVENUE, WATSONVILLE, CA 95076
FIGURE NO.	ATTACHMENT 4



GEND:

-1 = LOCATION OF BACKHOE TEST PIT (12 MARCH 2009)

BACKHOE TEST PIT SITE PLAN
Twin Lakes Beachfront Project
Santa Cruz County, California

SCALE: NO SCALE	Photo from Santa Cruz County FTP website
DRAWN BY: JD	
DATE: June 2009	HARO, KASUNICH & ASSOCIATES, INC.
REVISED:	GEOTECHNICAL AND COASTAL ENGINEERS
JOB NO: SC9809	116 E. LAKE AVENUE, WATSONVILLE CA 95076 (831) 722-4175

FIGURE NO. ATTACHMENT 4

GEND:

CPT-1 = LOCATION OF CONE PENTROMETER TEST (2 MARCH 2009)

CONE PENTROMETER TEST SITE PLAN
Twin Lakes Beachfront Project
Santa Cruz County, California

SCALE: NO SCALE	Photo from Santa Cruz County FTP website
DRAWN BY: JD	
DATE: June 2009	HARO, KASUNICH & ASSOCIATES, INC.
REVISED:	GEOTECHNICAL AND COASTAL ENGINEERS
JOB NO: SC9809	116 E. LAKE AVENUE, WATSONVILLE, CA 95076
FIGURE NO.	(831) 722-4175

ATTACHMENT

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

California Push Technologies Inc.
104 Constitution Drive Suite 2
Menlo Park CA 94025
IC-57 license #884827I

office: 650 854 0300
fax: 650 854 0301

www.cptinc.com

Cone penetration testing and soil sampling methods description.

Rig Description

Our services are based on the state-of-the-art, Geoprobe Model 6625CPT rig, a limited-access, self-anchoring, 20-ton push capacity, track-mounted push platform for dedicated Geotechnical CPT applications with the unique and valuable added ability to quickly perform intermittent or continuous soil sampling.

Weight = ~ 9,500 pounds
Surface load = ~ 4.5 psi
Push capacity = ~ 20 tons; self-anchoring achieved using 10- or 15-inch diameter helical soil anchors driven 4- to 10-feet into the soil
Sampling hammer percussion rate = 32 Hz & 20,000 lbs force/blow
Length = ~ 12 feet; Width = ~ 7 feet
Height (folded) = 7 feet; Height (unfolded) = 14 feet

CPT Description

Our Geoprobe 6625CPT incorporates the Swedish-made Geotech AB Cone Penetration Testing tools which meet the ASTM D-5778 Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils. Cones have 10 cm^2 tips and 150 cm^2 friction sleeves, and include a porous filter and pressure sensor located in the u_2 position directly behind the cone. The cone and porous filter are saturated under vacuum with glycerin to promote rapid equilibration with in-situ pore pressures. Cones are advanced at the ASTM standard rate of 2 cm/second. Baseline readings are performed both before and after each push to check for load cell drift. The cone measures bearing (max load = 100 MPa ~ 1044 TSF), friction sleeve (max load = 1.0 MPa ~ 10.4 TSF), and dynamic pore pressure (max load = 2.5 MPa ~ 363 psi) at 2 cm or 4 cm intervals (client's choice) and this data is plotted in real-time and recorded on a laptop computer adjacent to the push platform. Holes are grouted upon completion of each push, or at the end of each day, as site conditions and regulations warrant.

The basic equation to determine the depth to the free water surface from the pore pressure dissipation test is;

Depth to phreatic surface = [Dissipation depth] – [equilibrium pore pressure / unit weight of H2O x unit conversation factor]

...where;

1) Surface elevation is always assumed to be 0 feet
2) Dissipation depth = the depth (feet) below surface elevation where the cone advancement was paused while waiting for equilibrium pore pressure to be achieved
3) Equilibrium pore pressure = the pore pressure after an elapsed time where no increase or decrease in pore pressure is occurring, in pounds per square inch (psi)
4) Unit weight of water = 62.3 pounds per cubic foot (lb/ft^3)
5) Unit conversion factor (for dimensional analysis): 1 psi = 144 lb/ft^3

From the dissipation plots, simply read the dissipation depth and dissipated pressure for the values to plug into the equation above. On the plots, pore pressure (psi) is on the abscissa and log time (seconds) is on the ordinate.

Sampling Description

Geoprobe® brand Dual Tube Sampling Systems are efficient methods of collecting continuous soil cores with the added benefit of a cased hole. Dual tube sampling uses two sets of probe rods to collect continuous soil cores. One set of rods is driven into the ground as an outer casing (2.2 or 3.25 inches in diameter). These rods receive the driving force from the hammer and provide a sealed hole from which soil samples may be recovered without the threat of cross contamination. The second, smaller set of rods are placed inside the outer casing. The smaller rods hold a sample liner in place as the outer casing is driven one sampling interval. The small rods are then retracted to retrieve the filled liner. Soil samples are collected in 1.85-inch diameter or 1.125-inch diameter clear PVC sample sheaths.

Interpretations

Soil behavior type (SBT), SPT N60 energy ratio, undrained shear strength, OCR, and unit weights are calculated and/or are interpretations generated by the CPT-Pro software based on empirical relationships derived in the following references;

P.K. Robertson, R.G. Campanella, D. Gillespie, and J. Greig, 1986, Use of Piezometer Cone Data, Proceedings of the ASCE Specialty Conference In Situ '86: Use of In Situ Tests in Geotechnical Engineering; pp. 1263-1280.

P.K. Roberston, 1990, Soil Classification Using the Cone Penetration Test, Canadian Geotechnical Journal, 27(1), pp. 151-158.

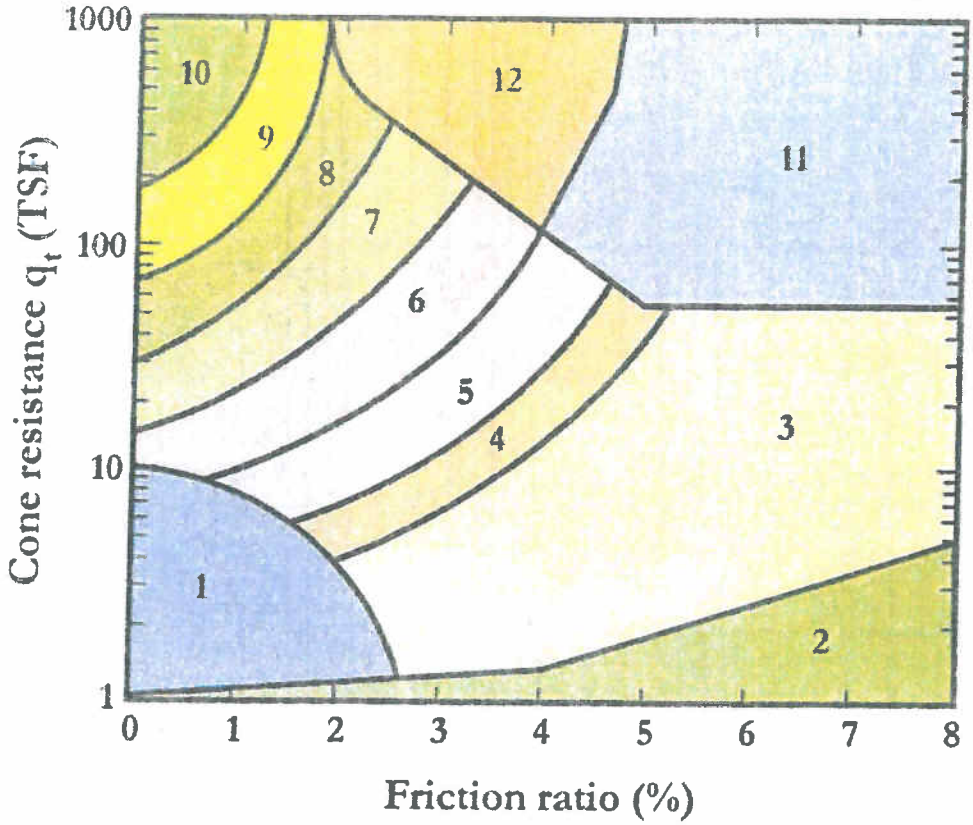
T. Lunne, P.K. Robertson, and J.J.M. Powell, 1997, Cone Penetration in Geotechnical Practice, Taylor and Francis Publishing.

CPT Inc. makes no recommendation on which soil behavior type analysis is "most-correct". The engineer should be aware of the limitations of using CPT data to derive soil behavior type and other engineering parameters and is encouraged to review the above references to better understand the applicability and limitations of CPT data. It is sometimes not possible to determine soil type based solely on tip resistance, sleeve friction, and dynamic pore pressure response, and confirmatory samples may be required.

Please do not hesitate to contact CPT Inc. if you have questions.

Sincerely,
John Rogie

President
California Push Technologies, Inc.



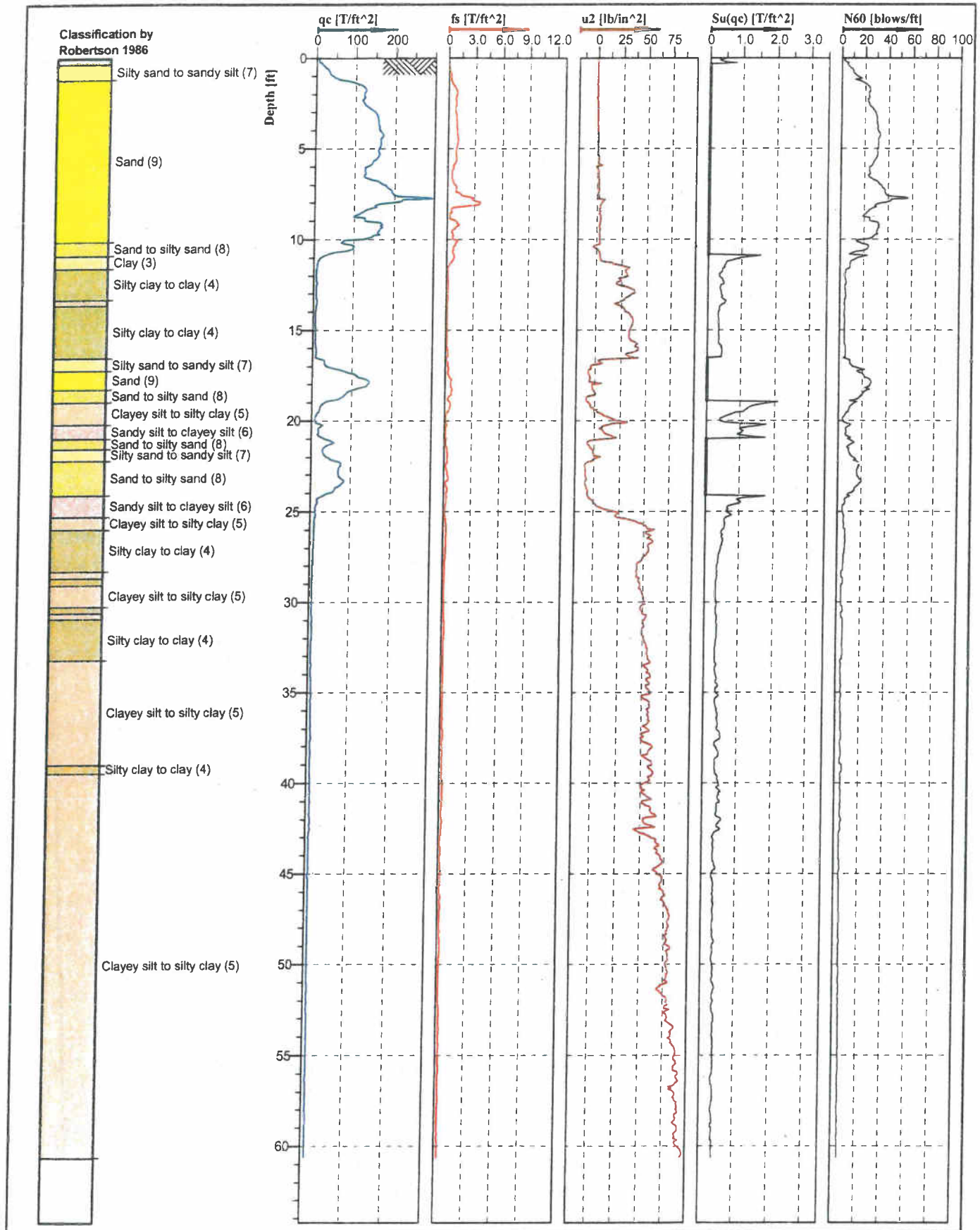
Zone	Soil Behavior Type
1	sensitive fine grained
2	organic material
3	clay
4	silty clay to clay
5	clayey silt to silty clay
6	sandy silt to clayey silt
7	silty sand to sandy silt
8	sand to silty sand
9	sand
10	gravelly sand to sand
11	very stiff fine grained (overconsolidated or cemented)
12	sand to clayey sand (overconsolidated or cemented)

Source: Robertson, P.K., Campanella, R.G., Gillespie, D., and Greig, J., 1986, Use of Piezometer Cone Data. Proceedings of the ASCE Specialty Conference In Situ 86: Use of In Situ Tests in Geotechnical Engineering.

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Soil Behavior Type (SBT) Model

ATTACHMENT 4



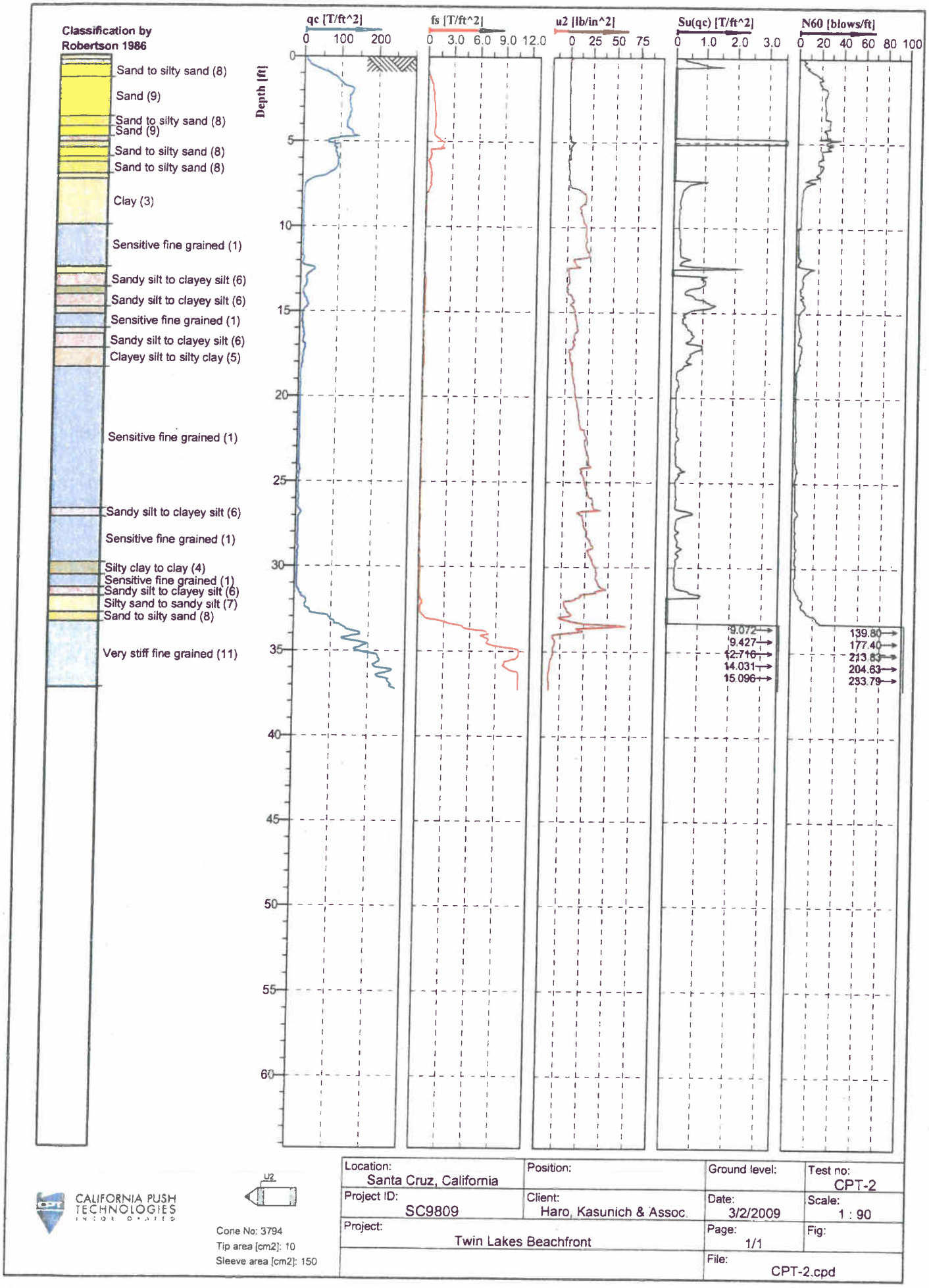
CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

U2

Cone No: 3794
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Santa Cruz, California	Position:	Ground level:	Test no: CPT-1
Project ID: SC9809	Client: Haro, Kasunich & Assoc.	Date: 3/2/2009	Scale: 1 : 90
Project: Twin Lakes Beachfront		Page: 1/1	Fig:
		File: CPT-1.cpd	

ATTACHMENT 4



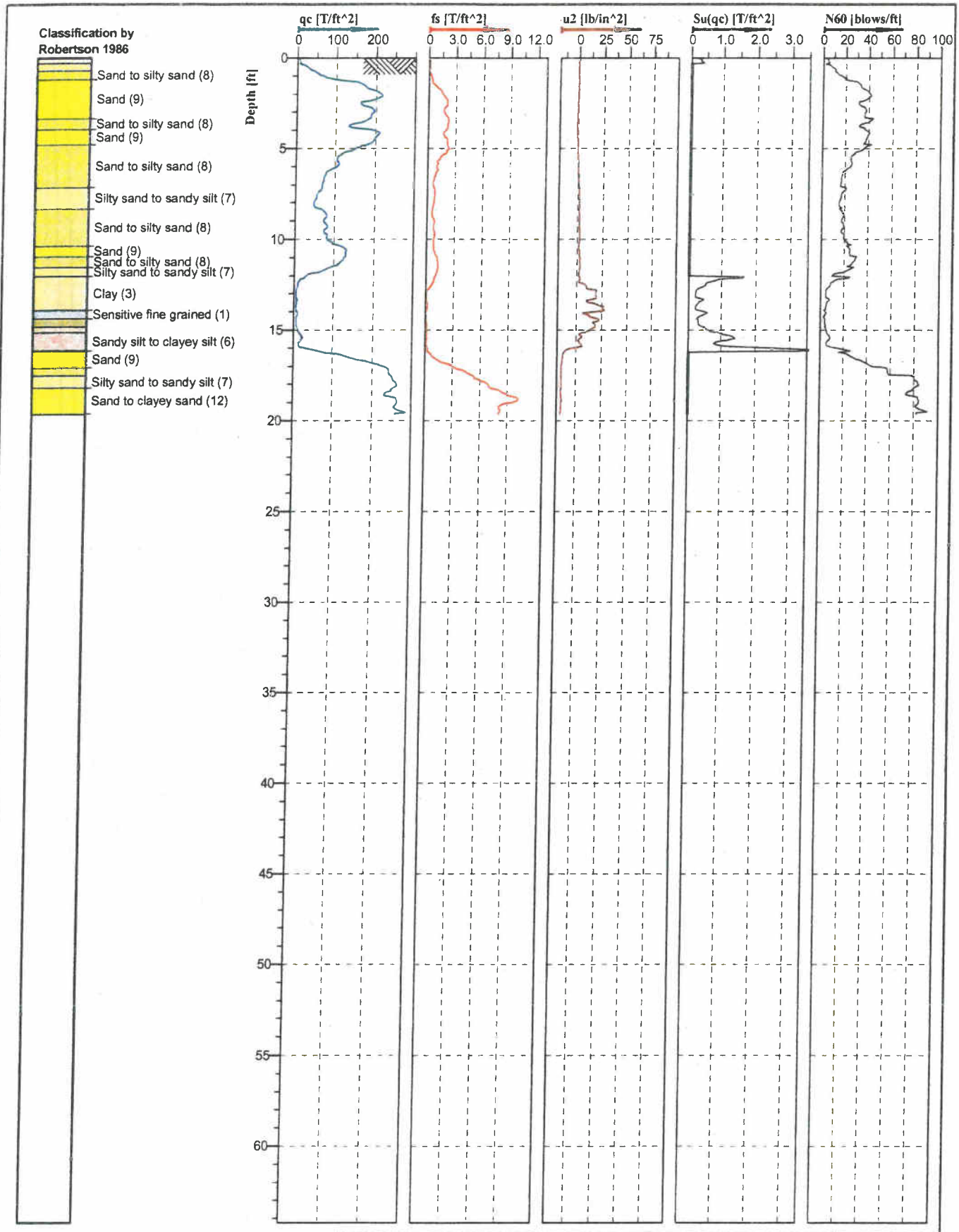
CALIFORNIA PUSH TECHNOLOGIES

U2

Cone No: 3794
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Santa Cruz, California	Position:	Ground level:	Test no: CPT-2
Project ID: SC9809	Client: Haro, Kasunich & Assoc.	Date: 3/2/2009	Scale: 1 : 90
Project: Twin Lakes Beachfront		Page: 1/1	Fig:
		File: CPT-2.cpd	

ATTACHMENT 4



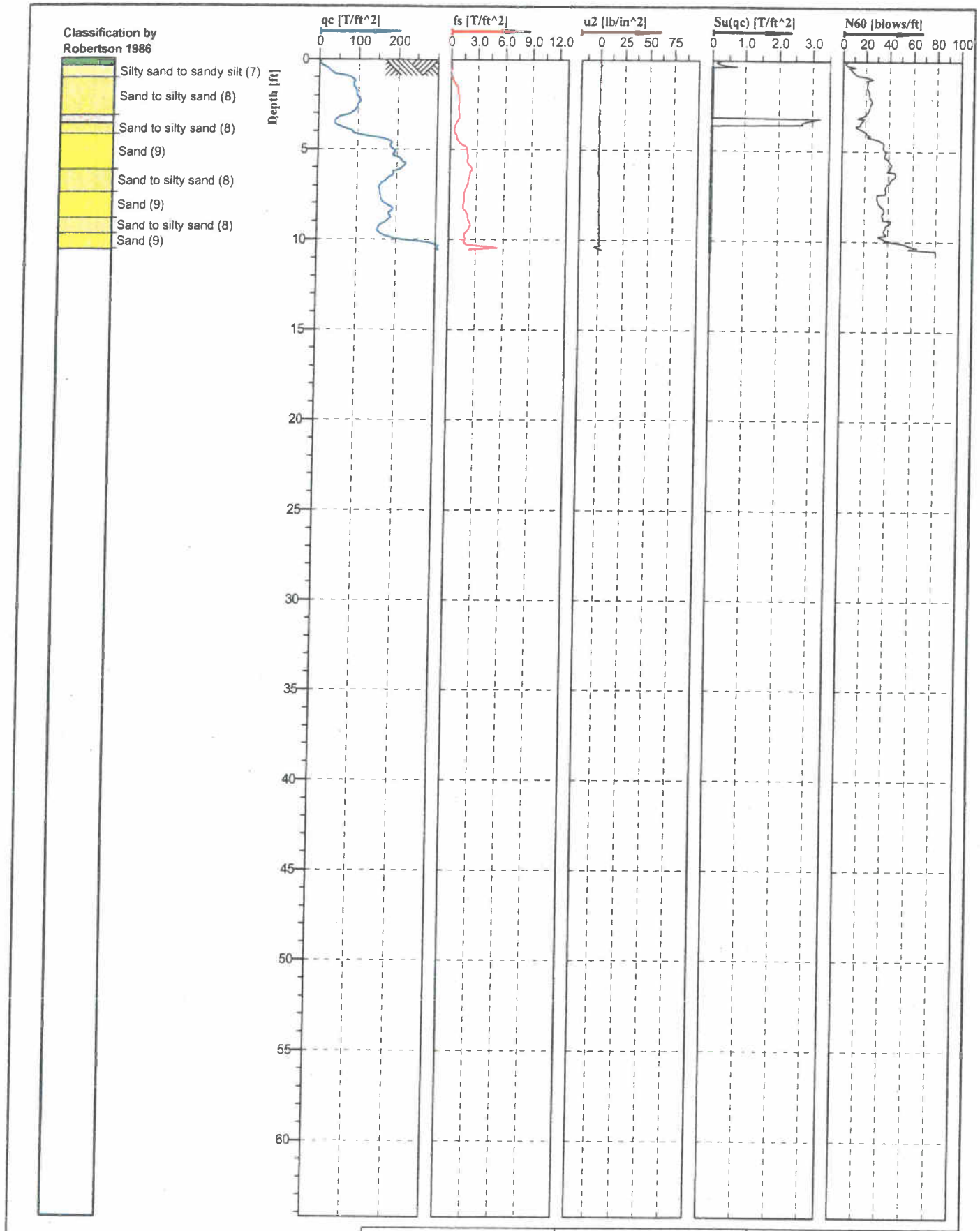
Location: Santa Cruz, California	Position:	Ground level:	Test no: CPT-3
Project ID: SC9809	Client: Haro, Kasunich & Assoc.	Date: 3/2/2009	Scale: 1 : 90
Project: Twin Lakes Beachfront		Page: 1/1	Fig:
		File: CPT-3.cpd	

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

U2

Cone No: 3794
Tip area [cm2]: 10
Sleeve area [cm2]: 150

ATTACHMENT 4



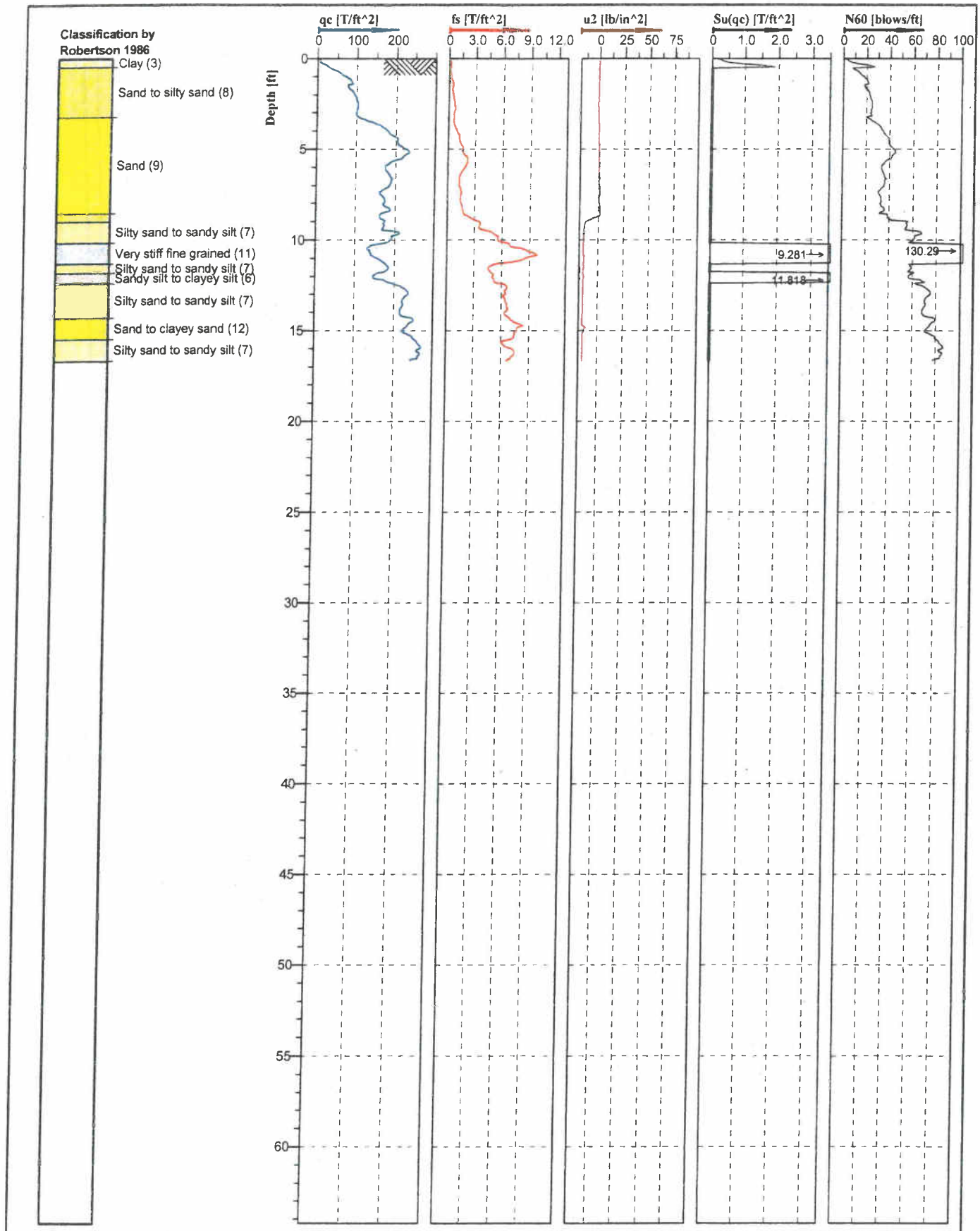
CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

U2

Cone No: 3794
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Santa Cruz, California	Position:	Ground level:	Test no: CPT-4
Project ID: SC9809	Client: Haro, Kasunich & Assoc.	Date: 3/2/2009	Scale: 1 : 90
Project: Twin Lakes Beachfront		Page: 1/1	Fig:
		File: CPT-4.cpd	

ATTACHMENT 4



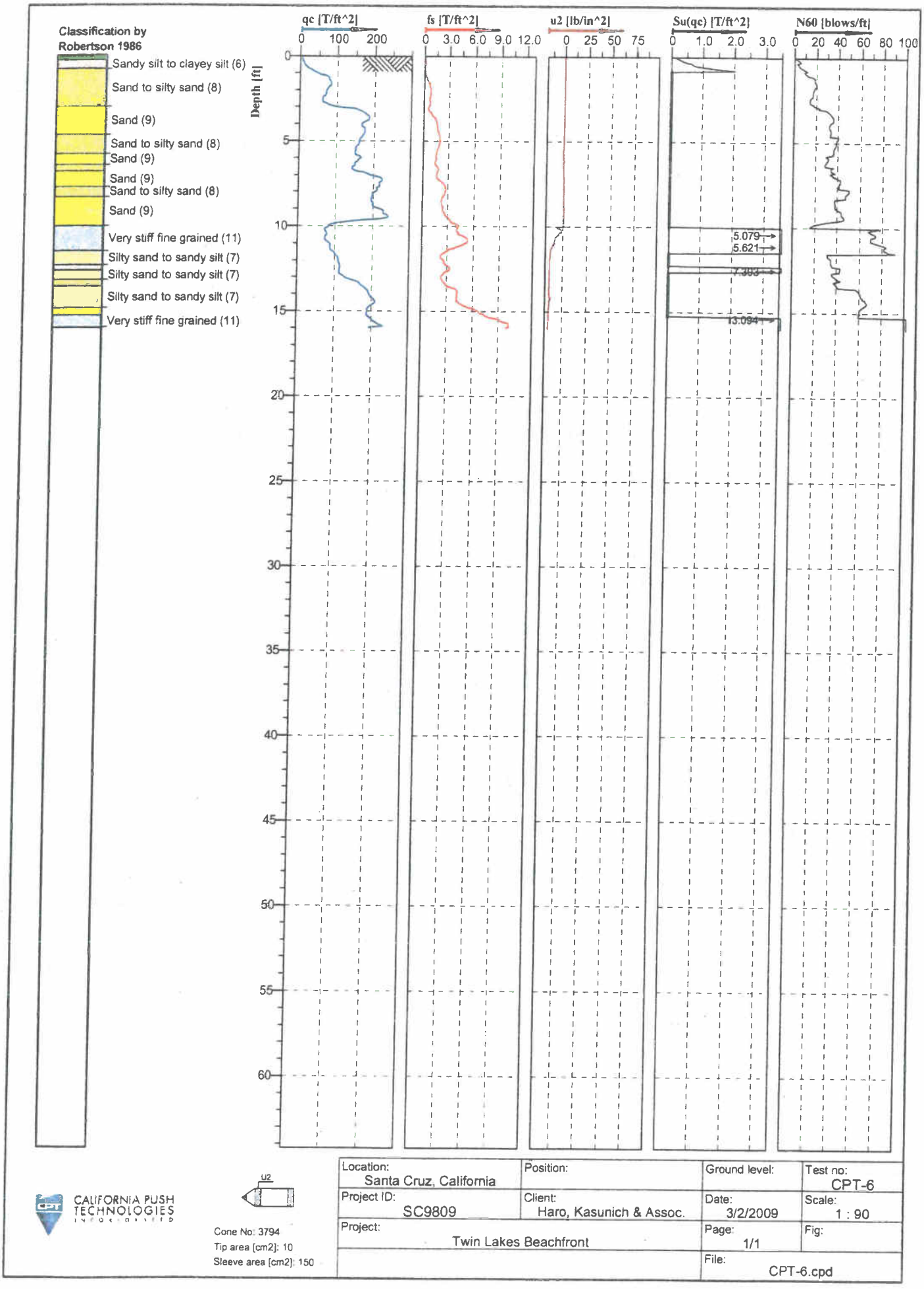
Location: Santa Cruz, California	Position:	Ground level:	Test no: CPT-5
Project ID: SC9809	Client: Haro, Kasunich & Assoc.	Date: 3/2/2009	Scale: 1 : 90
Project: Twin Lakes Beachfront		Page: 1/1	Fig:
		File: CPT-5.cpd	

CALIFORNIA PUSH TECHNOLOGIES

U2

Cone No: 3794
Tip area [cm2]: 10
Sleeve area [cm2]: 150

ATTACHMENT 4



CALIFORNIA PUSH TECHNOLOGIES

U2

Cone No: 3794
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: Santa Cruz, California	Position:	Ground level:	Test no: CPT-6
Project ID: SC9809	Client: Haro, Kasunich & Assoc.	Date: 3/2/2009	Scale: 1 : 90
Project: Twin Lakes Beachfront		Page: 1/1	Fig:
		File: CPT-6.cpd	

ATTACHMENT 4

Project No. SC9809
5 June 2009
Revised 27 August 2009

APPENDIX B

Wave Runup Analysis Results

Key to Wave Runup Tables

Wave Runup Results Tables and Output Data Sheets:

RJA Section A-A'

RJA Section B-B''

RJA Section E-E'

RJA Section F-F'

RJA Section H-H'

Goda Formula Schematic – Vertical Walls

ATTACHMENT 4

Key to Wave Runup Results Tables

Section #: Geologic Section from Rogers Johnson & Associates 14 May 2009 Site Geologic Map

Elevation of Scour Platform at Structure Toe: Elevation of winter scour platform at toe of shoreline protection structure or barrier in feet NGVD29. Winter scour platform at the project site is either sandstone bedrock or lagoon deposits atop deep bedrock.

Nearshore Scour Platform Gradient: The winter scour platform gradient or slope (H:V) seaward of the shoreline protection toe or slope. The nearshore scour platform gradient is a parameter utilized to determine the Breaker Depth Index.

Breaker Depth Index: The ratio between the breaking wave or incident wave height (H_b) and the depth at breaking (D_b) based on the CEM-PE Figure II-4-2.

Breaker Depth: The vertical water column height between the Stillwater Level (SWL) and the winter scour platform feet at which the wave breaks or plunges.

Breaking Wave Height: The height of the breaking wave with 78% of the wave height above the Stillwater Level measured in feet.

Structure Slope & Top Elevation: Shoreline structure or barrier slope gradient (H:V) and the elevation of the top of the shoreline structure or barrier in feet NGVD29.

Potential Runup along Imaginary Slope Extension: The imaginary extension of the shoreline protection structure or barrier slope which allows the computation of the hypothetical or potential runup above the structure or barrier measure in feet. This runup is above the SWL. See Figure D.2.8-10 in the FEMA February 2007 Guidelines and Specifications for Flood Hazard Mapping Partners.

Adjusted Runup Elevation: FEMA caps the Base Flood Elevation at 3 feet above the crest of the overtopped shoreline protection structure or barrier (maximum ground elevation) in feet NGVD29.

Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope: Using Figure D.2.8-11 in the FEMA February 2007 Guidelines and Specifications for Flood Hazard Mapping Partners, the inland limit of wave runup above the top of the shoreline barrier along a positive gradient slope measured in feet can be estimated.

RJA Section: A-A' – short vertical or stepped wall above 5:1 (H:V) slope - D_b at 0 ft NGVD29
Bearing: 191°
Location: 6th Avenue

Wave Runup Analysis at Stillwater Level = 7.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
A-A'	11 ft	20:1	1.1	7.3 ft	8.0 ft	5:1 16 ft	17.3 ft	19 ft	140 ft

Wave Runup Analysis at Stillwater Level = 9.0 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
A-A'	11 ft	20:1	1.1	9.0 ft	9.9 ft	5:1 18 ft	21.6 ft	19 ft	Beyond chart limits

ATTACHMENT 4

RJA Section: A-A' – short vertical or stepped wall above 5:1(H:V) slope - D_b at 0 ft NGVD29
Bearing: 191°
Location: 6th Avenue

Wave Runup Analysis at Stillwater Level = 10.6 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
A-A'	11 ft	20:1	1.1	10.6 ft	11.7 ft	5:1 16 ft	25.9 ft	19 ft	Beyond chart limits

Wave Runup Analysis at Stillwater Level = 12.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
A-A'	11 ft	20:1	1.1	12.3 ft	13.5 ft	5:1 16 ft	29.1ft	19 ft	Beyond chart limits

ATTACHMENT 4

Equations VI-5-3 to 5-19
Wave Runup and Rundown

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Wave Period (T)	16	sec
Slope cot(α)	5	
γ_R	0.9	
γ_B	1	
γ_H	0.8	
γ_β	1	
A	0	
C	3	

H_s (ft)	uop	ξ_{op}	Runup (ft)
7	0.00534025	2.73684	15.12
8	0.00610314	2.56008	17.28
9	0.00686603	2.41367	19.44
10	0.00762892	2.2898	21.6
11	0.00839181	2.18324	23.76
12	0.00915471	2.0903	25.92
13	0.0099176	2.00829	28.08
14	0.0106805	1.93524	30.24

Input Parameter	Value	Units
Wave angle of incidence	0	deg
γ_β	1	

A-A'

ATTACHMENT 4

RJA Section: B-B' – Vertical Wall
Bearing: 188°
Location: APN 27-182-06/APN 27-182-05

Wave Runup Analysis at Stillwater Level = 7.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
B-B'	-1 ft	50:1	0.95	9.3	8.8	Vertical 20 ft	13.2 ft	20.5 ft	NA – vertical walls

Wave Runup Analysis at Stillwater Level = 9.0 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
B-B'	-1 ft	50:1	0.95	11.0	10.5	Vertical 20 ft	15.8 ft	23 ft	NA – vertical walls

ATTACHMENT 4

RJA Section: B-B'– Vertical Wall
Bearing: 188°
Location: APN 27-182-06/APN 27-182-05

Wave Runup Analysis at Stillwater Level = 10.6 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
B-B'	-1 ft	50:1	0.95	12.6	12.0	Vertical 20 ft	18.0 ft	23 ft	NA – vertical walls

Wave Runup Analysis at Stillwater Level = 12.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
B-B'	-1 ft	50:1	0.95	14.3	13.6	Vertical 20 ft	20.4 ft	23 ft	NA – vertical walls

ATTACHMENT 4

Table VI-5-53 / Equations VI-5-147 to 5-151
Goda formula for irregular waves

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Mean density of water (ρ_w)	1.98902	slugs/ft³
Angle of incidence (β)	0	deg
Significant wave height (Hs)	8.8	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	9.3	ft
Water depth to berm fronting structure (d)	8.3	ft
Height of structure above swl (h_c)	12.7	ft
Water depth at toe fronting structure (h_s)	8.3	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
H_{design}	8.8	ft
Deepwater wavelength (Lo)	1310.8	ft
Wavelength at depth h_b (L)	274.7	ft
α^*	0.0402907	
α_1	1.07665	
α_2	0.0402907	
α_3	0.982246	
η^*	13.2	ft
p_1	628.968	lbf/ft²
p_2	23.8245	lbf/ft²
p_3	617.801	lbf/ft²
p_u	595.516	lbf/ft²

SWL = 7.3' NGVD29

B-B'

ATTACHMENT 4

Table VI-5-53 / Equations VI-5-147 to 5-151 Goda formula for irregular waves		
Input Parameter	**Value**	**Units**
Gravity	32.1719	ft/sec^2
Mean density of water (ρ_w)	1.98902	slugs/ft^3
Angle of incidence (β)	0	deg
Significant wave height (Hs)	10.5	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	11	ft
Water depth to berm fronting structure (d)	10	ft
Height of structure above swl (h_c)	11	ft
Water depth at toe fronting structure (h_s)	10	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
H_{design}	10.5	ft
Deepwater wavelength (Lo)	1310.8	ft
Wavelength at depth h_b (L)	298.345	ft
α^*	0.0334091	
α_1	1.07145	
α_2	0.0334091	
α_3	0.978226	
η^*	15.75	ft
p_1	742.357	lbf/ft^2
p_2	223.885	lbf/ft^2
p_3	726.193	lbf/ft^2
p_u	704.234	lbf/ft^2

SWL = 9.0' NGVD29

B-B'

ATTACHMENT 4

Table VI-5-53 / Equations VI-5-147 to 5-151
Goda formula for irregular waves

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Mean density of water (ρ_w)	1.98902	slugs/ft³
Angle of incidence (β)	0	deg
Significant wave height (Hs)	12	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	12.6	ft
Water depth to berm fronting structure (d)	11.6	ft
Height of structure above swl (h_c)	9.4	ft
Water depth at toe fronting structure (h_s)	11.6	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
H_{design}	12	ft
Deepwater wavelength (Lo)	1310.8	ft
Wavelength at depth h_b (L)	318.893	ft
α^*	0.028311	
α_1	1.06658	
α_2	0.028311	
α_3	0.974438	
η^*	18	ft
p_1	840.755	lbf/ft²
p_2	401.694	lbf/ft²
p_3	819.263	lbf/ft²
p_u	798.079	lbf/ft²

SWL = 10.6' NAVD 29

B-B'

ATTACHMENT 4

Table VI-5-53 / Equations VI-5-147 to 5-151 Goda formula for irregular waves		
Input Parameter	**Value**	**Units**
Gravity	32.1719	ft/sec^2
Mean density of water (ρ_w)	1.98902	slugs/ft^3
Angle of incidence (β)	0	deg
Significant wave height (Hs)	13.6	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	14.3	ft
Water depth to berm fronting structure (d)	13.3	ft
Height of structure above swl (h_c)	7.7	ft
Water depth at toe fronting structure (h_s)	13.3	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
H_{design}	13.6	ft
Deepwater wavelength (Lo)	1310.8	ft
Wavelength at depth h_b (L)	339.259	ft
α^*	0.0243735	
α_1	1.06144	
α_2	0.0243735	
α_3	0.970412	
η^*	20.4	ft
p_1	944.953	lbf/ft^2
p_2	588.28	lbf/ft^2
p_3	916.994	lbf/ft^2
p_u	896.41	lbf/ft^2

SWL = 12.3 'NGVD 29

B-B'

ATTACHMENT 4

RJA Section: E-E' – Vertical Wall
Bearing: 200°
Location: 8th Avenue

Wave Runup Analysis at Stillwater Level = 7.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
E-E'	0 ft	50:1	0.95	8.3	7.9	Vertical 20 ft	11.9 ft	19.2 ft	NA – vertical walls

Wave Runup Analysis at Stillwater Level = 9.0 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
E-E'	0 ft	50:1	0.95	10.0	9.5	Vertical 20 ft	14.3 ft	23 ft	NA – vertical walls

ATTACHMENT 7

RJA Section: E-E' – Vertical Wall
Bearing: 200°
Location: 8th Avenue

Wave Runup Analysis at Stillwater Level = 10.6 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
E-E'	0 ft	50:1	0.95	11.6	11.0	Vertical 20 ft	16.5 ft	23 ft	NA – vertical walls

Wave Runup Analysis at Stillwater Level = 12.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
E-E'	0 ft	50:1	0.95	13.3	12.6	Vertical 20 ft	18.9 ft	23 ft	NA – vertical walls

ATTACHMENT 4

Table VI-5-53 / Equations VI-5-147 to 5-151
Goda formula for irregular waves

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Mean density of water (ρ_w)	1.98902	slugs/ft³
Angle of incidence (β)	0	deg
Significant wave height (Hs)	7.9	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	8.3	ft
Water depth to berm fronting structure (d)	7.3	ft
Height of structure above swl (h_c)	12.7	ft
Water depth at toe fronting structure (h_s)	7.3	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
H_{design}	7.9	ft
Deepwater wavelength (Lo)	1310.8	ft
Wavelength at depth h_b (L)	259.72	ft
α^*	0.0470337	
α_1	1.07972	
α_2	0.0470337	
α_3	0.982497	
η^*	11.85	ft
p_1	569.601	lbf/ft²
p_2	0	lbf/ft²
p_3	559.631	lbf/ft²
p_u	536.271	lbf/ft²

SWL = 7.3' NGVD29

E-E'

ATTACHMENT 4

Table VI-5-53 / Equations VI-5-147 to 5-151 Goda formula for irregular waves		
Input Parameter	**Value**	**Units**
Gravity	32.1719	ft/sec²
Mean density of water (ρ_w)	1.98902	slugs/ft³
Angle of incidence (β)	0	deg
Significant wave height (Hs)	9.5	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	10	ft
Water depth to berm fronting structure (d)	9	ft
Height of structure above swl (h_c)	11	ft
Water depth at toe fronting structure (h_s)	9	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
H_{design}	9.5	ft
Deepwater wavelength (Lo)	1310.8	ft
Wavelength at depth h_b (L)	284.69	ft
α^*	0.0371399	
α_1	1.07451	
α_2	0.0371399	
α_3	0.978435	
η^*	14.25	ft
p_1	675.781	lbf/ft²
p_2	154.126	lbf/ft²
p_3	661.208	lbf/ft²
p_u	639.117	lbf/ft²

SWL = 9.0' NGVD29

E-E'

ATTACHMENT 4

Table VI-5-53 / Equations VI-5-147 to 5-151
Goda formula for irregular waves

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Mean density of water (ρ_w)	1.98902	slugs/ft³
Angle of incidence (β)	0	deg
Significant wave height (Hs)	11	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	11.6	ft
Water depth to berm fronting structure (d)	10.6	ft
Height of structure above swl (h_c)	9.4	ft
Water depth at toe fronting structure (h_s)	10.6	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
H_{design}	11	ft
Deepwater wavelength (Lo)	1310.8	ft
Wavelength at depth h_b (L)	306.225	ft
α^*	0.0309453	
α_1	1.06962	
α_2	0.0309453	
α_3	0.974618	
η^*	16.5	ft
p_1	774.686	lbf/ft²
p_2	333.35	lbf/ft²
p_3	755.022	lbf/ft²
p_u	733.793	lbf/ft²

SWL = 10.6' NGVD29

E-E'

ATTACHMENT 4

Table VI-5-53 / Equations VI-5-147 to 5-151
Goda formula for irregular waves

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Mean density of water (ρ_w)	1.98902	slugs/ft³
Angle of incidence (β)	0	deg
Significant wave height (Hs)	12.6	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	13.3	ft
Water depth to berm fronting structure (d)	12.3	ft
Height of structure above swl (h_c)	7.7	ft
Water depth at toe fronting structure (h_s)	12.3	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
H_{design}	12.6	ft
Deepwater wavelength (Lo)	1310.8	ft
Wavelength at depth h_b (L)	327.446	ft
α^*	0.0263001	
α_1	1.06446	
α_2	0.0263001	
α_3	0.970567	
η^*	18.9	ft
p_1	879.461	lbf/ft²
p_2	521.162	lbf/ft²
p_3	853.575	lbf/ft²
p_u	832.994	lbf/ft²

SWL = 12.3' NGVD29

E-E'

ATTACHMENT 4

RJA Section: F-F' – quarrystone revetment – toe embedded into Lagoon Deposits at +4 ft NGVD29
Bearing: 201°
Location: 9th Avenue

Wave Runup Analysis at Stillwater Level = 7.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
F-F'	Lg @ +4 ft Tp @ -4 ft	50:1	0.95	4.8 ft	4.6 ft	1.5:1 19 ft	2.9 ft	10.2 ft	No overtopping

Wave Runup Analysis at Stillwater Level = 9.0 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
F-F'	Lg @ +4 ft Tp @ -4 ft	50:1	0.95	6.5 ft	6.2 ft	1.5:1 19 ft	4.6 ft	13.6 ft	No overtopping

ATTACHMENT 4

RJA Section: F-F' – quarrystone revetment – toe embedded into Lagoon Deposits at +4 ft NGVD29
Bearing: 201°
Location: 9th Avenue

Wave Runup Analysis at Stillwater Level = 10.6 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) Feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
F-F'	Lg @ +4 ft Tp @ -4 ft	50:1	0.95	8.1ft	7.7 ft	1.5:1 19ft	6.3 ft	16.9 ft	No overtopping

Wave Runup Analysis at Stillwater Level = 12.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) Feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
F-F'	Lg @ +4 ft Tp @ -4 ft	50:1	0.95	9.8 ft	9.3 ft	1.5:1 19ft	8.1ft	21ft	30 ft

ATTACHMENT 4

Equations VI-5-3 to 5-19
Wave Runup and Rundown

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Wave Period (T)	16	sec
Slope cot(α)	1.5	
γ_R	0.6	
γ_B	1	
γ_H	0.8	
γ_β	1	
A	-0.15	
C	3	

H_s (ft)	uop	ξ_{op}	Runup (ft)
4			
6			
7			
8			
9			
10			

Input Parameter	Value	Units
Wave angle of incidence	0	deg
γ_β		

Toe @ +4' NGVD29

F-F'

ATTACHMENT 4

RJA Section: F-F' – quarrystone revetment – toe embedded into Sandstone at -4 ft NGVD29
Bearing: 201°
Location: 9th Avenue

Wave Runup Analysis at Stillwater Level = 7.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
F-F'	Lg @ +4 ft Tp @ -4 ft	50:1	0.95	12.8 ft	12.2 ft	1.5:1 19 ft	11.3 ft	18.6 ft	No overtopping

Wave Runup Analysis at Stillwater Level = 9.0 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
F-F'	Lg @ +4 ft Tp @ -4 ft	50:1	0.95	14.5 ft	13.8 ft	1.5:1 19 ft	13.7 ft	22.7 ft	25 ft

EXHIBIT 4

RJA Section: F-F' – quarrystone revetment – toe embedded into Sandstone at -4 ft NGVD29
Bearing: 201°
Location: 9th Avenue

Wave Runup Analysis at Stillwater Level = 10.6 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) Feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
F-F'	Lg @ +4 ft Tp @ -4 ft	50:1	0.95	16.1ft	15.3 ft	1.5:1 19ft	15.5 ft	23 ft	105 ft

Wave Runup Analysis at Stillwater Level = 12.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) Feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup On 2% Slope feet (horizontal)
F-F'	Lg @ +4 ft Tp @ -4 ft	50:1	0.95	17.8 ft	16.9 ft	1.5:1 19ft	17.3ft	23ft	175 ft

ATTACHMENT 4

Equations VI-5-3 to 5-19
Wave Runup and Rundown

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Wave Period (T)	16	sec
Slope cot(α)	1.5	
γ_R	0.6	
γ_B	1	
γ_H	0.8	
γ_β	1	
A	-0.15	
C	3	

H_s (ft)	u_{op}	ξ_{op}	Runup (ft)

Input Parameter	Value	Units
Wave angle of incidence	0	deg

Toe @ -4' NGVD29

F-F'

ATTACHMENT 4

RJA Section: H-H' – quarrystone revetment at 1.5:1 (H:V) – top of scour platform at -5 ft NGVD29
Bearing: 218°
Location: Mouth of Schwan Lake

Wave Runup Analysis at Stillwater Level = 7.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup on 0.1% Slope feet (horizontal)
H-H'	-5 ft	100:1	0.85	13.3	11.3	1.5:1 13ft	10.2 ft	16 ft	75 ft

Wave Runup Analysis at Stillwater Level = 9.0 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup on 0.1% Slope feet (horizontal)
H-H'	-5 ft	100:1	0.85	15	12.8	1.5:1 13ft	12.2 ft	16 ft	135 ft

ATTACHMENT 4

RJA Section: H-H' – quarrystone revetment at 1.5:1 (H:V) – top of scour platform at -5 ft NGVD29
Bearing: 218°
Location: Mouth of Schwan Lake

Wave Runup Analysis at Stillwater Level = 10.6 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup on 0.1% Slope feet (horizontal)
H-H'	-5 ft	100:1	0.85	16.6 ft	14.1 ft	1.5:1 13 ft	13.7 ft	16 ft	Beyond chart limits

Wave Runup Analysis at Stillwater Level = 12.3 ft NGVD29

Section #	Elevation Of Scour Platform at Structure Toe feet NGVD29	Nearshore Scour Platform Gradient (H:V)	Breaker Depth Index	Breaker Depth D_b feet	Breaking Wave Height ($H_b = H_i$) feet	Structure Slope & Top Elevation (H:V) feet NGVD29	Potential Runup Along Imaginary Slope Extension feet (vertical)	Adjusted Runup Elevation feet NGVD29	Estimate of Landward Limit of Overtopping Wave Runup on 0.1% Slope feet (horizontal)
H-H'	-5 ft	100:1	0.85	18.8 ft	15.6 ft	1.5:1 13 ft	15.5 ft	16 ft	Beyond chart limits

EXHIBIT 4

Equations VI-5-3 to 5-19
Wave Runup and Rundown

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Wave Period (T)	16	sec
Slope cot(α)	1.5	
γ_R	0.6	
γ_B	1	
γ_H	0.8	
γ_β	1	
A	-0.15	
C	3	

H_s (ft)	uop	ξ_{op}	Runup (ft)
11	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]

Input Parameter	Value	Units
Wave angle of incidence	0	deg
γ_β	[illegible]	

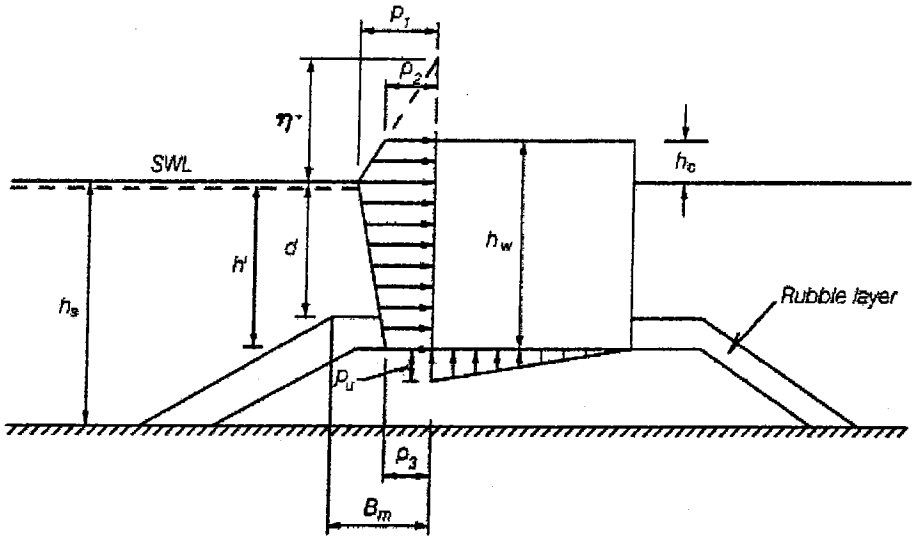
Scour 2-5 'NGUD29

H-H'

ATTACHMENT 4

Table VI-5-53

Goda Formula for Irregular Waves (Goda 1974; Tanimoto et al. 1976)



Goda Schematic Key - Vertical Walls

Project No. SC9809
5 June 2009
Revised 27 August 2009

APPENDIX C

Wave Pressure Calculations

RJA Section A-A' – Short Wall Landward of Stillwater Level

RJA Section B-B' – Vertical Wall – Toe at -1 ft NGVD29

RJA Section E-E' – Vertical Wall – Toe at -1 ft NGVD29

Goda Formula Schematic – Vertical Walls

ATTACHMENT 4

HARO, KASUNICH
& ASSOCIATES, INC.
116 East Lake Avenue
WATSONVILLE, CALIFORNIA 95076
(831) 722-4175 FAX 722-3202

JOB Twin Lakes Beachfront
SHEET NO. 1 OF 2
CALCULATED BY RP DATE 30 May 09
CHECKED BY DATE
SCALE RJA Section A-A'

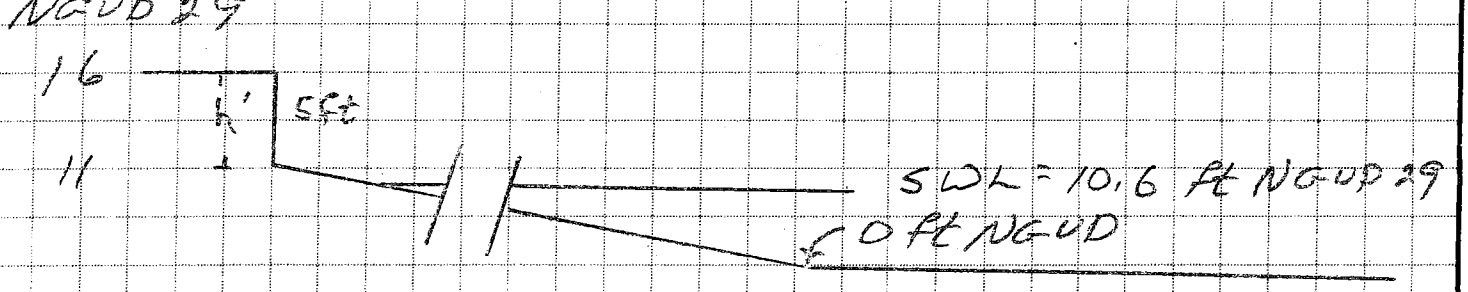
Wave Force Calcs - Dynamic Pressure

Short Vertical or stepped wall from 16 to 13 ft NAVD29 above a 5:1 (H:V) slope to 0 ft NAVD29

Structure will be landward of SWL

Design SWL = 10.6 ft NAVD H_b = 11.7 ft

Reference USACE - 1984 SPM 7.4.6



X_1 = SWL to structure = 2 ft

X_2 = SWL to inland limit of wave uprush
use $2 H_b = 23.4$ ft $\times 5 = 117$ ft

v' = velocity = $\sqrt{g D_b (1 - X_1/X_2)} = 18.1$ ft/sec

$h_c = 0.78 \cdot H_b = 9.1$ ft

$h' = h_c \cdot (1 - X_1/X_2) = 8.9$ ft - exceeds 5 ft

h_1 = wave impact zone = height of wall = 5 ft

ATTACHMENT 4

GAVILAN PRINTERS

HARO, KASUNICH
& ASSOCIATES, INC.
116 East Lake Avenue
WATSONVILLE, CALIFORNIA 95076
(831) 722-4175 FAX 722-3202

JOB Twin Lakes Beach
SHEET NO. 2 OF 2
CALCULATED BY RP DATE 30 May 09
CHECKED BY DATE
SCALE RSA Section A-A'

Dynamic Wave Pressure - to be applied to wall from 11 to 16 ft NAVD29

$$P_m = w D_b / 2 \left(1 - x_1/x_2\right)^2$$

$$\Rightarrow 64\ \#/ft^3 \cdot 10.6\ ft/2 \cdot (0.96) = 326\ psf$$

Use 330 psf acting from +11 ft NGVD to +16 ft NAVD29 for design case w/ SWL = 10.6 ft NGVD

ATTACHMENT 4

GAVILAN PRINTERS

B-B' - Wave Pressure Distribution

Table VI-5-53 / Equations VI-5-147 to 5-151 Goda formula for irregular waves		
Input Parameter	**Value**	**Units**
Gravity	32.1719	ft/sec²
Mean density of water (ρ_w)	1.98902	slugs/ft³
Angle of incidence (β)	0	deg
Significant wave height (Hs)	12	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	12.6	ft
Water depth to berm fronting structure (d)	11.6	ft
Height of structure above swl (h_c)	9.4	ft
Water depth at toe fronting structure (h_s)	11.6	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
[illegible]	[illegible]	

Wave Pressures - RJA Section B-B'
Vertical Wall w/ Standing Wave (η^*)

p_1 = wave pressure @ SWL (10.6 ft NGVD 29)
= 840 psf

pressure loss gradient above SWL
= p_1 / η^* = 47 psf/ft

pressure @ top of wall
= p_1 - [(top of wall - SWL) · 47 psf/ft)
= 400 psf @ 20 ft NGVD 29

ATTACHMENT 4

E-E' - Wave Pressure Distribution

Table VI-5-53 / Equations VI-5-147 to 5-151 Goda formula for irregular waves		
Input Parameter	**Value**	**Units**
Gravity	32.1719	ft/sec²
Mean density of water (ρ_w)	1.98902	slugs/ft³
Angle of incidence (β)	0	deg
Significant wave height (Hs)	11	ft
Water depth at $5H_s$ from breakwater front wall (h_b)	11.6	ft
Water depth to berm fronting structure (d)	10.6	ft
Height of structure above swl (h_c)	9.4	ft
Water depth at toe fronting structure (h_s)	10.6	ft
Design factor	1	
Significant wave period (Ts)	16	sec
Modification factor (λ_1)	1	
Modification factor (λ_2)	1	
Modification factor (λ_3)	1	
H_{design}	[illegible]	
Deepwater wavelength (Lo)	[illegible]	
Wavelength at depth h_s (L)	[illegible]	
π^*	[illegible]	
α_1	[illegible]	
α_2	[illegible]	
α_3	[illegible]	
η^*	[illegible]	
p_1	[illegible]	
p_2	[illegible]	
p_3	[illegible]	
p_4	[illegible]	

Wave Pressures - RJA Section E-E'
Vertical Wall w/ Standing Wave (η^*)

p_1 = Wave pressure @ SWL (10.6 ft NAVD 29)
= 775 psf

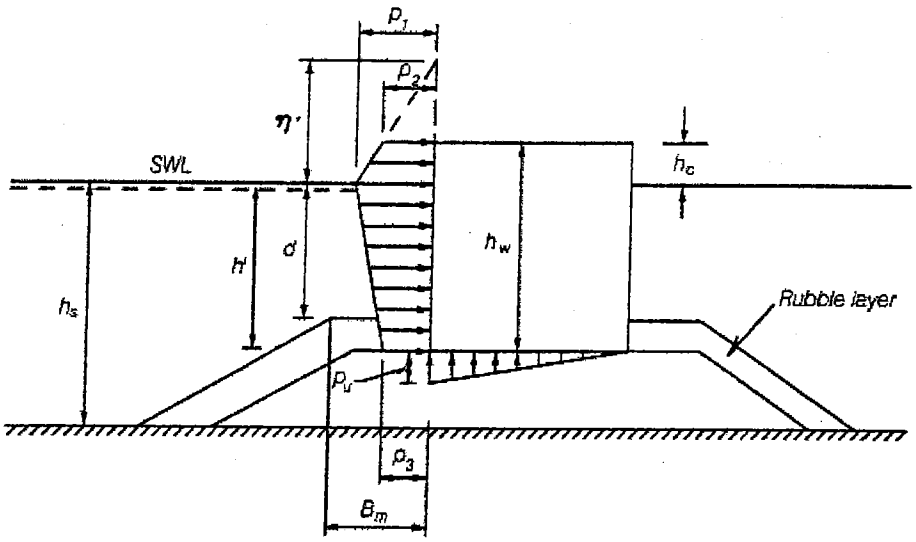
pressure loss gradient above SWL
= p_1/η^* = 47 psf/ft

pressure @ top of wall
= p_1 - [(top of wall - SWL) · 47 psf/ft]
≈ 330 psf @ 20 ft NAVD 29

ATTACHMENT 4

Table VI-5-53

Goda Formula for Irregular Waves (Goda 1974; Tanimoto et al. 1976)



Goda Schematic
Key - Vertical walls

ATTACHMENT 2

Project No. SC9809
5 June 2009
Revised 27 August 2009

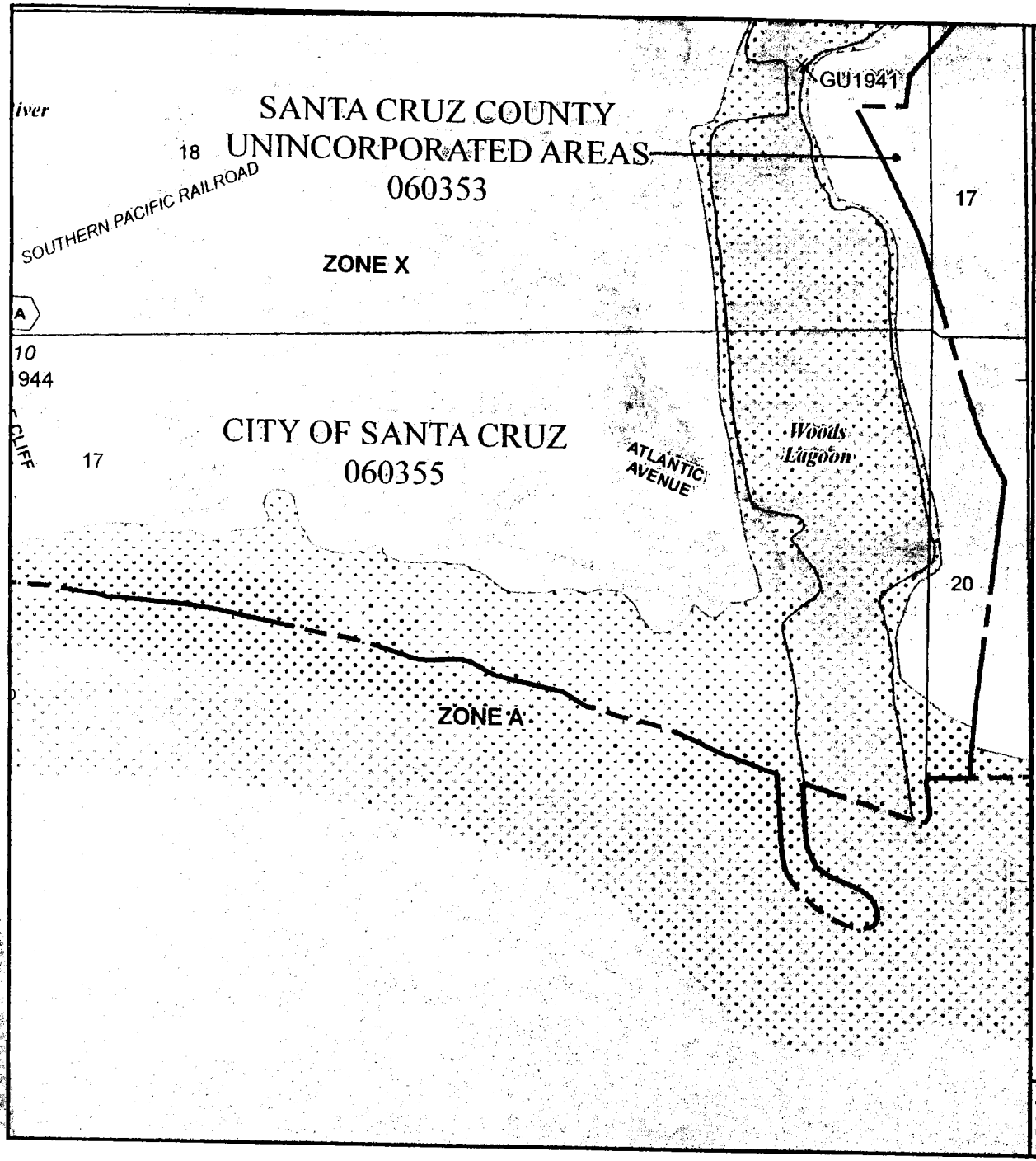
APPENDIX D

FEMA Firmettes

Map #06087C0334D

Map #06087C0353D

ATTACHMENT 4



MAP SCALE 1" = 500'

250 0 500 1000

FEET

METER

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0334D

FIRM

FLOOD INSURANCE RATE MAP

SANTA CRUZ COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 334 OF 470

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
SANTA CRUZ COUNTY	060353	0334	D
SANTA CRUZ, CITY OF	060355	0334	D

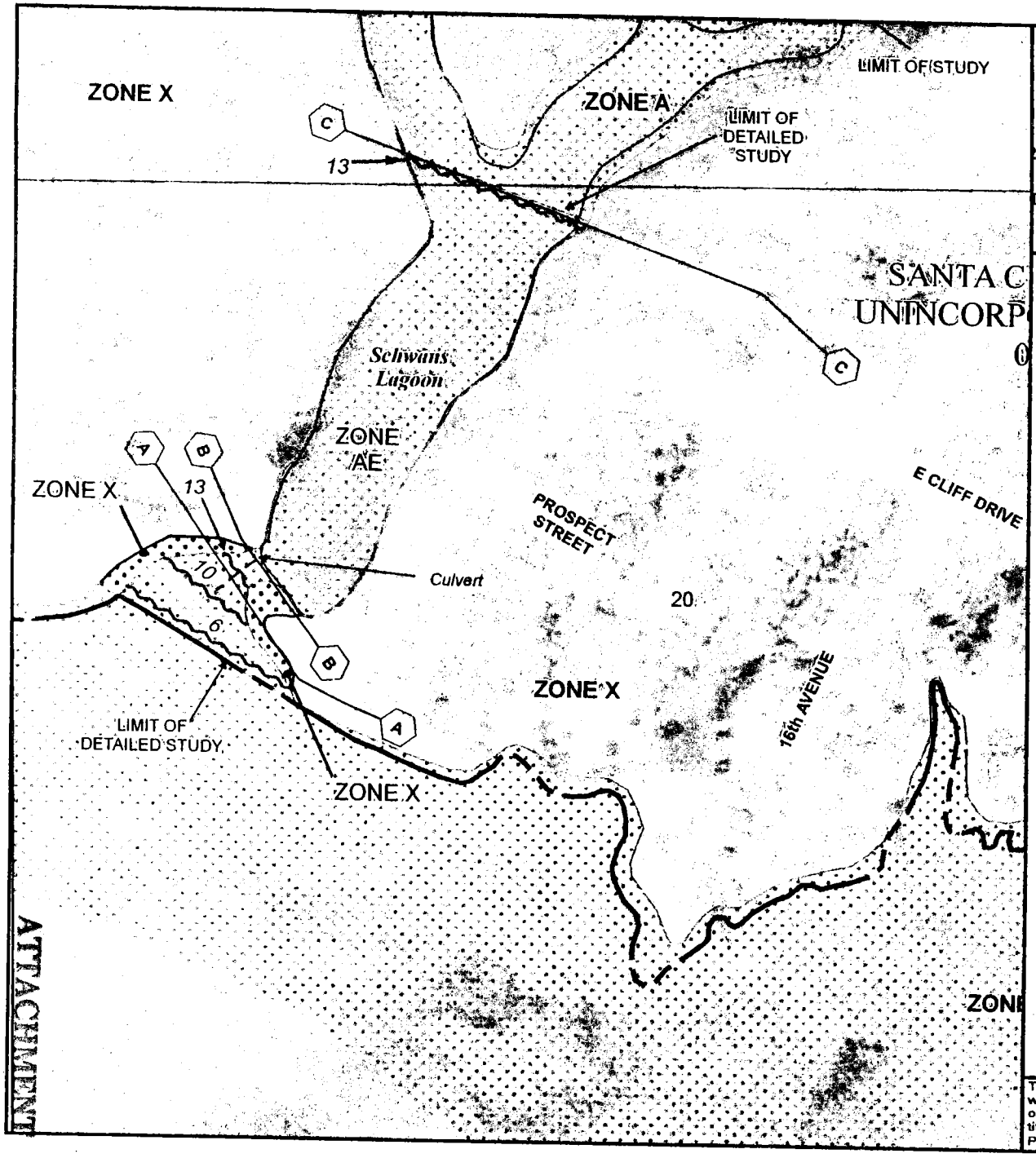
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
06087C0334D

EFFECTIVE DATE
MARCH 2, 2006

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



MAP SCALE 1" = 500'

50 0 500 1000

FEET

METER

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0353D

FIRM

FLOOD INSURANCE RATE MAP

SANTA CRUZ COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 353 OF 470

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CAPITOLA, CITY OF	060354	0353	D
SANTA CRUZ COUNTY	060353	0353	D

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
06087C0353D

EFFECTIVE DATE
MARCH 2, 2006

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

ATTACHMENT 4

Project No. SC9809
5 June 2009
Revised 27 August 2009

APPENDIX E

Liquefaction Analyses

Twin Lakes Beachfront Project:

CGS – Ground Motion Page

CPT-1 Liquefaction Analysis - 2009

CPT-2 Liquefaction Analysis - 2009

O'Neill Yacht Building – 2222 East Cliff Drive:

Boring Site Plan

Boring Log B-3

B-3 Liquefaction Analysis - 2003

ATTACHMENT 4

Department of Conservation
California Geological Survey
Probablistic Seismic Hazards Assessment Page
Earthquakes (Recent & Historic)
California Fault Database
Loss Estimation
Aquist-Priolo Earthquake Fault Zoning Act
Seismic Shaking Hazard Maps of California
CGS Links
bout Us
ntact Us
bs
te Map
lp/FAQ

Probabilistic Seismic Hazards Mapping Ground Motion Page

User Selected Site

Longitude	-121.9971
Latitude	36.9619

Ground Motions for User Selected Site

Ground motions (10% probability of being exceeded in 50 years) ar expressed as a fraction of the acceleration due to gravity (g). Three values of ground motion are shown, peak ground acceleration (Pga) spectral acceleration(Sa) at short (0.2 second) and moderately long (1.0 second) periods. Ground motion values are also modified by th local site soil conditions. Each ground motion value is shown for 3 different site conditions: firm rock (conditions on the boundary between site categories B and C as defined by the building code), soft rock (site category C) and alluvium (site category D).

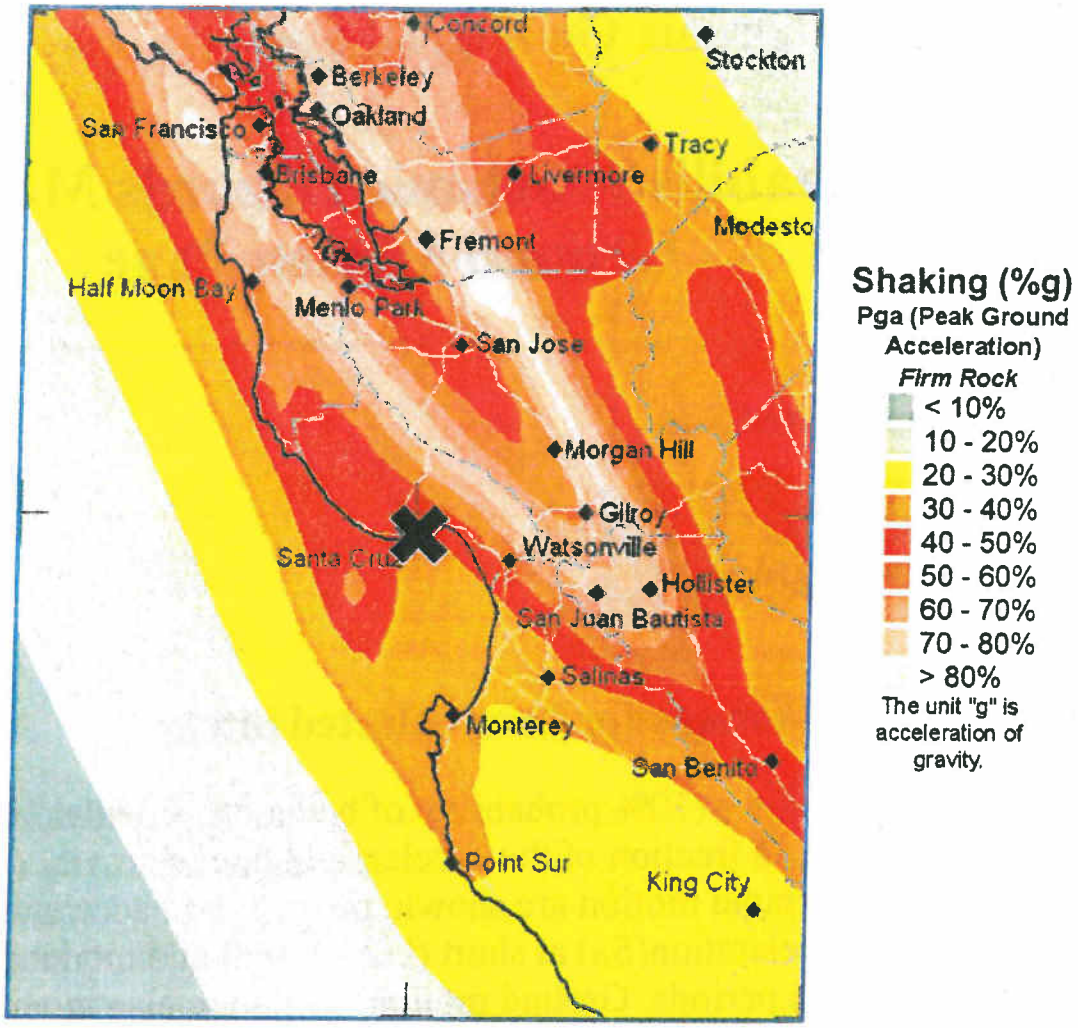
Ground Motion	Firm Rock	Soft Rock	Alluvium
Pga	0.409	0.409	0.446
Sa 0.2 sec	0.955	0.967	1.061
Sa 1.0 sec	0.405	0.494	0.583

NEHRP Soil Corrections were used to calculate Soft Rock and Alluvium.

Ground Motion values were interpolated from a grid (0.05 degree spacing)

ATTACHMENT 4

of calculated values. Interpolated ground motion may not equal values
calculated for a specific site, therefore these values are not intende for
design or analysis.



Click here to return to the statewide PSHA map or enter new coordinates below:

Longitude: _____ Latitude: _____ Submit

Please enter coordinates as Decimal Degrees
Example: Longitude -122.0017 Latitude 36.9894

Back to Top of Page

Last edited on June 12, 2008

Contact: webmaster@consrv.ca.gov | Copyright © California Department of Conservation, 2007. All rights reserved.

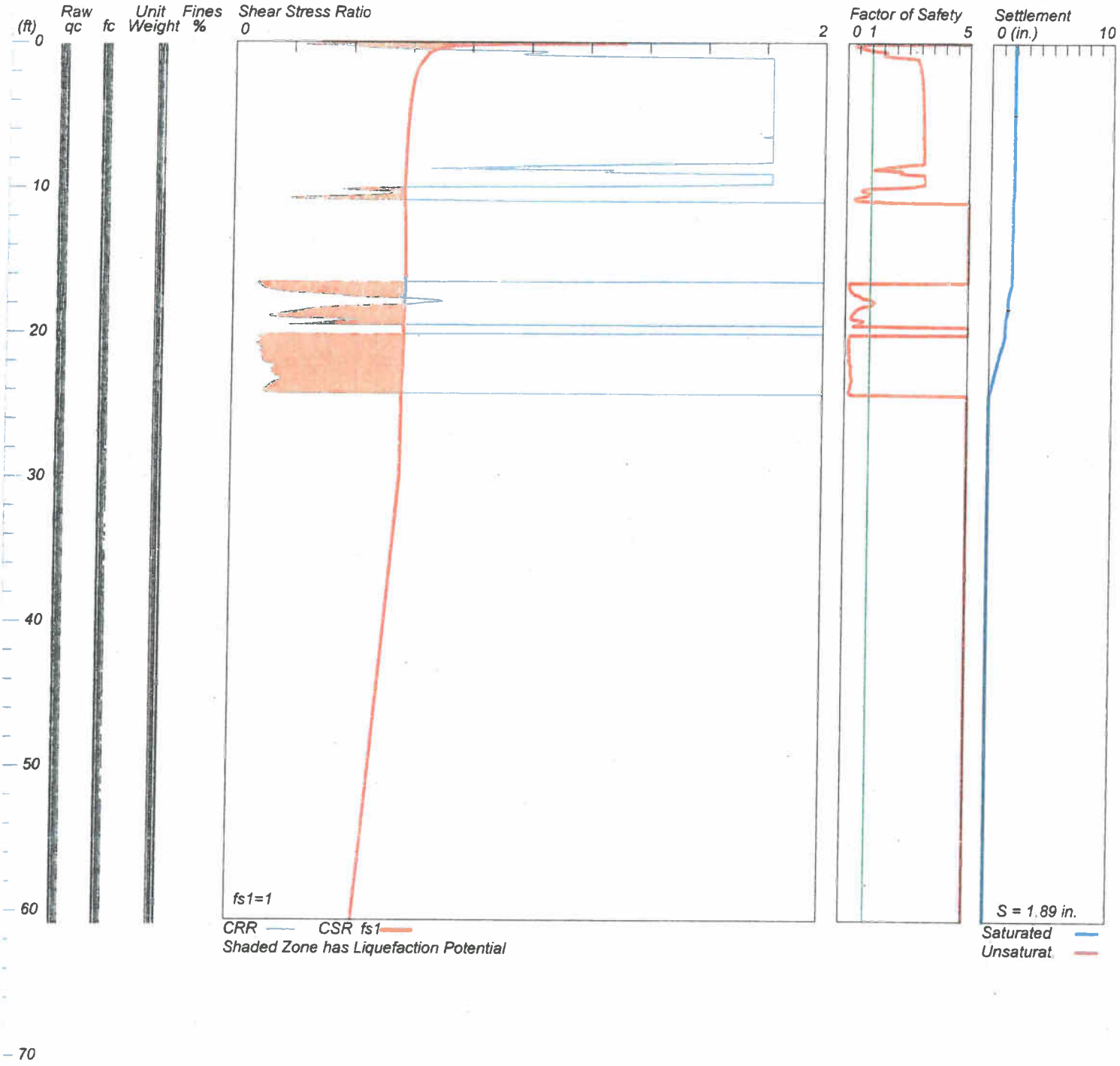
ATTACHMENT 4

LIQUEFACTION ANALYSIS

Twin Lakes Beachfront

Hole No.=CPT-1 Water Depth=0 ft

Magnitude=7.9
Acceleration=0.446g



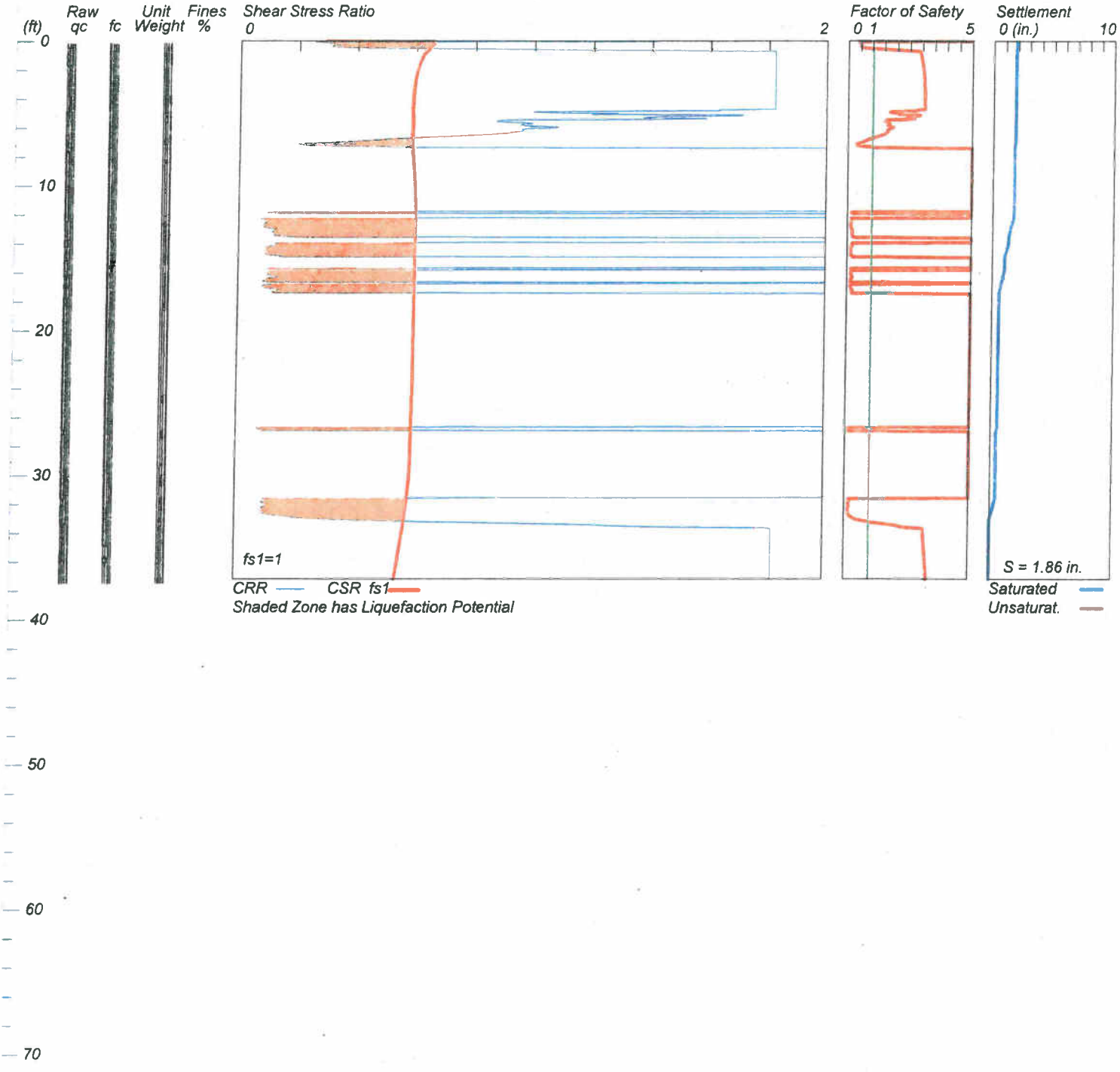
ATTACHMENT 4

LIQUEFACTION ANALYSIS

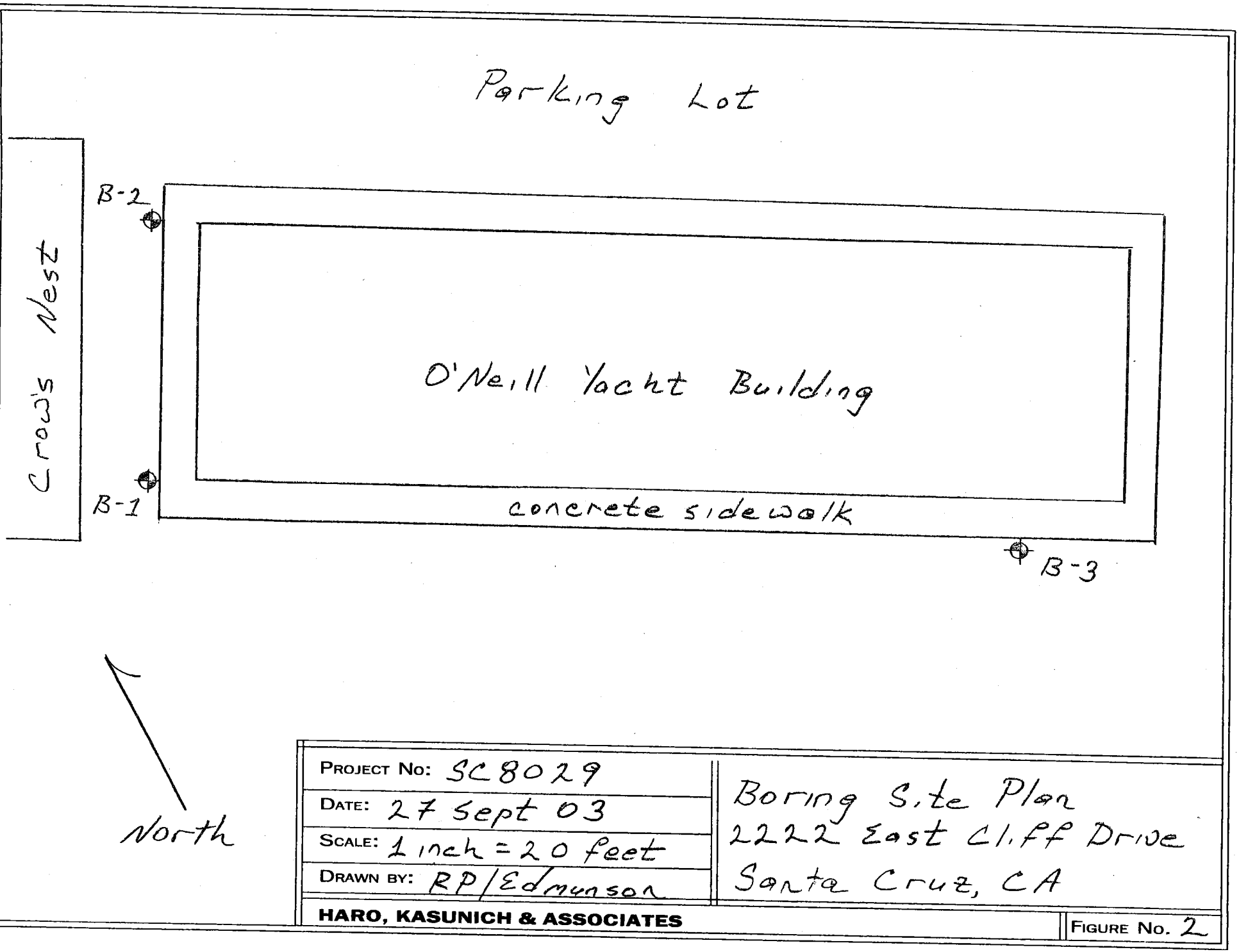
Twin Lakes Beachfront

Hole No.=CPT-2 Water Depth=0 ft

Magnitude=7.9
Acceleration=0.446g



ATTACHMENT 4



PROJECT NO: SC8029	Boring Site Plan
DATE: 27 Sept 03	2222 East Cliff Drive
SCALE: 1 inch = 20 feet	Santa Cruz, CA
DRAWN BY: RP/Edmunson	
HARO, KASUNICH & ASSOCIATES	FIGURE NO. 2

ATTACHMENT 4
61

PROJECT NO. SC8029

LOGGED BY RLP/MW DATE DRILLED September 18, 2002 BORING DIAMETER 4 7/8" BORING NO. 3

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t. s. f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
			SE Corner, adjacent shower						
1			Hand auger, casing set						
2									
3									
4									
5			Beach sand						
6									
7									
8									
9									
10	3 - 1 T		Brown medium to coarse grain SAND, wet, medium dense		28				%Passing #200Sieve = 5.9%
11									
12									
13									
14									
15	3 - 2 T		Gray medium grain SAND, wet, medium dense		25				%Passing #200Sieve = 4.2%
16									
17									
18			Transition to finer grain soil.						
19									
20	3 - 3 T		Dark gray Silty Fine SAND, wet, medium dense		15				%Passing #200Sieve = 15.8%
21									
22									
23									
24									

BY Haro, Kasunich and Associates, Inc. | FIGURE NO. 12 LOG OF TEST BORING ATTACHMENT 4

PROJECT NO. SC8029

LOGGED BY RLP/MW DATE DRILLED September 18, 2002 BORING DIAMETER 4 7/8" BORING NO. 3

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t. s. f. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
26	3 - 4 T		Gray Silty SAND, wet, medium dense		14				%Passing #200Sieve = 18.4%
27									
28			Drilling suspended for Thursday						
29			Drilling resumed on Friday						
30	3 - 5 T		Gray Silty CLAY, wet, very soft		0			35.1	%Passing #200Sieve = 94%
31									
32									
33									
34									
35									
36									
37									
38									
39			Driller - Shell layer @ 38 1/2 ft						
40	3 - 6 T		Gray Silt, wet, very soft		0			32.8	
41									
42									
43									
44									
45									
46									
47									
48									
49									

BY: Haro, Kasunich and Associates, Inc. | FIGURE NO. 4 LOG OF TEST BORING

ATTACHMENT 4

Bore Log File
page 11

PROJECT NO. SC8029

LOGGED BY RLP/MW DATE DRILLED September 18, 2002 BORING DIAMETER 4 7/8" BORING NO. 3

Depth, ft.	Sample No. and type	Symbol	SOIL DESCRIPTION	Unified Soil Classification	Blows/foot 350 ft - lbs.	Qu - t. s. t. Penetrometer	Dry Density p.c.f.	Moisture % dry wt.	MISC. LAB RESULTS
51			Grey Clayey SILT, very soft						
52	3 - 7 T		Grey Silt, stiffer material but sampler was "stuffed" so blowcounts are ambiguous		0/12"			29.1	Atterberg Limits LL = 22.4% PI = 2.1% PL = 20.3%
53									
54									
55									
56									
57									
58									
59			Driller - no increase in drilling resistance to 60 ft.						
60	3 - 8								
61	T		Grey fine grain SANDSTONE, dense		37			29.1	Atterberg Limits LL = 22.4% PI = 2.1% PL = 20.3%
62									
63			Drill cuttings - cemented SANDSTONE/SILTSTONE						
64									
65	3T 9				56/12"				%Passing #200Sieve = 20.1%
66			BORING TERMINATED AT 65.5 ft.						
67									
68									
69									
70									
71									
72									
73									
74									

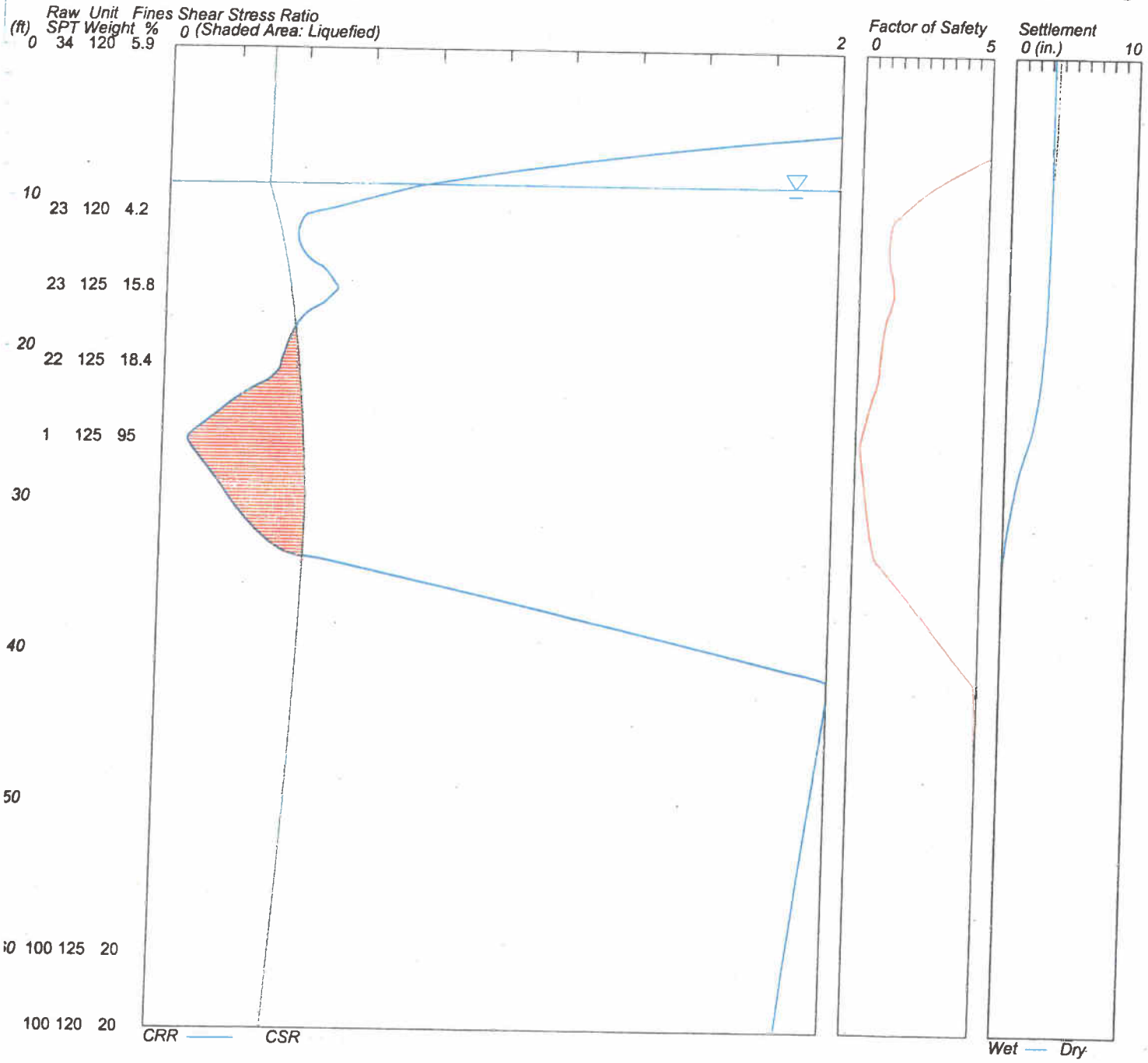
BY: Haro, Kasunich and Associates, Inc.

FIGURE NO. 15 LOG OF TEST BORING

Liquefaction Report
O'Neill Building Downcoast End

Hole No.=B-3 Water Depth=9 ft

Magnitude=7.9
Acceleration=0.4g



Project No. SC9809
5 June 2009
Revised 27 August 2009

APPENDIX F

Quarrystone Sizing Analyses

1.5:1 (H:V) Revetment Slope- Rock Sizes

2:1 (H:V) Revetment Slope- Rock Sizes

1.5:1 (H:V) Revetment Slope- Generalized Wave Runup

2:1 (H:V) Revetment Slope- Generalized Wave Runup

Table VI-5-22/Equation VI-5-67
Hudson stability formula
for 2-layer rock slopes

Gravity	32.1719	ft/sec²
Mass density of rock	5.27	slugs/ft³
Mass density of water	1.98901	slugs/ft³
K_D	2	
[illegible]	[illegible]	ft
Slope (cot[α])	1.5	

H_s (ft)	D_{n50} (ft)	M_{50} (slugs)	W_{50} (tons)	Stability Number (N_s)
[illegible]				

1.5:1 (H:V)

Table VI-5-22/Equation VI-5-67
Hudson stability formula
for 2-layer rock slopes

Gravity	32.1719	ft/sec²
Mass density of rock	5.27	slugs/ft³
Mass density of water	1.98901	slugs/ft³
K_D	2	
Δ	[illegible]	
Slope (cot[α])	1.5	

H_s (ft)	D_{n50} (ft)	M_{50} (slugs)	W_{50} (tons)	Stability Number (N_s)
[illegible]				

1.5:1 (H:V)

Table VI-5-22/Equation VI-5-67
Hudson stability formula
for 2-layer rock slopes

Gravity	32.1719	ft/sec²
Mass density of rock	5.27	slugs/ft³
Mass density of water	1.98901	slugs/ft³
K_D	2	
Δ	1.649561	
Slope (cot[α])	2	

H_s (ft)	D_{n50} (ft)	M_{50} (slugs)	W_{50} (tons)	Stability Number (N_s)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

2:1 (H:V)

Table VI-5-22/Equation VI-5-67
Hudson stability formula
for 2-layer rock slopes

Gravity	32.1719	ft/sec²
Mass density of rock	5.27	slugs/ft³
Mass density of water	1.98901	slugs/ft³
K_D	2	
Δ	1.64956	ft
Slope (cot[α])	2	

H_s (ft)	D_{n50} (ft)	M_{50} (slugs)	W_{50} (tons)	Stability Number (N_s)
10	3.81896	293.526	4.72165	1.5374
11	4.20086	390.683	6.28461	1.5374
12	4.58276	507.213	8.15901	1.5374
13	4.96465	644.377	10.3735	1.5374
14	5.54655	805.496	12.9551	1.5374
15	5.72845	990.651	15.9355	1.5374
16	6.11034	1202.28	19.3[illegible]	1.5374
17	6.49224	1442.09	23.1975	1.5374

2:1 (H:V)

ATTACHMENT 4

Equations VI-5-3 to 5-19
Wave Runup and Rundown

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Wave Period (T)	16	sec
Slope cot(α)	1.5	
γ_R	0.6	
γ_B	1	
γ_H	0.8	
γ_β	1	
A	-0.15	
C	3	

H_s (ft)	u_{op}	ξ_{op}	Runup (ft)
5	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]

Input Parameter	Value	Units
Wave angle of incidence	0	deg
γ_β	[illegible]	

1.5:1 (H:V)

Equations VI-5-3 to 5-19
Wave Runup and Rundown

Input Parameter	Value	Units
Gravity	32.1719	ft/sec²
Wave Period (T)	16	sec
Slope cot(α)	2	
γ_R	0.6	
γ_B	1	
γ_H	0.8	
γ_β	1	
A	-0.15	
C	3	

H_s (ft)	uop	ξ_{op}	Runup (ft)
5	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]

Input Parameter	Value	Units
Wave angle of incidence	0	deg
γ_β	[illegible]	

2:1 (H:V)

ATTACHMENT 4

COUNTY OF SANTA CRUZ

PLANNING DEPARTMENT
701 OCEAN STREET, 4TH FLOOR, SANTA CRUZ, CA 95060
(831) 454-2580 FAX: (831) 454-2131 TDD: (831) 454-2123
KATHLEEN MOLLOY PREVISICH, PLANNING DIRECTOR

October 17, 2011

Sheryl Bailey
Parks Division of the Department of Public Works
Simpkins Swim Center
C/O Department of Public Works
701 Ocean Street, 4th Floor
Santa Cruz, 95060

Subject: Review of Halcrow Sea Wall Design Report dated August 1, 2011,

And,

Engineering Geology Report by Rogers E. Johnson and Associates dated June 4, 2009, Job Number C09001-54;

And,

Geotechnical Engineering Report by Haro, Kasunich, and Associates, dated June 4, 2011, Project Number SC9809.

APN** (no specific APN), **Application #: REV111054

Dear Sheryl Bailey:

The purpose of this letter is to inform you that the Planning Department has accepted the subject report for the portion of the reports content that deals with the improvements proposed between 5th and 7th avenue. The following items shall be required:

1. All construction shall comply with the recommendations of the reports.

2. Final plans shall reference the reports and include a statement that the project shall conform to the reports' recommendations.

3. The project must comply with FEMA regulations.

4. After plans are prepared that are acceptable to all reviewing agencies (and prior to completeness), please submit plan review letters from the Halcrow; Haro, Kasunich and Associates; and Rogers E. Johnson and Associates to the County Planning Department. The review letters must states the project plans conform to the recommendations of the respective reports, and shall be written by the authors of the reports. They must also conclude that the proposed improvements will not adversely affect the residential structures between 5th and 7th.

(over)

ATTACHMENT

5. Please submit an electronic copy of the soils report in .pdf format via compact disk or email to: pln829@co.santa-cruz.ca.us. Please note that the reports must be generated and/or sent directly from the consultants of record.

After building permit issuance the soils engineer *must remain involved with the project* during construction. Please review the *Notice to Permits Holders* (attached).

Please note: *Please note the Halcrow work has not address compliance with FEMA regulations and some grading issues. Please see the August 31, 2011 comments from A. Gentile Discretionary completeness comments 111134 for the FEMA items that must be still be addressed.*

Please note that this determination may be appealed within 14 calendar days of the date of service. Additional information regarding the appeals process may be found online at: http://www.sccoplanning.com/html/devrev/plnappeal_bldg.htm

Please call the undersigned at (831) 454-3175 if we can be of any further assistance.

Sincerely,

Joe Hanna CEG 1313
County Geologist

Cc: Antonella Gentile, Planning
Sheila McDaniel, Planning
consultants

ATTACHMENT 5

NOTICE TO PERMIT HOLDERS WHEN A SOILS REPORT HAS BEEN PREPARED, REVIEWED AND ACCEPTED FOR THE PROJECT

After issuance of the building permit, the County requires that your Coastal Engineer, Geotechnical Engineer, and Engineering Geologist to remain involved during construction. Several letters or reports are required to be submitted to the County at various times during construction. They are as follows:

1. **When a project has engineered fills and / or grading**, a letter from your soils engineer must be submitted to the Environmental Planning section of the Planning Department prior to foundations being excavated. This letter must state that the grading has been completed in conformance with the recommendations of the soils report. Compaction reports or a summary thereof must be submitted.

2. **Prior to placing concrete for foundations**, letters from the soils engineer and engineering geologist must be submitted to the Planning Department stating that the consultants have observed the excavation, and conclude that that excavations meet the recommendations of the reports.

3. **At the completion of construction,** final letters from your Coastal Engineer, Geotechnical Engineer, and Engineering Geologist are required to be submitted to the Planning Department that summarize the observations and the tests completed by your consultants. The final letter must also state the following: "Based upon our observations and tests, the project has been completed in conformance with our report's recommendations."

   If the *letters* identify any items of work remaining to be completed or that any portions of the project were not observed by the consultants, you must complete the remaining items of work.

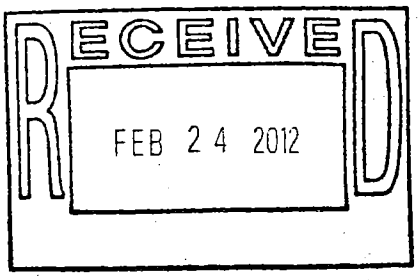
(over)

HARO, KASUNICH AND ASSOCIATES, INC.

CONSULTING GEOTECHNICAL & COASTAL ENGINEERS

Project No. SC10287
23 February 2012

RRM DESIGN GROUP
3765 S. Higuera Street, Suite 102
San Luis Obispo, California 93401



Attention: Mike Sherrod, ASLA

Subject: Geotechnical Review of Conceptual Project Plans

Reference: Twin Lakes Beachfront Project
5th to 7th Avenue
Santa Cruz County, California

Dear Mr. Sherrod:

This letter outlines our review of the geotechnical aspects of the conceptual project plans for the proposed Public Right-of-Way and Road Improvements for East Cliff Drive at Twin Lakes Beachfront from 5th to 7th Avenue in Santa Cruz County, California. The project plan set was prepared by the RRM Design Group.

We previously prepared the 6 December 1995 Geotechnical and Coastal Engineering Investigation - East Cliff Drive Improvements – Santa Cruz Harbor to Schwan Lake and the Update Geotechnical and Coastal Engineering Investigation - Santa Cruz Harbor to Schwan Lake for the project dated 27 August 2009.

It is our understanding that a new coastal engineering study and investigation has been completed for the project by Halcrow, Inc. dated August 2011. We also understand the new coastal engineering study has been reviewed and accepted by the appropriate regulatory agencies for project design. As such, we have been asked to serve only as the geotechnical engineers of record for the project and not address coastal engineering components such as sea level rise, Stillwater Level elevations, wave runup, overtopping, and wave impact force analyses.

The proposed project will enhance public access to the project site area by widening East Cliff Drive from the 5th Avenue roundabout to the 7th Avenue intersection. Additional parking will provided on the both the landward and seaward sides of the proposed new alignment of East Cliff Drive. A combined pedestrian/bicycle path is planned along the seaward perimeter of the new roadway alignment. The outboard portion of the new roadway/parking alignment and the universal access pathway will be supported by an engineered fill slope and protected from wave action by a seawall.

The conceptual project plan set was prepared by the RRM Design Group and is dated 10 February 2012. Specifically we reviewed the following plan sheets:

a. Sheet 1.1 – Title Sheet;
b. Sheet 1.2 – Existing Conditions;
c. Sheet 2.1 – Illustrative Plan;
d. Sheet 3.1 – Site Plan;
e. Sheet 4.1 – Accessibility Plan;
f. Sheet 5.1 – Grading Plan;
g. Sheet 6.1 – Erosion Control Plan;
h. Sheet 7.1 – Landscape Plan;
i. Sheet 8.1 – Site Sections dated; and
j. Sheet 8.2 – Site Sections.

The project alignment from the 5th Avenue roundabout to 6th Avenue is underlain by beach sand, lagoon deposits and from a construction perspective, deep bedrock.

From 6th Avenue to 7th Avenue, shallow sandstone bedrock is available to support the seaward perimeter of the proposed project improvements.

The 7th Avenue curve area has been designated as an area of low wave erosion potential and no seawall is proposed for this section.

A composite seawall system is proposed to protect the project alignment from wave action and to buttress the fill slope needed to accommodate the proposed improvements. The proposed seawall consists of a reinforced, engineered fill slope tied to a structural shotcrete face. The reinforced or mechanically stabilized fill slope will be constructed by placing wire or plastic mesh between layers of engineered fill. Soil reinforcement facilitates placement of engineered fill at finish slope gradients much steeper than the 2:1 (Horizontal to Vertical) slope maximum currently allowed by building codes. Beach sand is proposed as an economic fill material that allows compaction over a range of moisture conditions. The reinforced mass of soil performs as a gravity type retaining wall where the weight of the reinforced section overcomes sliding and overturning.

The reinforced sand fill, composite seawall system must be vertically supported throughout the design life of the project. The project plans show the composite seawall being supported by either a deep piles/piers or by placement upon cut sandstone bedrock.

The conceptual project plan set was prepared by the RRM Design Group and is dated 10 February 2012. Specifically we reviewed the following plan sheets:

a. Sheet 1.1 – Title Sheet;
b. Sheet 1.2 – Existing Conditions;
c. Sheet 2.1 – Illustrative Plan;
d. Sheet 3.1 – Site Plan;
e. Sheet 4.1 – Accessibility Plan;
f. Sheet 5.1 – Grading Plan;
g. Sheet 6.1 – Erosion Control Plan;
h. Sheet 7.1 – Landscape Plan;
i. Sheet 8.1 – Site Sections dated; and
j. Sheet 8.2 – Site Sections.

The project alignment from the 5th Avenue roundabout to 6th Avenue is underlain by beach sand, lagoon deposits and from a construction perspective, deep bedrock.

From 6th Avenue to 7th Avenue, shallow sandstone bedrock is available to support the seaward perimeter of the proposed project improvements.

The 7th Avenue curve area has been designated as an area of low wave erosion potential and no seawall is proposed for this section.

A composite seawall system is proposed to protect the project alignment from wave action and to buttress the fill slope needed to accommodate the proposed improvements. The proposed seawall consists of a reinforced, engineered fill slope tied to a structural shotcrete face. The reinforced or mechanically stabilized fill slope will be constructed by placing wire or plastic mesh between layers of engineered fill. Soil reinforcement facilitates placement of engineered fill at finish slope gradients much steeper than the 2:1 (Horizontal to Vertical) slope maximum currently allowed by building codes. Beach sand is proposed as an economic fill material that allows compaction over a range of moisture conditions. The reinforced mass of soil performs as a gravity type retaining wall where the weight of the reinforced section overcomes sliding and overturning.

The reinforced sand fill, composite seawall system must be vertically supported throughout the design life of the project. The project plans show the composite seawall being supported by either a deep piles/piers or by placement upon cut sandstone bedrock.

The project plans show deep piers or piles being used to support the composite seawall from 5th to 6th Avenue. During the final design of the project, we recommend additional subsurface exploration be conducted along the seawall alignment of the project from 5th to 6th Avenue to determine depths to bedrock for project structural engineering design and construction planning. The final project design for the 5th to 6th Avenue alignment section should support of the entire composite seawall system, including the reinforced sand backfill, in order to mitigate the predicted seismic settlement of about 3 inches. Deep foundation support will also mitigate potential consolidation of the underlying lagoon deposits, soft silts and clays.

As shown on the conceptual project plans, the composite seawall will be placed upon cut sandstone bedrock from 6th Avenue to the 7th Avenue curve. Liquefaction is not a concern along this section of the alignment. The structural shotcrete seawall face is shown to be embedded into the bedrock platform or below design scour elevations. Minimum embedment depth into bedrock should be provided by the project engineering geologists, Rogers E. Johnson & Associates. Embedment depths into the undulating bedrock platform should also be dependent upon the configuration of the bedrock platform seaward of the footing excavations.

At the 7th Avenue curve area, an engineered fill slope is proposed to support the outboard perimeter of the proposed improvements. Final design drawings should show the engineered fill placed upon level benches with a keyway at the toe of the fill slope.

The retaining wall/seawall system should be designed for active earth pressures, seismic surcharge and traffic surcharge. Portions of the seawall that cannot be drained during design storm conditions should be designed for submerged earth pressures and hydrostatic head.

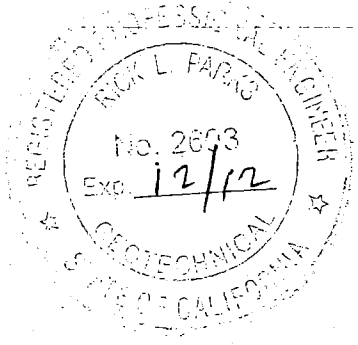
The structural integrity of the proposed composite seawall is dependent upon continued vertical support and the compacted sand backfill staying intact. The wall ends and any access openings should be protected from outflanking and wave erosion. The sand backfill should be protected from both terrestrial drainage and wave overtopping. Water flowing through or adjacent the relatively fine grained, fill material can induce internal erosion or piping. Overtime soil piping would result in the loss of sand backfill and the development of a sinkhole at the surface. The reinforced soil backfill and the wall face will need to be drained unless the composite seawall system is to be designed for undrained conditions (full hydrostatic head and submerged earth active pressure). The street drain/storm drain system and any internal drains such as the reinforced sand backfill drain, or a drain between the reinforced slope face and inside of the concrete wall face must all be designed in a manner not to induce piping.

The geotechnical aspects of the outlined conceptual project plan set have been prepared in general conformance with our recommendations. We will work with the project team to incorporate our geotechnical recommendations into the project design drawings.

Haro Kasunich & Associates has reviewed only the geotechnical aspects of these plans. We are not the Civil or Structural Engineers of Record for this project. We provide no warranties, either expressed or implied, concerning the dimensions or accuracy of the plans and analysis.

If you have any questions concerning this letter or the geotechnical aspects of the project, please call our office.

Respectfully submitted,



HARO, KASUNICH & ASSOCIATES, INC.

Rick L. Parks, GE 2603
Senior Geotechnical Engineer

RLP/dk

Copies: 4 to Addressee
1 to Rogers Johnson and Associates
Attention: Greg Easton, CEG

ROGERS E. JOHNSON AND ASSOCIATES
Consulting Engineering Geologists

41 Hangar Way, Suite B
Watsonville, California 95076-2458
e-mail: greg_easton@sbcglobal.net
Ofc (831) 728-7200 • Fax (831) 728-7218

21 February 2012

Sheryl Bailey, Project Manager
County of Santa Cruz Department of Public Works
701 Ocean Street, Room 410
Santa Cruz, CA 95060

Job No. C09001-54

Re: Revised Preliminary Plan Review
Twin Lakes Beachfront
East Cliff Drive between 5th and 7th Avenues
Santa Cruz, California

Dear Ms. Bailey:

As requested and as required by the Santa Cruz County Planning Department, we have reviewed plans pertaining to the proposed improvements of the Twin Lakes beachfront between 5th and 7th Avenues in Santa Cruz, California. The preliminary plans were prepared by RRM, the project civil and landscape engineers (RRM, 2012). We performed a geologic investigation of the subject area in 1995, with an update report completed in 2009 (REJA, 1995; 2009).

The plans depict the currently proposed improvements extending seaward beyond the present edge of bluff. The improvements will be protected by a shoreline protection structure consisting of layered, geofabric-wrapped sand, encased with a reinforced concrete slab keyed into the bedrock wave-cut platform. The surface of the bedrock platform is highly irregular, and may vary in elevation by perhaps 10 feet over short distances. Based on follow-up conversations with the project civil engineers, we understand the seaward edge of the proposed structure will be embedded into the bedrock wave-cut platform to below the 50 year project design scour elevation. It is also our understanding the keyway design and construction will take into account the irregular nature of the platform so as to protect the improvements from scour and undercutting for the project's 50 year design life. The embedment depths will be verified with additional detailed field study and outlined in final design plans.

As depicted on Sheet 8.1: Section 3, the lower portion of the seaward edge of the access pathway is not embedded into the bedrock platform and is subject to undercutting. This will be addressed in final design plans.

In the vicinity of 5th Avenue, there is no bedrock wave-cut platform. The seaward edge of the proposed improvements will be supported by deep, precast concrete piles. In addition, a precast concrete wall will protect the base of the improvements from scour. The pilings and wall will extend below the 50 year design scour elevation. This piling and wall system should be incorporated wherever bedrock is not encountered along the seaward edge of the proposed project where subject to wave attack. The piling and wall system, and the entire shoreline protection structure as a whole, should be designed to withstand liquefaction and shaking effects generated by the design earthquake.

Please note: Figures 2 and 3 in our update investigation illustrate the irregularity of the shore platform (REJA, 2009). We did not elaborate on the unevenness of the platform in our 2009 update report as the proposed development plans depicted the improvements, for the most part, upon the blufftop.

The proposed improvements will allow for the infiltration of runoff into the native materials comprising the blufftop, with an allowance for excess runoff to flow into the storm drain system in the event of larger runoff events. We understand that provisions will be made to prevent the buildup of groundwater behind the proposed shoreline protection structure to prevent high pore pressures and piping. Alternatively, the shoreline protection structure should be designed to accommodate saturated undrained conditions.

The fill slope underlying East Cliff Drive between the landward end of the proposed shoreline protection structure and the corner of 7th Avenue is susceptible to scour during the project design life. Provisions to protect the toe of the fill slope from erosion will be outlined in the final design phase of the project.

The improvement area and shoreline protection structure should be periodically inspected, especially after significant wave runup events and/or oceanic storms scour the beach and expose the bedrock platform and the base of the shoreline protection structure.

We would be pleased to assist in additional detailed field studies to help determine and verify the depths and/or extent of the bedrock platform upon which much of the shoreline protection structure will be founded.

We request the privilege of performing final plan reviews when the final design phase of this project has been completed.

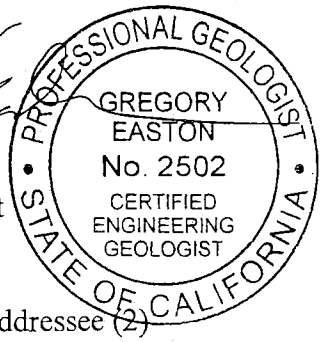
The preliminary plans are in general geologic conformance with the recommendations of our reports.

ATTACHMENT 7

Please contact us if you have any questions or comments.

Sincerely,

ROGERS E. JOHNSON & ASSOCIATES



Gregory Easton
Project Geologist
C.E.G. No. 2502

Rogers E. Johnson
Principal Geologist
C.E.G. No. 1016

Copies: Addressee (2)
RRM, attn: Mike Sherrod
Haro, Kasunich and Associates, attn: Rick Parks

References:

Rogers Johnson & Associates, 1995, Geologic Report, Proposed Improvements to East Cliff Drive, Santa Cruz Harbor to Schwan Lake, Santa Cruz County, California, unpublished consultants report, job no. C95033-68, prepared 16 October 1995, 57p.

Rogers Johnson and Associates, 2009, Update to Geologic Investigation, Proposed Improvements to Twin Lakes Beachfront, East Cliff Drive - 5th Avenue to Schwan Lake, Santa Cruz, California, Job No. C09001-54, prepared 4 June 2009, 69p.

RRM Design Group, 2012, County of Santa Cruz Department of Public Works, Permit Review Plans for Construction of Public Right-of-Way and Road Improvements for East Cliff Drive at Twin Lakes Beachfront, 5th Avenue to 7th Avenue, Job No. 1309513, 11 sheets dated 10 February 2012.

ATTACHMENT 7

Halcrow, Inc.
6700 East Pacific Coast Highway, Suite 180
Long Beach, CA 90803
Tel (562) 493 8300 Fax (562) 493 8308
www.halcrow.com

Halcrow

August 1, 2011

Mr. James Davies
Project Manager
County of Santa Cruz
701 Ocean Street, Room 510
Santa Cruz, CA 95060

RE: Twin Lakes Beachfront Improvements Project

Dear Jim:

Attached is our Conceptual Design of Coastline Protection Structures report for the Twin Lakes Beachfront Improvements Project. The project consists of roadway realignment, bicycle lanes, pedestrian walkways, and improved parking and beach access on the stretch of coastline along East Cliff Drive from 5th to 7th Avenue.

As part of the RRM Design Group team, Halcrow, Inc. was responsible for developing, evaluating and recommending alternatives for coastal protection structures. We performed coastal studies and investigations to characterize the site and assess local conditions from the marine perspective; developed conceptual designs, evaluated protective structures and structural system alternatives, and recommended preferred alternatives.

Please feel free to contact us if you have any questions about this report.

Very truly yours,

HALCROW, INC.

Claudio Fassardi
Principal

Robert Andrews, P.E.
Vice President
Civil Engineer, CA #45405
Exp. 9/30/12

SJ/nc

ATTACHMENT 8

County of Santa Cruz

Twin Lakes Beachfront Improvements

Conceptual Design of Coastline Protection Structures

August 2011

Final Report

Halcrow, Inc.

Halcrow, Inc.
6700 E. Pacific Coast Highway, Suite 180, Long Beach, CA 90803
Tel: (562) 493-8300, Fax: (562) 493-8308
www.halcrow.com

Halcrow, Inc. has prepared this report in accordance with the instructions of their client, the County of Santa Cruz, for their sole and specific use. Any other persons who use any information contained herein do so at their own risk.

© Halcrow Group Limited 2011

County of Santa Cruz

Twin Lakes Beachfront Improvements

Conceptual Design of Coastline Protection Structures

Contents Amendment Record

This report has been issued and amended as follows:

Revision	Description	Date	Approved by
0	Draft report	1/10/11	CF
1	Draft report	3/11/11	RA
2	Draft report incorporating bluff erosion assessment and geotextile bluff stabilization system description	7/26/11	CF
4	Final report	8/1/11	CF

Table of Contents

1	**Executive Summary**	**1**
2	**Introduction**	**3**
3	**Characterization of the Site**	**7**
	3.1 Kick-Off Meeting and Site Visit	*7*
	3.2 Collection and Analysis of Data and Information	*7*
	3.3 Waves	*8*
	3.4 Bathymetry	*9*
	3.5 Tidal Datums and Water Levels	*9*
	3.6 Beach Profiles	*11*
	3.7 Topography and Aerial Photo	*16*
	3.8 Schwan Lake Revetment and Culvert Outfall Structure	*16*
4	**Assessment of the Need of Protection Structures**	**26**
5	**Approach to the Definition of Total Water Levels (TWL's)**	**34**
6	**Definition of TWL's**	**36**
	6.1 Sea Level Rise Scenarios	*36*
	6.2 Wave Conditions at TLSB	*38*
	6.3 Total Water Levels (TWL)	*42*
7	**Comparison of Predicted and Observed TWL's**	**46**
	7.1 Storm of February 24, 2008	*46*
	7.2 Storms of January 29 - February 7, 1998	*49*
	7.3 Storm of January 5, 2008	*51*
	7.4 Storm of January 5, 1982	*53*
	7.5 Storm of January 26, 1983	*57*
8	**Estimation of the Elevation of Protective Structures**	**60**
9	**Analysis of Potential Protection Structures and Structural Systems**	**69**
	9.1 Monolithic Cast-In-Place Concrete Structure	*75*
	9.2 Cast-in-place Concrete Retaining Wall	*76*
	9.3 Pre-cast Caissons	*77*

9.4 Cement Deep Soil Mixing (CDSM) 78
9.5 Combination of CDSM and Pre-cast Concrete Caisson 80
9.6 Combination of CDSM and Cast-in-place Structure 82
9.7 Rip-rap Revetment 84
1.8 Mechanically Stabilized Earth (MSE) 85

10 Selection of Preferred Protection Structures **89**
10.1 5th Avenue to 7th Avenue 89
10.2 7th Avenue to 9th Avenue 94
10.3 9th Avenue to 11th Avenue 97

11 Wave Overtopping Assessment **101**

12 References **104**

ATTACHMENT 8

List of Figures

Figure 1. Twin Lakes State Beach.....4

Figure 2. Timeline and extent of previous studies and investigations.....5

Figure 3. Location of GROW 39170 and CDIP's Station 006. 8

Figure 4. Monterey DEM. 9

Figure 5. Topography and beach transects at the west end of TLSB. 12

Figure 6. Topography and beach transects at the east end of TLSB.....13

Figure 7. Summer (nourished –solid-) and winter (eroded –dashed-) beach profiles, transects A-A' to E-E'.....14

Figure 8. Summer (nourished –solid-) and winter (eroded –dashed-) beach profiles, transects F-F' to H-H'.....15

Figure 9. TLSB topography and aerial photo (elevations in feet, NGVD 29).....16

Figure 10. Schwan Lake revetment along East Cliff Drive.....19

Figure 11. Example of void on revetment exposing underlayer and foundation along sections 8 to 9.....19

Figure 12. View to the east of the revetment on East Cliff Drive on east side of culvert outfall structure.....20

Figure 13. Vegetation along revetment.....20

Figure 14. Exposed revetment underlayer.....21

Figure 15. Underlayer rocks on the beach removed from the revetment. 22

Figure 16. View of the revetment from section 11 to 11th Avenue.....22

Figure 17. Revetment along 11th Avenue. 23

Figure 18. Schwan Lake culvert outfall structure. 24

Figure 19. SSFM alignment across the culvert outfall structure. 25

Figure 20. Culvert and SSFM cross-section. 25

Figure 21. TLSB in December 1961 prior to harbor construction, Griggs (1976). 27

Figure 22. Bluff erosion measurement stations and rates of erosion (Griggs, 1976)..... 28

Figure 23. Shoreline position at TLSB for selected winter storms after harbor construction, 1964 (double dashed line) non-nourished beach shoreline..... 29

Figure 24. View of TLSB to the east after the 1982 winter storms. 29

Figure 25. View of TLSB to the west after the 1982 winter storms..... 30

Figure 26. Rip-rap repair at the S-turn after the winter 1983 storms. 30

Figure 27. View of TLSB to the west in 1980..... 31

Figure 28. View of TLSB to the east after the storms of 1/29 to 2/7, 1998. 31

Figure 29. Rip-rap at the S-turn after the storms of 1/29 to 2/7, 1998. 32

Figure 30. Rip-rap and bluff at the S-turn after the storms of 1/29 to 2/7, 1998. 32

Figure 31. Water levels. 36

Figure 32. Mean sea level trend at Monterey. 37

Figure 33. Selected sea level rise due to global warming. 38

Figure 34. MIKE 2 SW wave modeling mesh. 39

Figure 35. Locations of TLSB wave hindcast and CDIP Station 006 (depths in m, MLLW)..... 40

Figure 36. Measured and predicted (hindcast adjusted) wave heights at the CDIP 006 location from 1993 to 2001. 42

Figure 37. Q-Q plot of predicted (hindcast adjusted) versus measured wave heights at the CDIP 006 location from 1993 to 2001..... 42

Figure 38. 100-year TWL's for the three selected sea level rise scenarios, summer (nourished) beach condition. 45

Figure 39. High water levels at the Schwan Lake inlet during the storm of February 24, 2008. 47

Figure 40. Predicted TWL during the peak of the storm of February 24, 2008 (dashed line shows location of local TWL contour after likely erosion of the berm to the southeast)..... 48

Figure 41. Significant wave height (Hm0) offshore TLSB, SWL and TWL (at transect FGH) during the storm of February 24, 2008 (GMT)..... 48

Figure 42. View of TLSB to the northeast on February 9, 1998 (RJA, 2009)..... 49

Figure 43. Predicted TWL on February, 1998 (dashed line shows location of local TWL contour after likely erosion of the berm to the southeast). 50

Figure 44. Significant wave height (Hm0) offshore TLSB, SWL and TWL (transect A-A') during the storm of February 1998 (GMT). 50

Figure 45. View of TLSB to the west on January 7, 2008..... 52

Figure 46. Predicted TWL on January 5, 2008 (dashed line shows location of local TWL contour after likely erosion of the berm to the southeast). 52

Figure 47. Significant wave height (Hm0) offshore TLSB, SWL and TWL (transect A-A') during the storm of January 5, 2008 (GMT)..... 53

Figure 48. Aerial view of TLSB on January 7, 1982 (dashed line traces approximate location of peak TWL)..... 55

Figure 49. TLSB at Assembly Avenue during the storm of January 5, 1982. 55

Figure 50. East view of Schwan Lake culvert outflow during the storm of January 5, 1982. 56

Figure 51. South view of Schwan Lake culvert outflow during the storm of January 5, 1982. 56

Figure 52. Predicted TWL on January 5, 1982. 57

Figure 53. Significant wave height (Hm0) offshore TLSB, SWL and TWL (transect A-A') during the storm of January 5, 1982 (GMT)..... 57

Figure 54. Significant wave height (Hm0), SWL and TWL (transect A-A') during the storms of January-March, 1983. 58

Figure 55. Predicted TWL on January 26, 1983. 59

Figure 56. Twin Lakes Beachfront Improvements architectural plan of March 2010..... 61

Figure 57. Significant wave height (Hm0) and peak period (Tp) offshore TWB during the storms of January through March of 1983. 64

Figure 58. Embankment (left) and promenade (right) seawalls (EUROTOP, 2007). 65

Figure 59. Schematization of protection structures for preliminary overtopping analysis (EUROTOP, 2007). 66

Figure 60. Twin Lakes Beachfront Improvements architectural plan of December 2009. 71

Figure 61. Twin Lakes Beachfront Improvements architectural plan of March 2010. 72

Figure 62. Twin Lakes Beachfront Improvements architectural plan of November 2010. 73

Figure 63. Example of beach access steps with cast-in-place concrete for section 5 of the architectural plan of March 2010. 76

Figure 64. Example of retaining wall with cast-in-place concrete for section 7 of the architectural plan of March 2010. 77

Figure 65. Example of pre-cast caissons for section 3 of the architectural plan of March 2010. 78

Figure 66. Example of CDSM for section 3 of the architectural plan of December 2009. 80

Figure 67. Example of CDSM and pre-cast concrete caisson for section 2 of the architectural plan of December 2009. 82

Figure 68. Example of CDSM and cast-in-place concrete wall for section 2 of the architectural plan of December 2009. 84

Figure 69. Example of rip-rap revetment section for section 8 of the architectural plan of March 2010. 85

Figure 70. Example of MSE for section 4 of the architectural plan of November 2010. 87

Figure 71. Schematic of section 1 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan. 91

Figure 72. Schematic of section 2 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.....91

Figure 73. Schematic of section 3 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.....92

Figure 74. Schematic of section 4 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.....92

Figure 75. Schematic of section 5 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.....93

Figure 76. Schematic of section 6 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.....93

Figure 77. Schematic of section 8 featuring pre-cast concrete retaining wall and simulated Purisima formation finish, November 2010 architectural plan.....95

Figure 78. Schematic of section 9 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.....96

Figure 79. Schematic of section 10 featuring rip-rap revetment, November 2010 architectural plan.....96

Figure 80. Schematic of section 11 featuring rip-rap revetment, November 2010 architectural plan.....97

Figure 81. Schematic of section 12 featuring rip-rap revetment, November 2010 architectural plan.....99

Figure 82. Schematic of section 13 featuring rip-rap revetment, November 2010 architectural plan.....100

Figure 83. Parameters used to represent structures for overtopping discharge calculations with NN_OVERTOPPING.....101

Figure 84. Example of parametrization of section 4 for NN_OVERTOPPING, November 2010 architectural plan.....102

List of Tables

Table 1. Tidal datums for Santa Cruz. 10

Table 2. Sea level rise scenarios 38

Table 3. Seas and swell conditions for the wave transformation simulations. 41

Table 4. 100-year TWL's at TLSB for transects A-A', B-B', E-E' and FGH 44

Table 5. Limits of overtopping for damage to crest or rear slope (EUROTOP, 2007). 66

Table 6. Preliminary wave overtopping analysis for 100-year winter TWL events. 67

Table 7. Comparison structures/structural systems alternatives. 88

Table 8. Mean overtopping discharges (Q) at various sections of architectural plan of November 2010. 103

1 Executive Summary

As part of the RRM Design Group (RRM) team, Halcrow, Inc. (Halcrow) performed coastal studies and investigations to support the development of architectural plans for the Twin Lakes Beachfront Improvements Project. In addition, Halcrow developed conceptual designs and evaluated protective structures and structural system alternatives, and recommended preferred alternatives. The County of Santa Cruz (County) project, which in August of 2009 consisted of the development of conceptual designs of a series improvements on the stretch of coastline from 5th Avenue to 9th Avenue at Schwan Lake, was expanded on October 2010 to include the stretch of coastline from 9th Avenue to 11th Avenue along which the construction of a pedestrian pathway across the lake's inlet was under consideration by the County. Subsequently, in mid 2011, the project was scaled back to accommodate a reduced project budget. The extents of the improvements were therefore limited to East Cliff Drive from 5th Avenue to 7th Avenue. This report describes the work performed by Halcrow as the design moved through the different stages since inception.

Halcrow performed a comprehensive collection and analysis of data and information, and performed two visits to characterize the project site and assess local conditions. In order to determine the need of structures to protect the planned improvements, an assessment of the risk of bluff erosion was performed. This assessment was of qualitative nature given the very limited data and information available for the project site. The analysis of the anecdotal evidence, scientific research, and results of previous investigations showed that during years of severe winter storms or less than planned beach nourishment, the beach would be depleted of sand due to the erosive action of the waves; exposing the bluffs, adjacent roadway at East Cliff Drive and the planned improvements to potential damage due to wave erosion, overtopping and flooding. It was concluded that on the basis of this analysis and in conjunction with current projected trends in sea level rise due to global warming and the exposed location of the project to ocean waves, the risk of bluff erosion is high and protection structures are considered necessary to stabilize the bluffs and protect the planned beachfront improvements.

Marine conditions at Twin Lakes State Beach (TLSB) consisting of wave, tide levels, wave runup and setup were defined by means of numerical modeling. Using the marine conditions and previous beach surveys performed on behalf of the County, 100-year return period Total Water Levels (TWL's) were estimated for three sea level rise scenarios: a) no global warming year 2110, b) with global warming year 2060 and c) with global warming year 2090.

ATTACHMENT 8

As the architectural plans evolved, a preliminary wave overtopping analysis was performed to determine initial estimates of the required crest elevations of the protective structures for each sea level rise scenario. The results of the analysis indicated that architectural plans featuring improvements and protective structures with crest elevations equal or marginally higher than the existing East Cliff Drive elevations would provide sufficient wave overtopping protection at least for the next 50 years in a sea level rise scenario with global warming, and that the elevations necessary to provide protection in a scenario of sea level rise with global warming in the next 100 years would be excessive and impractical.

Eight alternatives of structures/structural systems were analyzed including: cast-in-place retaining structures, pre-cast caissons, cement deep soil mixing, rip-rap revetment, and mechanically stabilized earth systems. Constructability, impacts to public access during construction, foundation effectiveness and relative cost were evaluated for each alternative.

Upon evaluating the advantages and disadvantages of each structure and structural system, and considering the requirements of the project and site conditions, structures consisting predominantly of a mechanically stabilized earth (MSE) structural system with a concrete facing finished to emulate the local Purisima geologic formation were recommended from 5th Avenue to 9th Avenue; and a rip-rap revetment from 9th Avenue to 11th Avenue.

A detailed wave overtopping analysis was performed on the final conceptual design sections, which showed that the architectural plan of November 2010 featuring improvements and protective structures with crest elevations equal or marginally higher than the existing East Cliff Drive elevations would provide sufficient wave overtopping protection at least for the next 50 years in a sea level rise scenario with global warming. On the basis of these initial findings and on a preliminary basis it can be concluded that existing adjacent properties and structures will not be negatively impacted by the proposed improvements.

2 Introduction

In August 2009, the County of Santa Cruz (County) contracted RRM Design Group (RRM) team to provide design services for the Twin Lakes Beachfront Improvements Project. The project consisted of the development of the conceptual design of improvements including roadway realignment, bicycle lanes, pedestrian walkways, and improved parking and beach access on the stretch of coastline from 5th Avenue to 9th Avenue at Schwan Lake. On October 2010, the scope was expanded to include the stretch of coastline from 9th Avenue to 11th Avenue along which the construction of a pedestrian pathway was under consideration by the County. Subsequently, in mid 2011, the project was scaled back to accommodate a reduced project budget. The extents of the improvements were therefore limited to East Cliff Drive from 5th Avenue to 7th Avenue. As part of the RRM team, Halcrow, Inc. (Halcrow) was responsible for developing, evaluating and recommending alternatives for coastal protection structures for the different stretches of the project coastline.

The project area along East Cliff Drive, shown in Figure 1, is fronted by the Twin Lakes State Beach (TLSB) which is limited to the west by the Santa Cruz Small Craft Harbor and to the east by 11th Avenue on the east side of Schwan Lake. The construction of the Santa Cruz Small Craft Harbor in the early 1960s disrupted the littoral drift reducing the supply of sand to the beaches to the east of the harbor entrance. The existing sandy Twin Lakes State Beach is the result of annual beach nourishment which has been performed since 1986. Sediment shoaling the harbor entrance channel is removed and deposited on the beach at a rate of approximately 200,000 cubic yards per year.

Anecdotal evidence, scientific research, and investigations conducted on behalf of the County (RJA, 2009) have shown that during years of severe winter storms or less than planned beach nourishment, the beach would be depleted of sand due to the erosive action of the waves; exposing the bluffs, adjacent roadway and the planned improvements to potential damage due to wave erosion, overtopping and flooding. Considering:

- that in the absence of the beach, storm waves would reach further landward,
- the current projected trends in sea level rise due to global warming, and
- the exposed location of the project to ocean waves

the risk of bluff erosion is high and protection structures are considered necessary to stabilize the bluffs and protect the planned beachfront improvements.

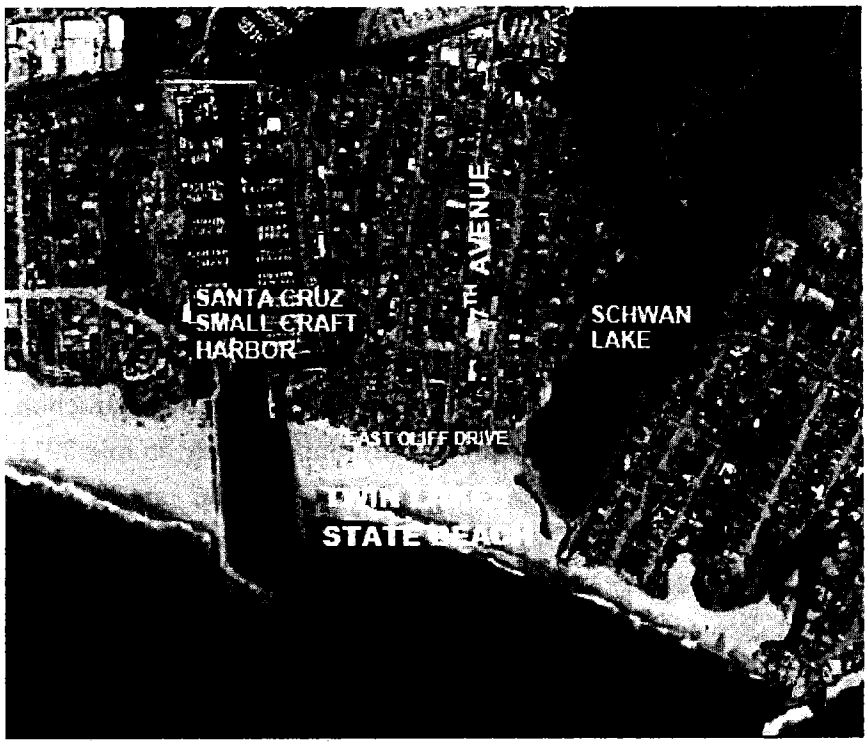


Figure 1. Twin Lakes State Beach.

However, the various combinations of projected sea level rise scenarios due to global warming, severe storms and possible disruption of beach nourishment would lead to a variety of scenarios for which different coastal protection solutions could be developed in a compromise between the impacts of the marine environment and the requirements of the project.

In order to conceive realistic scenarios for analysis, and to develop corresponding realistic coastal protection solutions Halcrow performed coastal engineering studies and investigations to characterize the site and to define design conditions. Using this information and the architectural plans developed by RRM, Halcrow developed and evaluated alternatives of coastal protection structures and structural systems, from which preferred alternatives were recommended for the different stretches of the project coastline.

This study complements studies performed by the County in the past. Figure 2 shows the timeline and extent of the study area covered by previous studies and investigations. Of particular relevance for the coastal engineering studies performed by Halcrow were the studies conducted by:

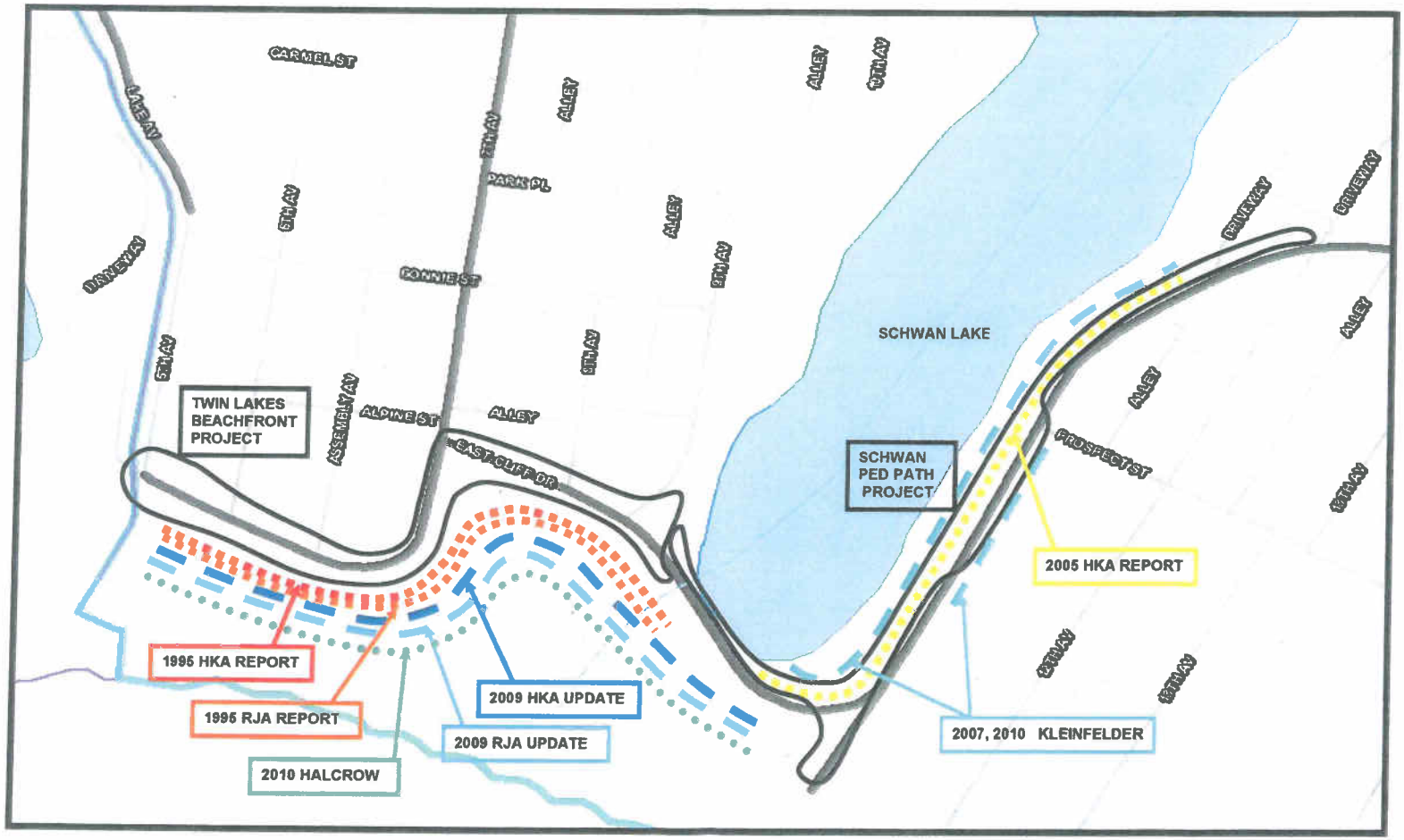


Figure 2. Timeline and extent of previous studies and investigations.

ATTACHMENT 8

- Haro, Kasunich and Associates, Inc., 1995 (HKA, 1995)
- Rogers E. Johnson & Associates, 1995 (RJA, 1995)
- Haro, Kasunich and Associates, Inc., 2009 (HKA, 2009)
- Rogers E. Johnson & Associates, 2009 (RJA, 2009)

Halcrow commenced the study performing a comprehensive collection and analysis of relevant data, literature and information, including a visit to the project site. These activities were followed by an assessment of the need of structures to protect the planned improvements, the definition of sea level rise scenarios and the determination of the corresponding marine design conditions, including extreme Total Water Levels (TWL's), to be used in the conceptual design of the coastal protection structures. On the basis of the predicted extreme TWL's, depth-limited wave heights were computed and the elevation of protective structures required to prevent damage due to wave overtopping were determined.

Once the project site was characterized and TWL's defined, Halcrow developed conceptual design alternatives for structures and structural systems to support the architectural plans developed by RRM, and the different concepts and aesthetic treatments that these included. Halcrow also considered in this development incorporating, or otherwise accommodating, in the concept designs storm water runoff management features that would allow for the retention of runoff and percolation to address water quality from roadway runoff. The design alternatives were therefore developed to provide some flexibility for use in different architectural plans.

3 Characterization of the Site

3.1 Kick-Off Meeting and Site Visit

On August 27, 2009 Halcrow joined the RRM team and attended the project kick-off meeting at the County offices in Santa Cruz, CA. During the meeting, several management and technical aspects of the project were discussed. Among the issues relevant to coastal engineering it was mentioned that coastline protection was envisioned to be minimally intrusive to the site's aesthetics, and that coastline protection solutions would be highly scrutinized by the California Coastal Commission. Halcrow coordinated with the County the future collection of data and information such as surveys, vertical datum, history of East Cliff Drive repairs and maintenance records, EIR of the East Cliff Bluff protection project; and also identified the USGS as a possible source of bathymetric data.

Upon conclusion of the kick-off meeting, the RRM team performed a site visit. At the project site, Mr. Brian Foss with the Santa Cruz Port District provided a brief description of TLSB. Mr. Foss described the construction of Santa Cruz Harbor, sedimentation issues, past and current dredging activities, and gave a general overview of the beach erosion processes and nourishment activities that the Port District performs to maintain TLSB. He presented a series of historical photos of the beach in various eroded and nourished stages. After the site visit, Halcrow met with Mr. Foss at his Port District office to collect aerial photos and coordinate the future collection of data and information such as vertical datum, tide records, descriptions of historical storm events, etc.

3.2 Collection and Analysis of Data and Information

Halcrow performed a comprehensive collection and analysis of publicly available data and information relevant to the project, with the purpose of identifying, analyzing and consolidating the data and information necessary to characterize the site from various perspectives such as wave conditions, bathymetry, tidal datums, water levels, beach topography, and geotechnical information.

These data and information were essential input for the determination of the marine design conditions at the project site. As they propagate to the coast, waves change height and direction due to the effect of the bathymetry, structures, coastal morphology and water levels. Once in shallow water, waves induce a wave setup and runup on the beach which is a function of the beach slope. Water levels consisting of the effect of tides, storm surge, wave

setup and runup are key input for the design and analysis of feasibility of coastal protection structures, and critical for the determination of the extreme water levels.

3.3 Waves

Similarly to many coastal development projects, site-specific long-term wave data at Santa Cruz was not available for this study. Therefore, use was made of a deep water long-term wave hindcast to synthesize a wave hindcast just offshore TLSB. Halcrow acquired GROW (Global Reanalysis of Offshore Winds) point 39170 wave hindcast from Oceanweather, Inc. This deep water wave hindcast consisted of wind speed and direction, and wave height, period and direction every 3 hours, partitioned in seas and swell, from January 1, 1970 to December 31, 2008. In addition, Halcrow collected wave measurements made by Scripp's Coastal Data Information Program (CDIP) offshore Santa Cruz for calibration of the wave hindcast at TLSB. The CDIP data set consisted of wave heights, periods and directions measured with a pressure sensor array from 1981 to 1999 (with a few gaps). Figure 3 shows the location of GROW point 39170 and CDIP Station 006.

Figure 3. Location of GROW 39170 and CDIP's Station 006.

3.4 Bathymetry

Offshore and local bathymetry was obtained from the Digital Elevation Model (DEM) developed by the National Geophysical Data Center (NGDC) for Monterey, CA. Bathymetric datasets used in the compilation of the Monterey DEM include 42 NOS hydrographic surveys, 17 California State Sea Floor Mapping Lab multi-beam sonar surveys located along the southern coast, 6 USGS multi-beam sonar surveys that cover the deeper areas within the bay, and extracted ENC/RNC sounding data. Coastline datasets for the Monterey DEM were obtained from NOAA's Office of Coast Survey (OCS) and the National Marine Fisheries Service, Southwest Fisheries Science Center/Moss Landing Marine Laboratory (NMFS,SWFSC/MLML); the California State Land Commission (CSLC); the California Dept. of Fish and Game, Marine Region GIS Unit (CDFG); and the U.S. Geological Survey (USGS). The Monterey DEM, shown in Figure 4, is referred to the Mean High Water (MHW).

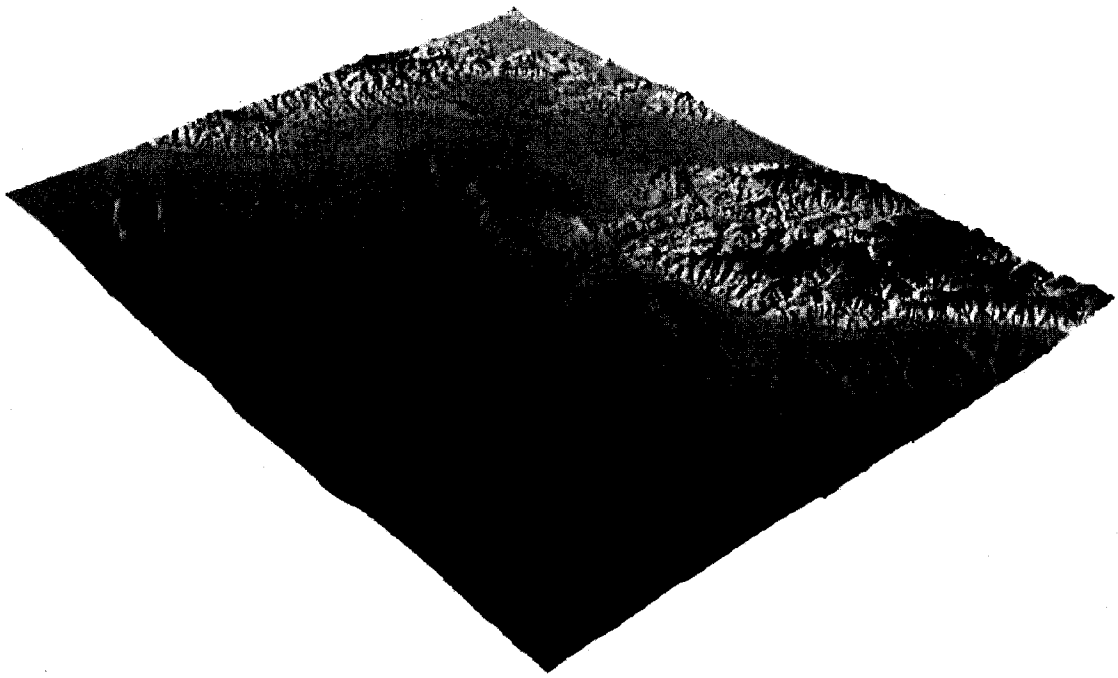


Figure 4. Monterey DEM.

3.5 Tidal Datums and Water Levels

Tidal datums for Santa Cruz were obtained from the NOAA nautical chart 18685. However, chart 18685 only provides the Mean Higher High Water (MHHW), Mean High Water (MHW) and Mean Low Water (MLW) all referred to the Mean Lower Low Water

(MLLW). Other tidal datums such as the Highest Astronomical Tide (HAT), Lowest Astronomical Tide (LAT), Mean Sea Level (MSL) and most importantly the offset between the MLLW and the National Geodetic Vertical Datum of 1929 (NGVD 29, Santa Cruz vertical topographic datum) were not available. These were derived using data from nearby Monterey and Moss Landing tide stations. HAT and LAT were computed using the harmonic constituents available for Santa Cruz at NOAA's Tide and Currents website (http://tidesandcurrents.noaa.gov). Table 1 shows the tidal datums for Santa Cruz. It is noted in Table 1 that the difference between MSL and NGVD 29 is 0.06 m (0.20 feet = 2.4 inches). Given this small difference and for the purposes of this study the MSL was considered coincident with the NGVD 29.

The time history of long-term still water levels at Santa Cruz (levels due to the astronomical tide, barometric and wind setup, El Niño/La Niña) required to perform this study using the response based approach were not available. Therefore, these were synthesized generating the astronomical tide using the harmonic constituents available for Santa Cruz and adding the water level anomaly (difference between measured and predicted) for Monterey to account for effects other than the astronomical tide. Given its close proximity to Santa Cruz, the water level anomaly for Monterey was considered representative for Santa Cruz. The contribution of wind and wave setup at the Monterey tide gauge can be considered to be negligible because this gauge is located in relatively deep water (Municipal Wharf) and the local bathymetry features relatively steep slopes. Therefore, the risk of double counting wind and wave setup at Santa Cruz when using the Monterey anomaly would be minimal.

Table 1. Tidal datums for Santa Cruz.

		re MLLW[1] (m)	re MLLW[1] (feet)	re NAVD 88 (m)	re NGVD 29 (m)	re NGVD 29 (feet)
Highest Astronomical Tide	HAT[2]	2.16	7.07	2.23	1.38	4.54
Mean Higher-High Water	MHHW	1.63	5.35	1.70	0.86	2.82
Mean High Water	MHW	1.42	4.65	1.49	0.64	2.12
Mean Sea Level	**MSL[3]**	*0.83*	2.73	*0.905*	0.06	0.20
Mean Low Water	MLW	0.34	1.11	0.41	-0.43	-1.42
Mean Lower-Low Water	MLLW	0.00	0.00	0.07	-0.77	-2.53
Lowest Astronomical Tide	LAT[2]	-0.49	-1.60	-0.42	-1.26	-4.13
North American Vertical Datum	NAVD 88	*-0.07*	-0.24	0.00	-0.84	-2.77
National Geodetic Vertical Datum	NGVD 29[4]	*0.77*	2.53	0.84	0.00	0.00

1. tidal datums per NOAA nautical chart 18685
2. HAT = M2 + S2 + N2 + K1 + O1, (LAT = - HAT)
3. MSL - MLLW = 0.833 m, and MSL - NAVD 88 = 0.905 m as in Moss Landing
4. NGVD 29 - NAVD 88 = 0.843 m (per RDA's BMCE.xls)

3.6 Beach Profiles

Beach surveys were provided by the County in the form of drawings. Figure 5 and Figure 6 show the topography of TLSB in a nourished condition and transects at the west and east ends, respectively, from surveys performed by RJA (2009). Please refer to the full size drawings in the RJA (2009) report for additional detail. Figure 7 and Figure 8 show the summer (nourished) and winter (eroded) beach profiles. The following are important considerations about the beach profiles:

- The summer beach profile is typically the result of nourishment operations conducted during the winter when dredge spoils from the Santa Cruz Small Craft Harbor entrance channel are deposited on TLSB.
- Dredge spoils are typically disposed at the shoreline and dispersed by the waves. Therefore, the resulting nourished beach configuration is difficult to characterize. The beach topography shown in Figure 5 and Figure 6 is just one of the very many that the beach could adopt. For the purposes of this study and because a history of beach profiles is not available, the nourished beach profiles presented in Figure 7 and Figure 8 were considered representative.
- Because TLSB is covered with sand most of the time, and storm events that expose the eroded beach platform are sporadic, the summer (nourished) beach profiles would be easier to survey and consequently, more accurate than the corresponding winter (eroded) profiles. In fact, winter (eroded) profiles in Figure 7 and Figure 8 are labeled as "approximate" (see - - ? - legend).

The following profiles were selected as representative of TLSB and used in this study for the computation of the TWL's:

- Profile A-A', representative of the stretch of coastline from 5th Avenue to Assembly Avenue (shown in red solid lines in Figure 5)
- Profile E-E', representative of the stretch of coastline from 7th Avenue to 9th Avenue (shown in Figure 5 and Figure 6)
- Seaward portion of profile E-E', representative of the missing seaward portions of profiles F-F', G-G' and H-H', and representative of the stretch of coastline from 9th Avenue to 11th Avenue (shown in red dotted lines in Figure 6) and hereinafter referred to as profile FGH. It is noted that the beach fronting Schwan Lake is, in general, very flat and only beyond the seaward end of transects F-F', G-G' and H-H' a slope is noticeable (site visit observation and inspection of photos).

ATTACHMENT 8

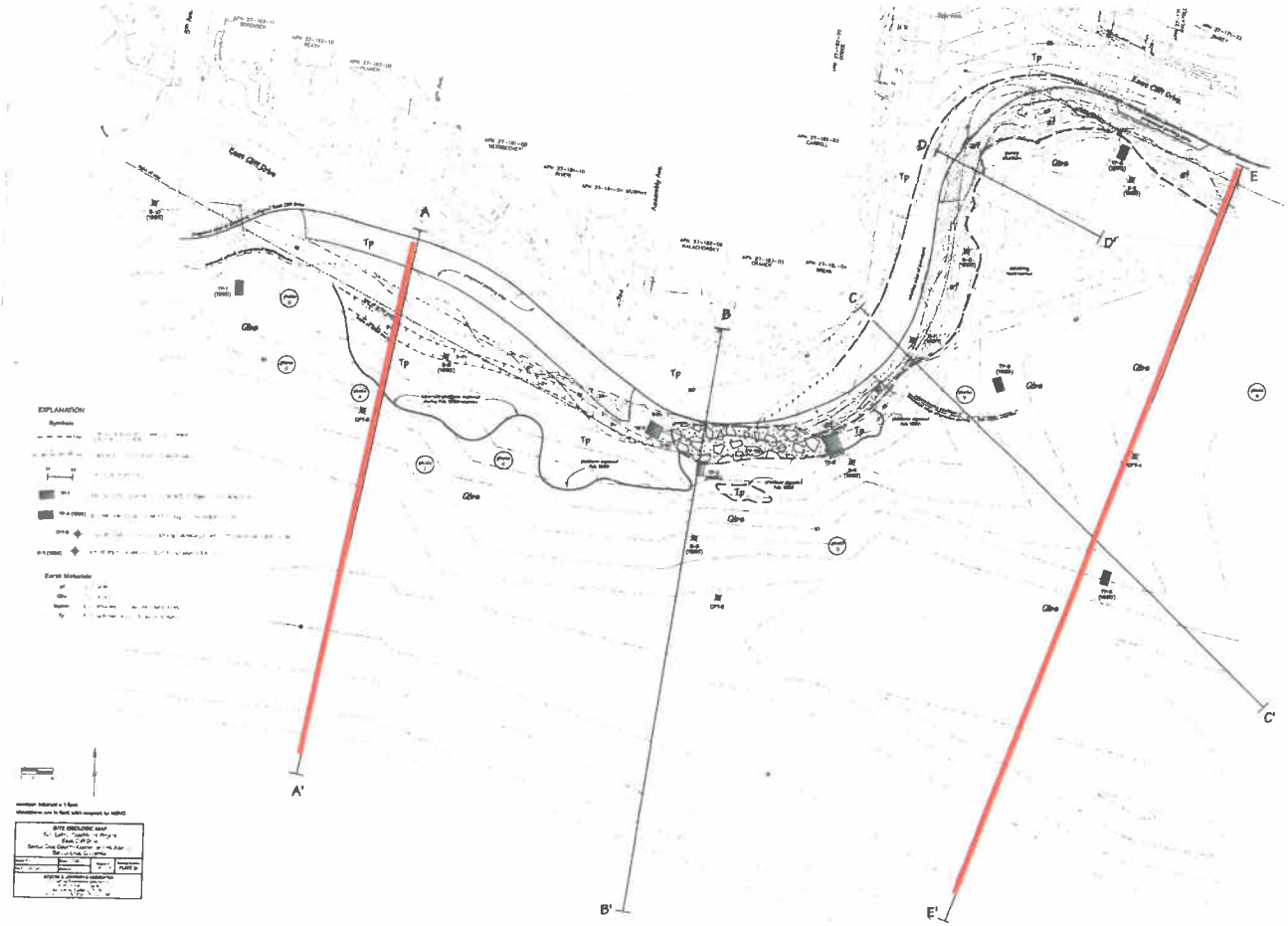


Figure 5. Topography and beach transects at the west end of TLSB.

ATTACHMENT 8

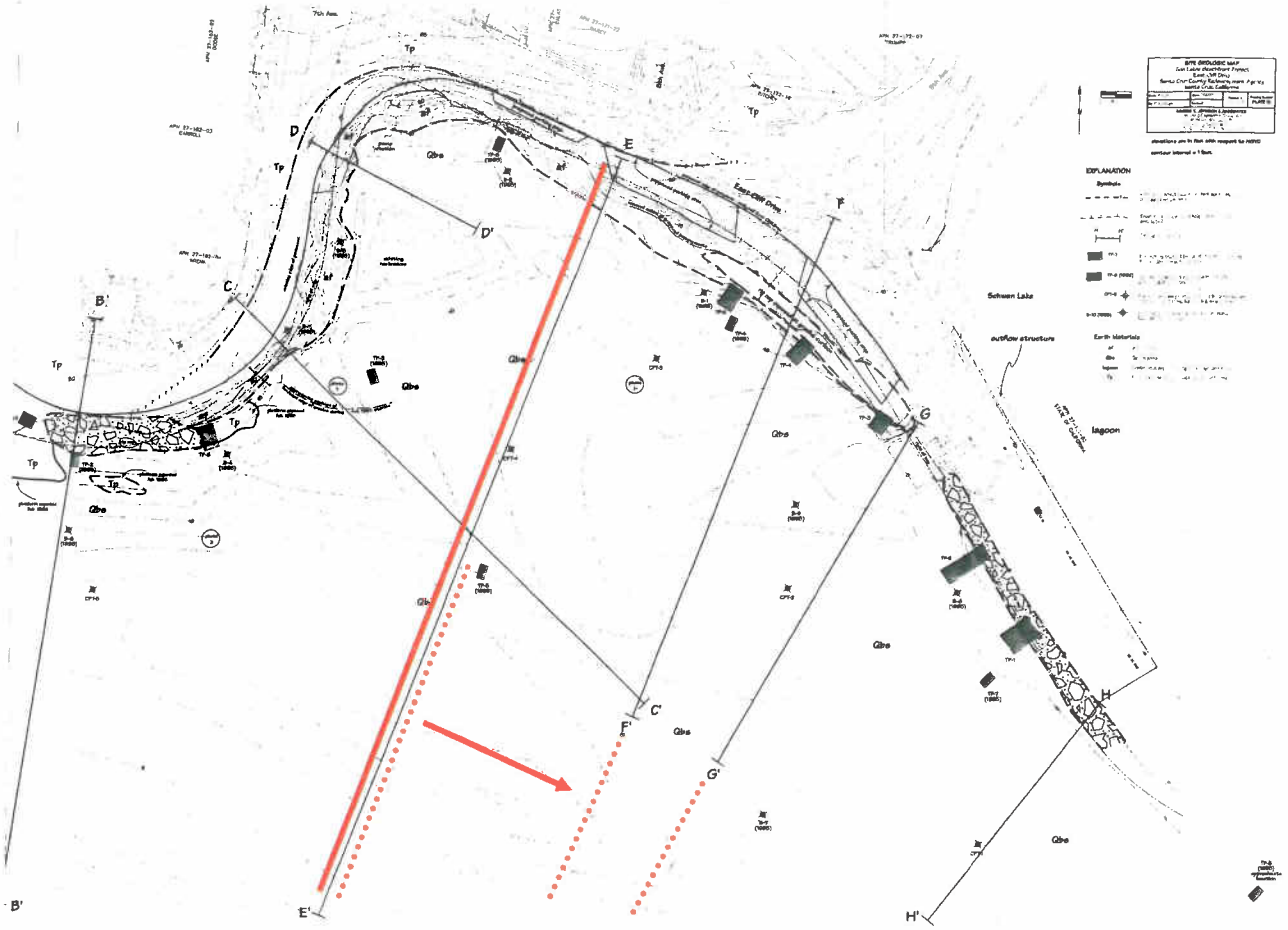


Figure 6. Topography and beach transects at the east end of TLSB.

ATTACHMENT 2

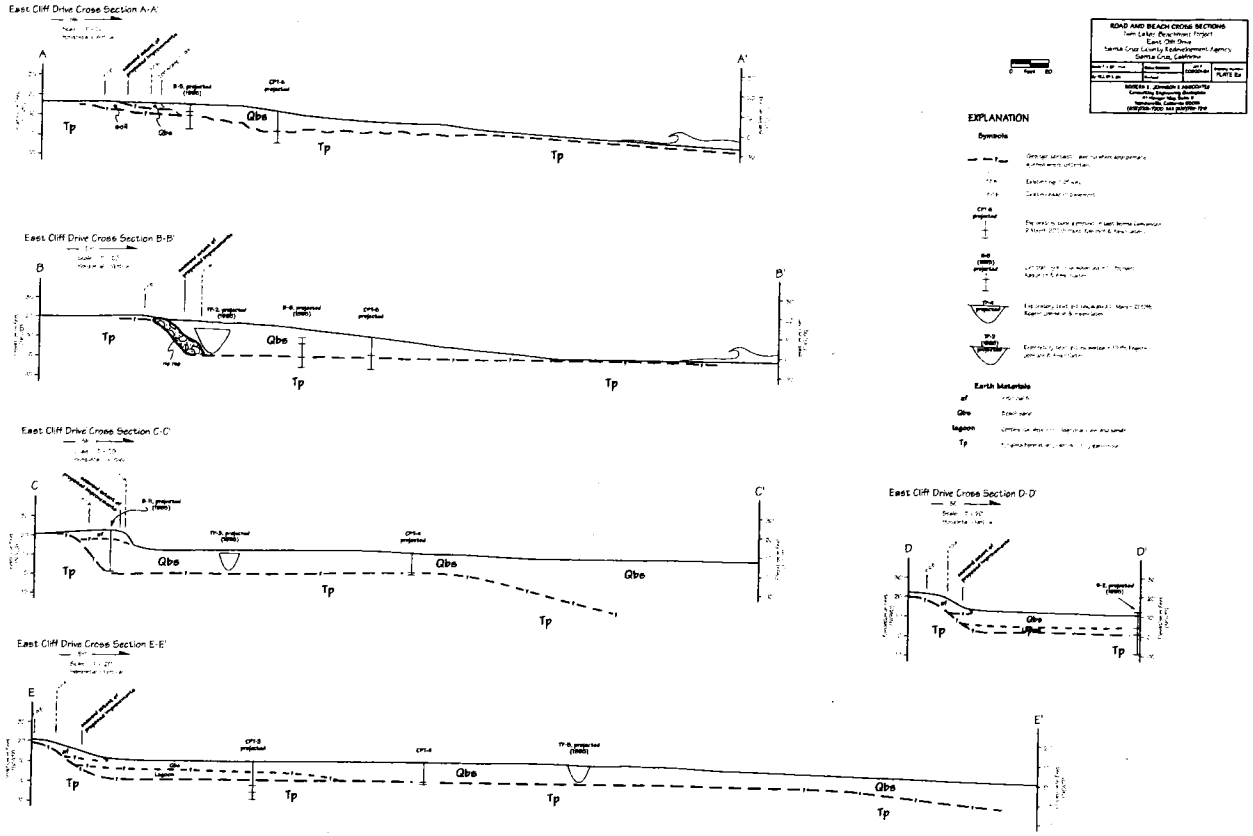


Figure 7. Summer (nourished –solid-) and winter (eroded –dashed-) beach profiles, transects A-A' to E-E'.

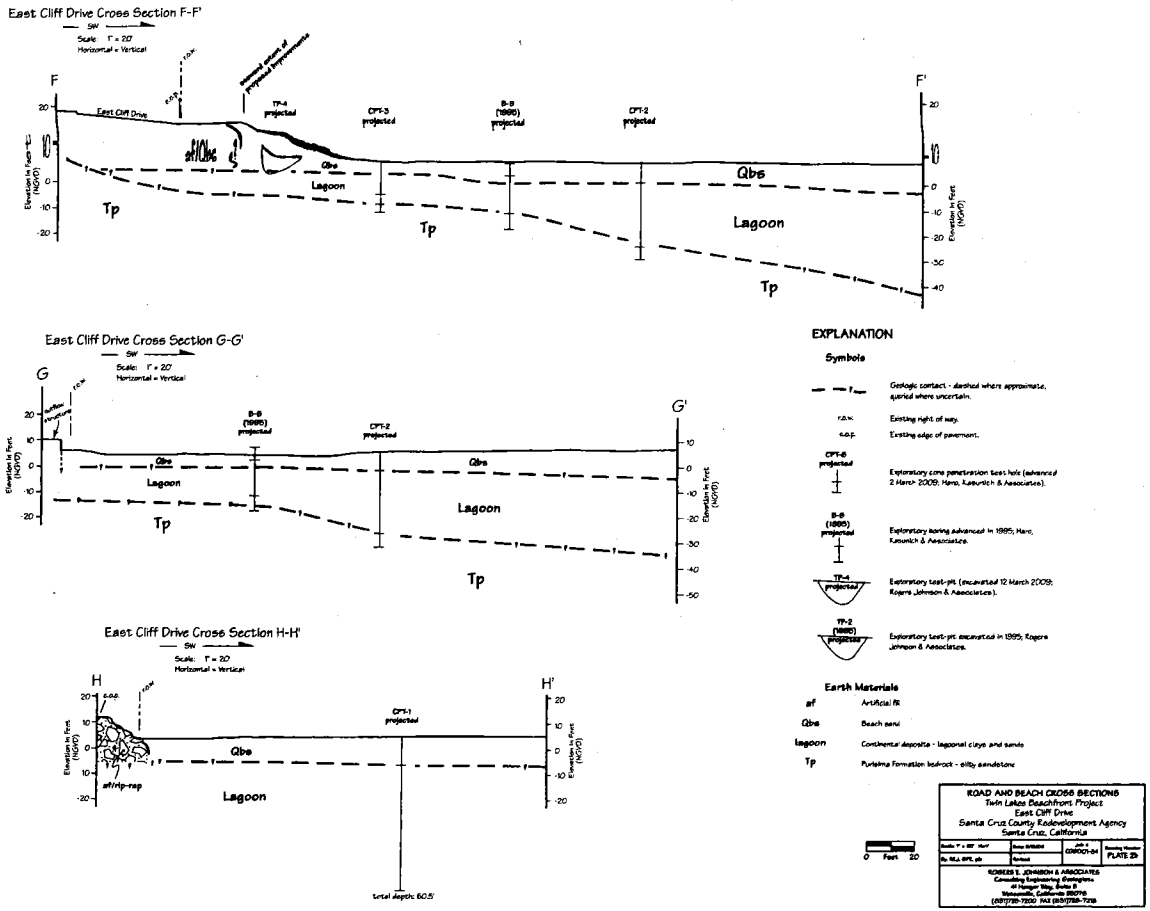


Figure 8. Summer (nourished –solid-) and winter (eroded –dashed-) beach profiles, transects F-F' to H-H'.

3.7 Topography and Aerial Photo

Project site topography and a geo-referenced aerial photo were provided by the County. Figure 9 shows the topography referred to NGVD 29 in feet at 1-foot intervals, with the aerial photo on the background.

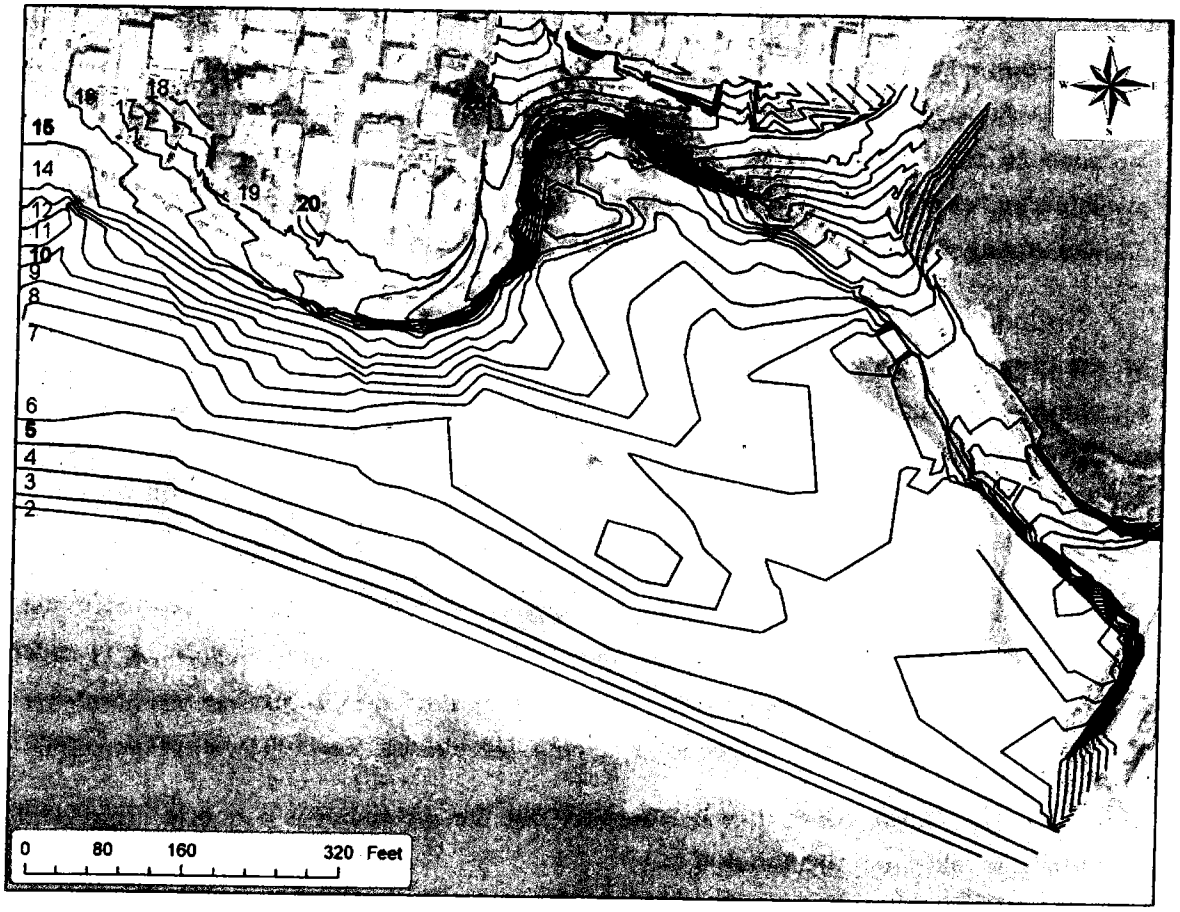


Figure 9. TLSB topography and aerial photo (elevations in feet, NGVD 29).

3.8 Schwan Lake Revetment and Culvert Outfall Structure

On October 2010, the scope was expanded to include the stretch of coastline from 9th Avenue to 11th Avenue along which the construction of a pedestrian pathway is being considered by the County. The pathway would be constructed on the beach side of East Cliff Drive along the causeway that spans the Schwan Lake inlet. Currently the road is wide enough to accommodate two-way traffic lanes and a shoulder on each side. Using fill material the causeway will be widened to the beach side to provide the necessary space for the pathway.

ATTACHMENT 8

During winter storms, and in periods when beach nourishment is interrupted or insufficient, high water levels and waves would impact the exposed slope that would result from the causeway widening. Unless this slope is protected, the foundations of the pedestrian pathway and the road will be subjected to erosion and their structural stability will be jeopardized.

The existing causeway is currently protected by a rock revetment which appears to have performed satisfactorily in the recent past. Therefore, it would be reasonable to assume that a similar structure would provide adequate protection to the pedestrian pathway and widened causeway. However, historical condition assessments of this structure were not available, and therefore, structural aspects like settlement, damage to armor and underlayers, and underlying slope condition needed to be assessed.

On October 1st, 2010, a visual inspection of the revetment was conducted, focusing on the general condition of the structure including settlement, damage of the armor units, condition of the underlayers, identification of type of filter layer, location and condition of the toe of the structure, condition of the structure's crest, identification of damage due to wave overtopping, causeway erosion, and road settlement. In addition, the culvert outfall structure connecting the lake to the ocean was observed.

To facilitate the identification of the location of observations, a reference line with an origin at the "Pt. No. 64.65" brass disk on top of the culvert outfall structure was defined along the crest of the revetment on the road, consisting of twelve 25-foot sections numbered 1 to 12. A vertical view of the revetment, reference line and sections is shown in Figure 10.

During the inspection it was observed that the revetment is a poorly engineered structure. The following was noted:

- the revetment lacks of a filter layer (geotextile or gravel),
- armors rocks appear randomly placed with some units displaced creating voids that expose the causeway's foundation, an example is shown in Figure 11,
- armor rocks throughout are of irregular shape with dimensions in the 30 to 40 inch range, and with an estimated weight of approximately 3,500 lbs (consistent with the 2-ton rock weight reported in RJA, 2009),
- from section 1 to 7, the stretch with the lowest elevation (approximately +10 to +11 feet NGVD 29) the revetment is buried in the sand with only the top 1 to 2 feet visible as shown in Figure 12,
- from section 8 onwards the road rises and the revetments top 6 feet is visible, an approximately 1V:1.5H slope is discernable,

ATTACHMENT 8

- dry debris carried by high water levels was observed between the rock voids in particular along the low-elevation sections 1 to 7 indicating the potential elevation of water levels, also observed was the presence of established vegetation which may indicate that wave overtopping along these sections may be minimal, a view of this area is shown in Figure 12 and Figure 13,
- from section 8 onwards the underlayer is visible, in particular along the crest of the structure, and composed of small rocks with approximate dimensions in the order of 10 inches or less as shown in Figure 14,
- the estimated weight of the underlayer rocks is in the range of 20 to 50 lbs, the underlayer is undersized relative to the armor rock weight (typically the weight of the underlayer rocks is 10% of the armor rock weight) therefore underlayer rocks can be removed from the revetment by wave action as shown in Figure 15,
- some large voids and causeway foundation exposed were observed at section 10 (see Figure 11), plus a cracked armor rock,
- from section 11 onwards up to 11th Avenue the revetment is mainly composed of 12-inch underlayer rocks, and few large armor rocks as shown in Figure 16,
- along 11th Avenue, the revetment is also poorly engineered consisting of only large rocks and no underlayer, the slope is exposed, however, vegetation is well established indicating that waves and high water levels may have negligible effect in this area, a view of the revetment along 11th Avenue is shown in Figure 17,
- most armor units did not show any cracking,
- the revetment and road did not show signs of settlement, and
- the crest showed no signs of overtopping damage.

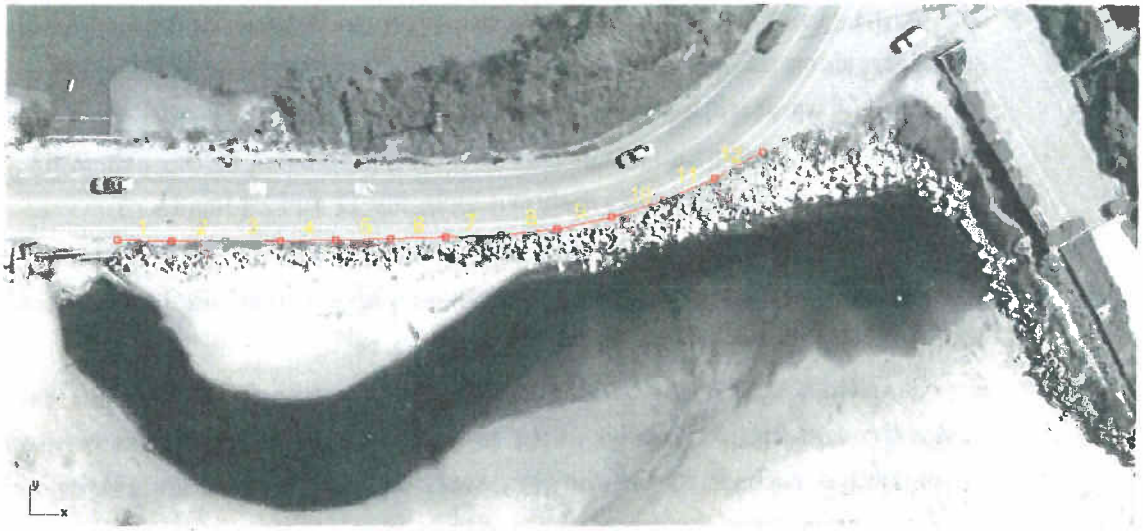


Figure 10. Schwan Lake revetment along East Cliff Drive.

Figure 11. Example of void on revetment exposing underlayer and foundation along sections 8 to 9.

ATTACHMENT 8

Figure 12. View to the east of the revetment on East Cliff Drive on east side of culvert outfall structure.

Figure 13. Vegetation along revetment.

ATTACHMENT 8

Figure 14. Exposed revetment underlayer.

ATTACHMENT 8

Figure 15. Underlayer rocks on the beach removed from the revetment.

Figure 16. View of the revetment from section 11 to 11th Avenue.

ATTACHMENT 8

Figure 17. Revetment along 11th Avenue.

ATTACHMENT 8

The culvert outfall structure is shown in Figure 18. It is a concrete structure with a top elevation of approximately +10 feet NGVD 29 (County of Santa Cruz Public Works, 2010) with three 66-inch culverts that connect Schwan Lake to the beach. Concrete wing walls that are buried under the revetment were noted.

A review of drawings provided by County of Santa Cruz Public Works showed that a 36-inch diameter Sanitary Sewer Force Main (SSFM) pipe is buried in the sand running just seaward and parallel to East Cliff Drive. The SSFM runs inside a rectangular concrete encasement with a top elevation of approximately +0 feet NGVD 29, which is the coincident with the MSL. According to a California State lifeguard interviewed during the inspection and who has been patrolling the beach for the last 7 years, the culverts which were half-filled with sand at the time of the inspection, have never been fully exposed due to beach erosion. This observation was later confirmed by County of Santa Cruz Public Works engineers (email dated 10/8/10) who indicated that there are no records of the SSFM having been exposed due to beach erosion. Figure 19 shows a plan view of the SSFM alignment and Figure 20 shows a cross-section developed by the County that resulted from a survey of the structure.

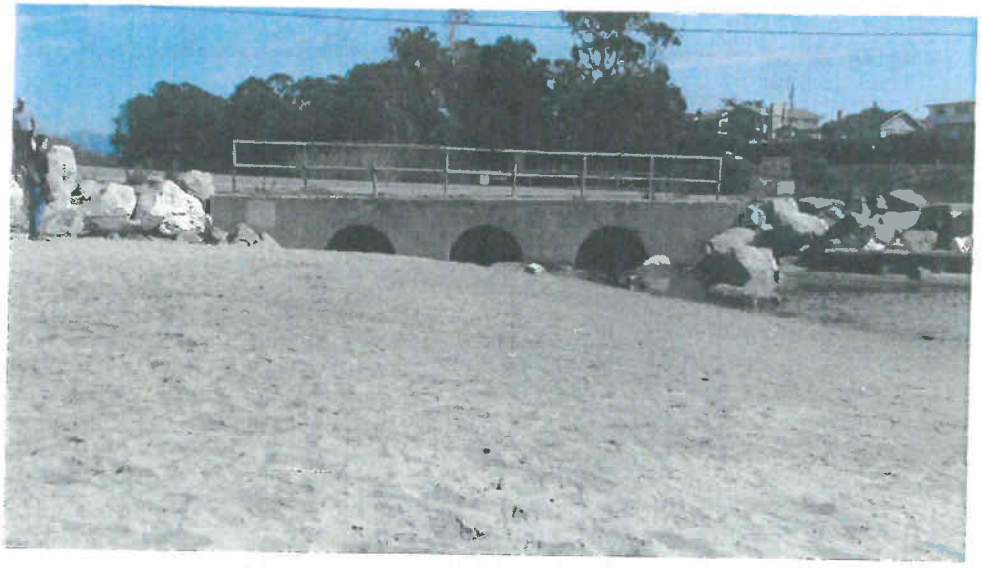


Figure 18. Schwan Lake culvert outfall structure.

ATTACHMENT 8

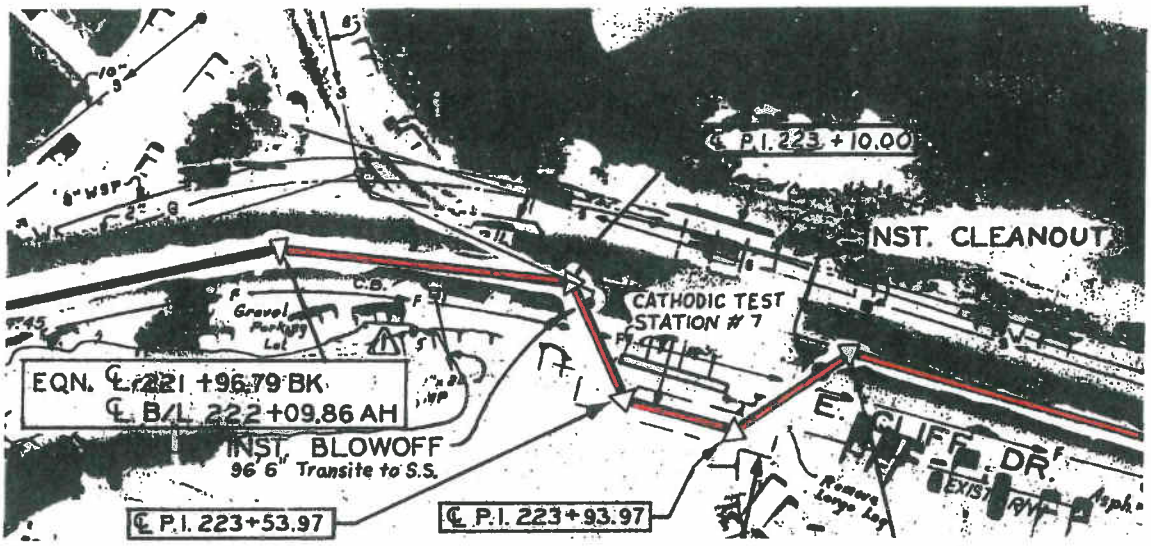


Figure 19. SSFM alignment across the culvert outfall structure.

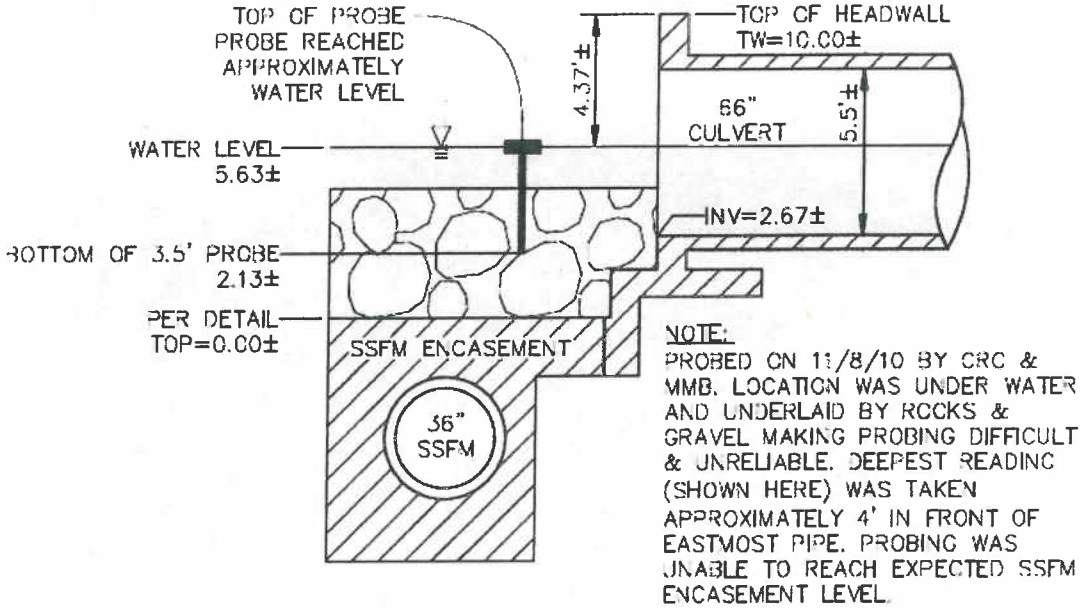


Figure 20. Culvert and SSFM cross-section.

ATTACHMENT 8

4 Assessment of the Need of Protection Structures

In order to determine the need of structures to protect the planned improvements, an assessment of the risk of bluff erosion was performed. This assessment was of qualitative nature given the very limited data and information available for the project site.

Bluff erosion is caused by a variety of reasons of marine and terrestrial nature. Among these, key reasons include the composition of the bluff, waves, water levels, and exposure such as the presence of a beach in front of the bluff. The project area along East Cliff Drive is fronted by the TLSB which is limited to the west by the Santa Cruz Small Craft Harbor and to the east by 11th Avenue on the east side of Schwan Lake. It consists of two straight segments near beach level separated by a more elevated, pronounced S-turn just east of Assembly Avenue. According to RJA (1995), the two straight segments are constructed on fill embankments over beach and/or lagoonal deposits. The S-turn occupies a partial bench cut in the low, moderately steep coastal bluff, with a fill wedge on the outboard side. The coastal bluffs in the area consist of interbedded marine sandstones and siltstones of the Pliocene Purisima Formation that are poorly to moderately indurated and vary considerably in resistance to wave erosion. These are overlain by unconsolidated sands and gravels of the Quaternary terrace deposits that are very erodible (Griggs, 1976). The beach is underlain by coastal deposits of variable thickness resting on Purisima bedrock. RJA (1995) and Griggs (1983) provided a very comprehensive analysis of storm history from 1910 to 1983 in northern Monterrey Bay from which it becomes evident that the likelihood of high storm waves/tides conditions conducive to beach and bluff erosion, and damage to structures is reasonably high. On this basis, Griggs (1983) recommended that serious and careful consideration should be given in the planning for coastal land use and protection in the Santa Cruz area. With regards to exposure, two time periods are relevant for the analysis of bluff erosion at TLSB, one prior and the other after the construction of the Santa Cruz Harbor in 1964. Prior to the construction of the harbor, the bluffs at the project site were fronted by a wide beach which received sand, mainly, from two sources: the San Lorenzo River and littoral drift from the northwest. Figure 21 shows TLSB in 1961 prior to the construction of the harbor. According to Griggs (1976), during most of the year prior to harbor construction practically no beach was exposed, and the bluffs were subjected to wave attack during high tide or storm periods and serious recession of the bluffs was occurring upcoast from the harbor. By the time the west jetty was completed in 1963 significant amount of sediment started to accumulate on the west side of the harbor entrance and at the

harbor's entrance channel, while TLSB and other beaches downcoast were subjected to a corresponding significant depletion of sediment. Since then and to date, annual maintenance dredging of the harbor and disposal of dredged material at TLSB is necessary to restore the beach and the littoral drift.

Figure 21. TLSB in December 1961 prior to harbor construction, Griggs (1976).

An analysis of bluff erosion pre and post harbor construction made by Griggs (1976) based on measurements at several stations and analysis of aerial photographs showed that for the project area, bounded by stations 9 to the east and 11 to the west, bluff erosion rates decreased significantly from approximately 20 cm/year to approximately 5 cm/year after the construction of the harbor, see Figure 22. This was attributed to the accumulation of sand on the beach to the west side of the harbor entrance (Seabright Beach) and the annual nourishment of TLSB. While no measurements of bluff erosion were made at TLSB, the estimates at stations 9, 10 and 11 at each side of TLSB could be considered representative of TLSB.

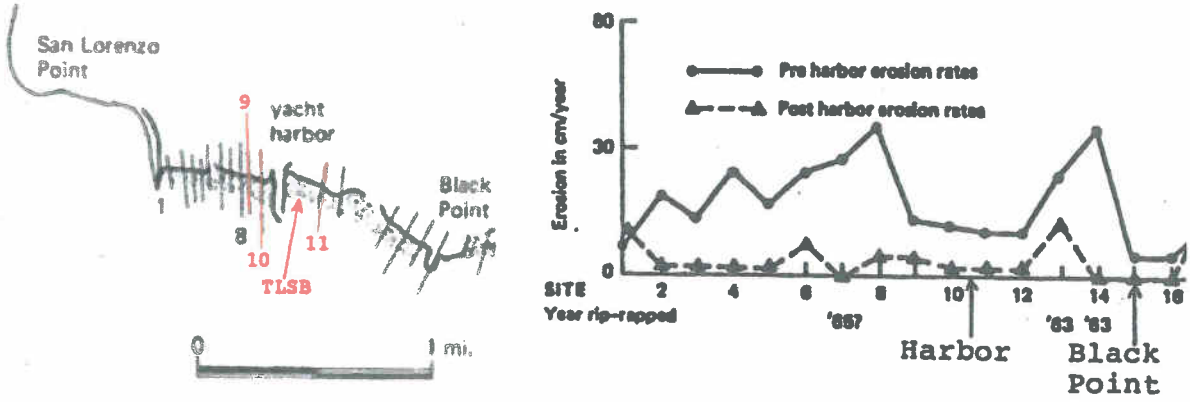


Figure 22. Bluff erosion measurement stations and rates of erosion (Griggs, 1976).

In 1995, RJA (1995) took the analysis of TLSB a step further and analyzed 13 large-scale stereo aerial photographs from 1931 to 1989. Figure 23 shows the position of the shoreline at TLSB for selected winter storms after the harbor was constructed. The 1964 shoreline, marked with the double dashed line, shows the configuration of the beach after construction but before the beach was nourished. The 1964 shoreline position could be indicative of that resulting in years of limited or no beach nourishment. In the absence of nourishment the beach width at TLSB would be narrower than before the construction of the harbor and, consequently, bluff erosion could also be higher.

However, despite the annual harbor maintenance dredging and nourishment of TLSB since 1965, winter storms have continued to erode the beach and have produced conditions conducive for bluff erosion in different degrees. Figure 23 shows estimated shoreline positions for the winter storms of 1982, 1983, 1984 and 1986. It can be observed that while the west side of the beach by the east harbor jetty could maintain a wide beach that would protect the bluff, the area at the S-turn at the end of Assembly Avenue continues to be vulnerable to bluff erosion. In this area, the worst erosion occurred in the El Niño winter of 1983 when the bluff was eroded approximately 20 feet; a retreat that exceeded the cumulative retreat (14 feet) at this location for the entire period of 1931 to 1973 (RJA, 1995). Rip-rap was placed at this location to prevent further undermining of the road foundation.

Figure 24 and Figure 25 show a view of TLSB to the east and west, respectively, from the S-turn at Assembly Avenue after the 1982-83 winter storms. It can be observed that the beach has been completely depleted of sand, the bedrock exposed and signs of wave erosion of the bluff and overtopping are evident. Figure 26 shows the rip-rap repair that was necessary to protect the bluff. Figure 27 shows a view of TLSB to the west in a relatively calm day in 1980 where due to high tide and an eroded beach condition waves are reaching

ATTACHMENT 8

the bluff's toe. By 1986, the parking lot, seen on the east side of the beach fronting the Schwan Lake inlet, was eroded and destroyed by the waves (RJA, 1995).

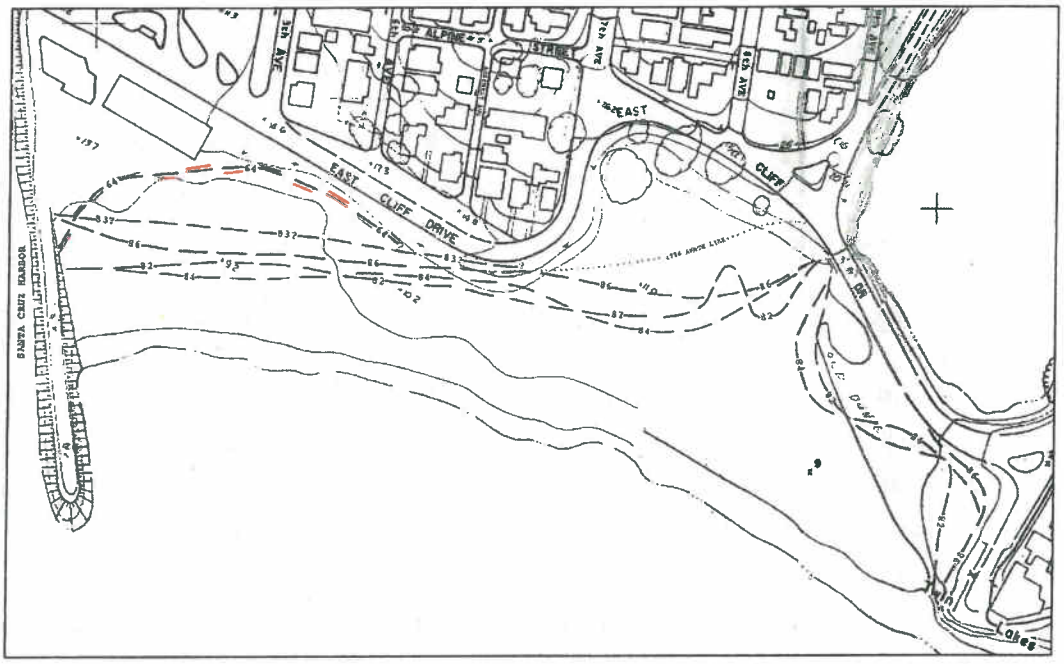


Figure 23. Shoreline position at TLSB for selected winter storms after harbor construction, 1964 (double dashed line) non-nourished beach shoreline.

Figure 24. View of TLSB to the east after the 1982 winter storms.

ATTACHMENT 8

Figure 25. View of TLSB to the west after the 1982 winter storms.

Figure 26. Rip-rap repair at the S-turn after the winter 1983 storms.

ATTACHMENT 8

Figure 27. View of TLSB to the west in 1980.

After the winter of 1983, several winter storms affected TLSB. However, the effects of these storms on the shoreline were not as significant as those occurring during El Niño winters. RJA (2009) reported the effects of the El Niño storms of January 29 to February 7 1998, when the TLSB suffered near complete erosion. Figure 28 shows a view of the beach to the east at the S-turn around Assembly Avenue where the exposure of the bedrock and evidence of bluff erosion can be observed.

Figure 28. View of TLSB to the east after the storms of 1/29 to 2/7, 1998.

ATTACHMENT 8

Figure 29 and Figure 30 show the rip-rap which was placed at the S-turn after the 1983 storm. The rip-rap seems undersized and appears to have been placed as a mound instead of an engineered structure. Evidence of damage to the rip-rap and bluff erosion can be observed.

Figure 29. Rip-rap at the S-turn after the storms of 1/29 to 2/7, 1998.

Figure 30. Rip-rap and bluff at the S-turn after the storms of 1/29 to 2/7, 1998.

ATTACHMENT 8

The preceding analysis of the anecdotal evidence, scientific research, and results of previous investigations showed that during years of severe winter storms or less than planned beach nourishment, the beach would be depleted of sand due to the erosive action of the waves; exposing the bluffs, adjacent roadway at East Cliff Drive and the planned improvements to potential damage due to wave erosion, overtopping and flooding. The low bluffs fronting TLSB have shown erosion both before and after the construction of the harbor although decreased retreat was observed for the latter.

It is therefore concluded that on the basis of preceding analysis and in conjunction with current projected trends in sea level rise due to global warming and the exposed location of the project to ocean waves, the risk of bluff erosion is high and protection structures are considered necessary to stabilize the bluffs and protect the planned beachfront improvements.

ATTACHMENT 8

5 Approach to the Definition of Total Water Levels (TWL's)

Generated by infrequent storms, extreme water levels are events of relatively short duration that can cause significant damage. The increase of water levels along the coast above the astronomical tide, hereinafter referred to as the Total Water Level (TWL), is mainly due to four distinct effects: barometric pressure, wind and wave setup, and wave runup. At exposed US Pacific Coast locations such as Santa Cruz, the increase of water level due to barometric pressure and wind setup, often referred to as "storm surge", could be a component of relatively minor effect when compared to the potential increase of water level due to wave setup and runup.

Traditionally, extreme water levels and corresponding flooding risks have been computed using an "event" based approach. At exposed locations on the US Atlantic and Gulf Coasts, where continental shelves are wide and hurricanes deliver strong winds, the risk of extreme water levels can be associated to the risk of the forcing event, a hurricane, given the dominant contribution of the event-induced effects to the total water level. At exposed locations on the US Pacific Coast no single effect is dominant; relatively lower wind velocities, narrow continental shelf widths and narrow wave spectra all combine to make wave setup and runup to be effects of the same order of magnitude as the astronomical tide. Furthermore, all these are statistically independent and their statistical relationships are not well defined. Consequently, the application of joint probabilities, Monte Carlo simulations or empirical methods is difficult and often inaccurate, given the somewhat subjective and simplified definition of the probabilities of the joint effects.

A "response" based approach, in turn, offers the principal advantage that assumptions concerning the joint probabilities of the astronomical tide, storm surge, swell and seas setup/runup do not need to be addressed since the risk of extreme water levels can be determined from the analysis of the long-term TWL (the response) that result from the combination of these processes, which are obtained from measurements and/or numerical predictions. In many ways, this is a more objective approach since any joint probability assumptions of events and simplifications do not have to be made.

Given the above considerations, and per FEMA guidelines (FEMA, 2004), a response based approach was used in this study to compute the extreme TWL's, for three sea level rise scenarios. Accordingly, and for each of these scenarios, a wave hindcast was computed in shallow water just offshore TLSB, which was then used in a wave runup model

to derive the corresponding long-term runup time history. The wave runup was added to predicted still water levels to obtain the TWL time histories. Finally, extreme value analysis were performed to compute the 1% annual extreme TWL (100-year return period) for each sea level rise scenario.

ATTACHMENT 8

6 Definition of TWL's

The TWL, referred to a datum of choice, is composed of water levels forced by different mechanisms and with different time scales. At one end of the time scale, the MSL exhibits variations in a time scale of years. The Still Water Level (SWL), which oscillates about the MSL, is forced by the astronomical tide and storm surge (wind setup and atmospheric pressure changes), both of which have time scales of hours. Locations on the US Pacific Coast such as Santa Cruz are affected by changes due to El Niño/La Niña which have an intra-annual time scale. Waves breaking on the beach will induce a time varying elevation of the SWL. The static (mean) elevation is often referred to as the wave setup while the swash, with a time scale of seconds, is the amplitude of the time varying elevation. Finally, the wave runup is defined as the set of discrete water-level elevation maxima measured on the foreshore, with respect to the SWL (Stockdon et al., 2006). Figure 31 shows a schematic of these various water levels.

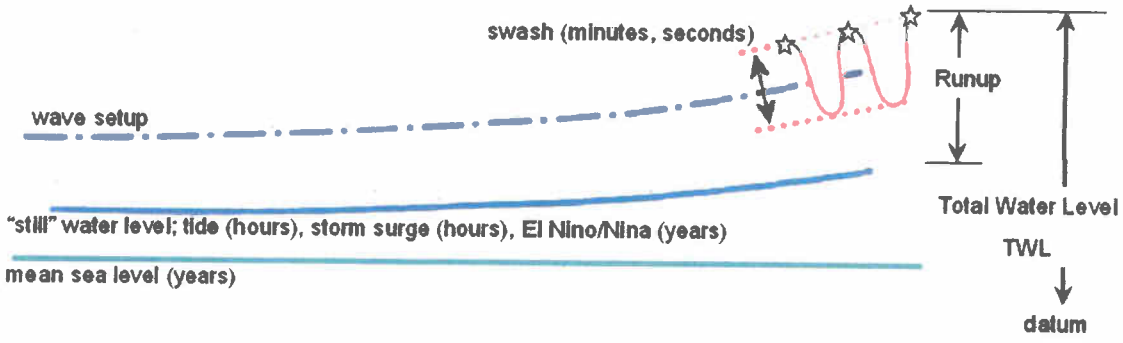


Figure 31. Water levels.

As described in section 3.5, the SWL was synthesized by adding the astronomical tide prediction at Santa Cruz to the water level anomaly at Monterey. To compute the TWL's, the wave runup was added to the SWL for each of the sea level rise scenarios considered. Because wave runup is a function of the wave conditions, a wave hindcast just offshore TLSB was computed.

6.1 *Sea Level Rise Scenarios*

Extreme TWL's were computer for the following three sea level rise scenarios:

- Sea level rise with no global warming, year 2110 (100 years from 2010)

ATTACHMENT 8

- Sea level rise due to global warming, year 2060 (50 years from 2010)
- Sea level rise due to global warming, year 2100 (90 years from 2010)

Due to the absence of long-term water level measurements at Santa Cruz, the sea level rise with no global warming for the year 2110 was computed extrapolating the linear trend of the historical measurements at Monterey. Figure 32 shows the mean sea level trend at Monterey, which represents an increase in the mean sea level of 0.134 m (0.44 feet) in 100 years.

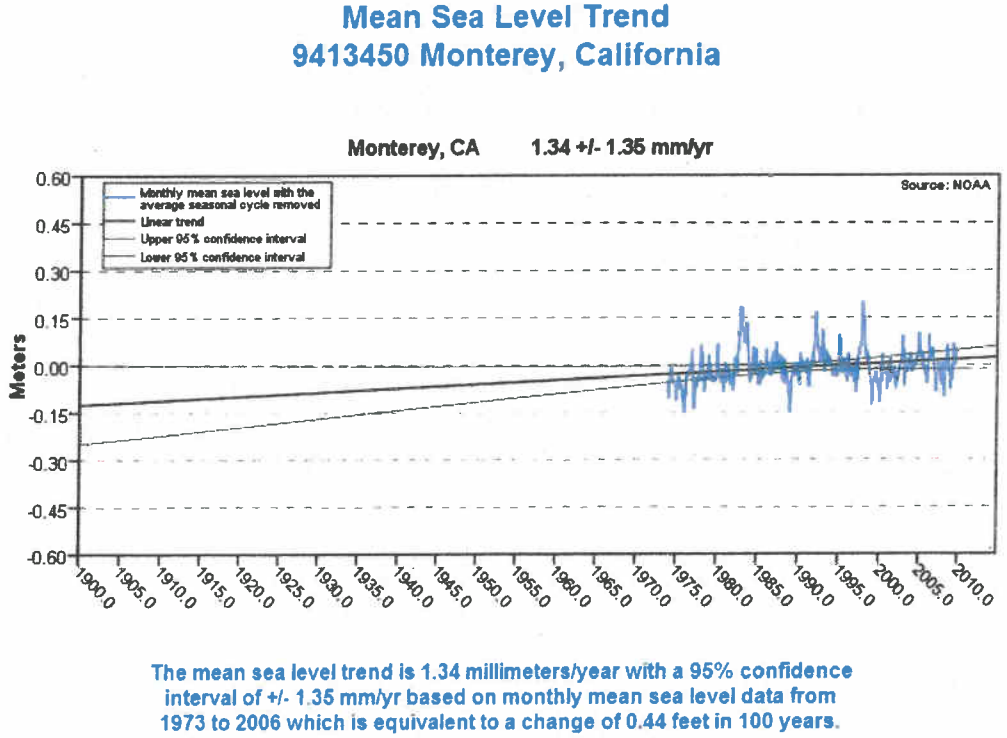


Figure 32. Mean sea level trend at Monterey.

Sea level rise due to global warming 50 and 90 years from 2010 were selected from Heberger et al. (2009). The A2 medium-high greenhouse-gas scenario, characterized by "self-reliance and preservation of local identities (IPCC, 2000), and population expected to continuously increase, but economic growth and technological development are expected to be slow" was selected, between the more and less conservative scenarios A1-F1 and B1. Shown in Figure 33, the predicted sea level rise by 2060 for scenario A2 would be in the order of 0.60 m (approximately 2 feet) and 1.4 m (4.6 feet) by 2100. Table 2 lists the three sea level rise scenarios selected for this study.

ATTACHMENT 8

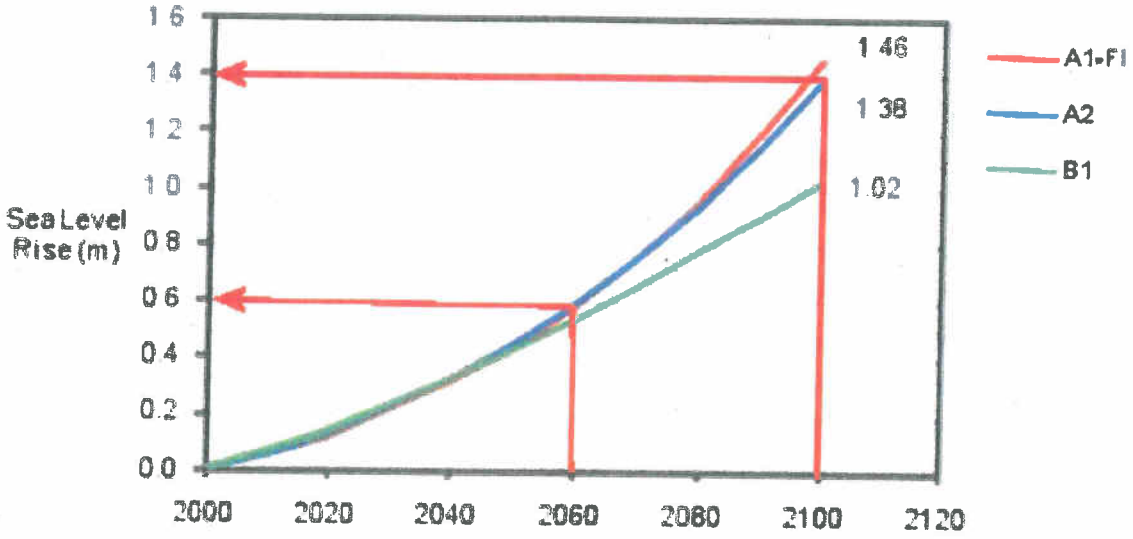


Figure 33. Selected sea level rise due to global warming.

Table 2. Sea level rise scenarios.

Scenario	Sea Level Rise m (feet)
No Global Warming, year 2110	0.13 (0.44)
Global Warming, year 2060 (50 years from 2010)	0.60 (2.00)
Global Warming, year 2100 (90 years from 2010)	1.40 (4.60)

6.2 *Wave Conditions at TLSB*

In order to derive wave conditions representative for TLSB, wave transformation modeling was performed by which the deep water long-term wave hindcast at GROW point 39170 was transformed to a location just offshore TLSB. Use was made of MIKE 21 Spectral Wave (SW), a numerical model developed by the Danish Hydraulic Institute (DHI). MIKE 21 SW uses a flexible unstructured mesh computational approach to simulate the growth, decay and transformation of waves and swells in offshore and coastal areas. The model has the capability to include the effects of refraction and shoaling due to varying depth, diffraction, dissipation due to bottom friction, wave-wave and wave-current interactions, and wave breaking due to depth and steepness.

ATTACHMENT 8

Given the computational expense of transforming the wave conditions at each time step (3 hours) of the 39-year long deep water wave hindcast, the wave hindcast at TLSB was computed using transfer functions. These transfer functions related the wave conditions at TLSB with the corresponding conditions in deep water. Given the availability of measurements at CDIP Station 006, wave conditions at this location were also computed in a similar manner to perform a calibration of the wave predictions. Figure 34 shows the MIKE 21 SW model mesh, and the locations of the GROW deep water wave hindcast and CDIP Station 006. Figure 35 shows the locations of CDIP Station 006, the location at which TLSB wave hindcast was derived in a water depth of approximately 9.55 m (MLLW), and selected representative beach transects A-A' and E-E'.

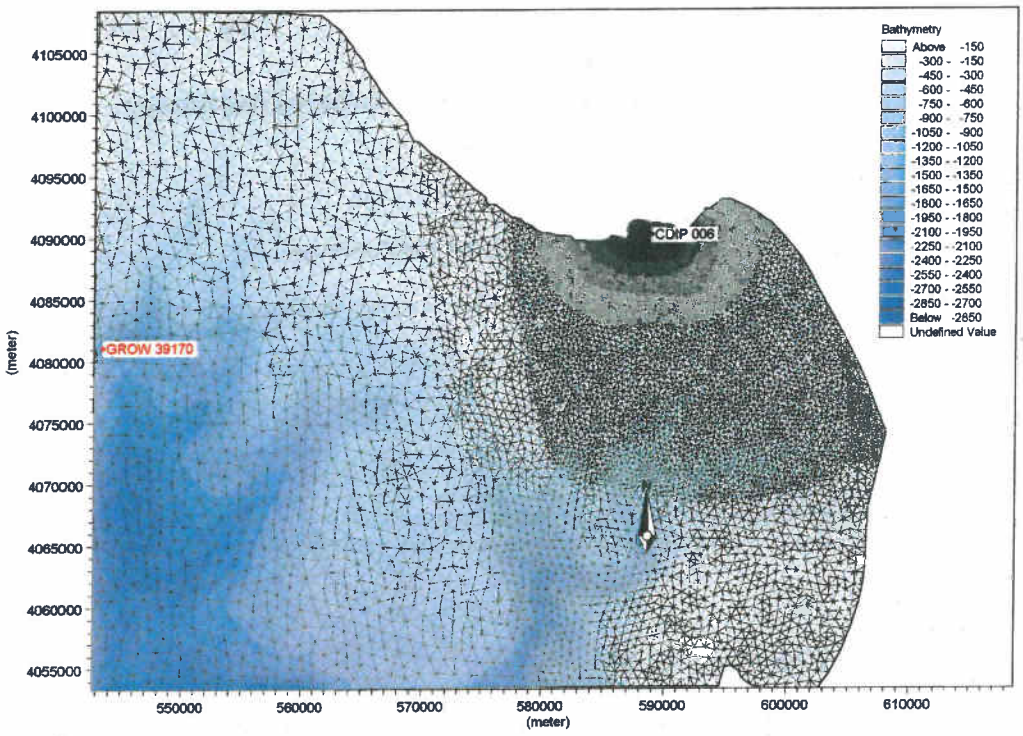


Figure 34. MIKE 2 SW wave modeling mesh.

ATTACHMENT 8

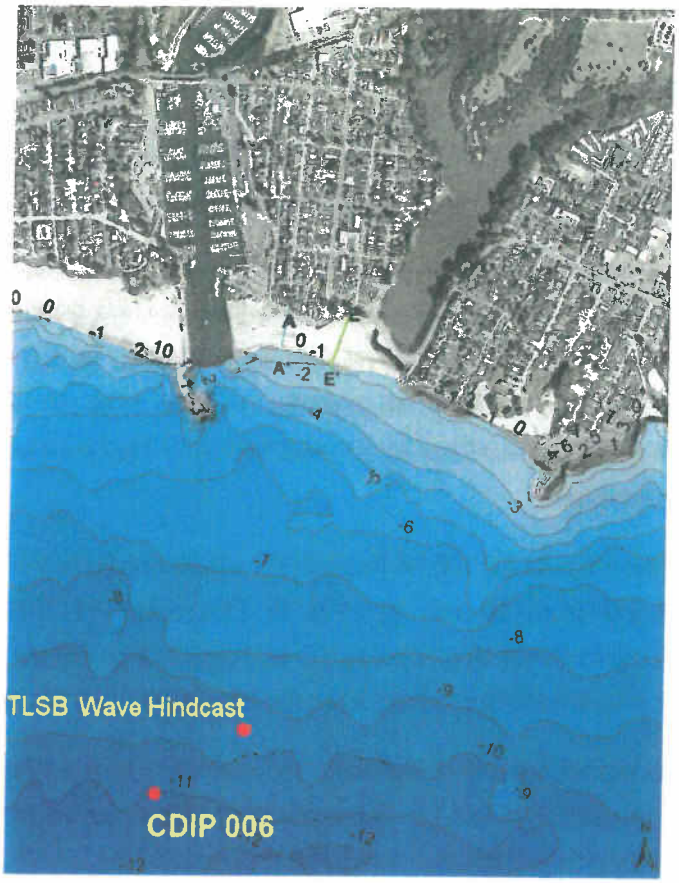


Figure 35. Locations of TLSB wave hindcast and CDIP Station 006 (depths in m, MLLW).

The computation of the wave hindcast at TLSB was performed as follows:

1. A Frequency of Occurrence Table (FOT) of period versus direction was computed from the deep water wave hindcast, and ranges for the most likely seas and swell conditions were defined.

2. Sea level rise scenarios and still water levels at Santa Cruz were examined, and three water levels were selected.

3. For seas and swells, and for each water level selected, a matrix of deep water wave period and direction combinations was defined.

4. For each water level and period/direction combination in the matrix, wave transformation simulations were performed using a unit significant wave height (Hm0 = 1 m). The resulting wave heights at the locations of interest represented the

ATTACHMENT 8

wave transformation coefficients. The wave period was assumed to remain unchanged.

5. For CDIP Station 006 and TLSB locations, seas and swell three-dimensional period, direction and water level transfer functions were computed using B-splines.

6. The transfer functions were used to derive the seas and swell conditions at CDIP Station 006 by applying the transfer function at each time interval of the deep water wave hindcast, for the sea level rise scenario with no global warming. Total wave heights were computed by adding the seas and swell energies according to Hm0_total = (Hm0_seas^2 + Hm0_swell^2)^1/2. This step was repeated for all sea level rise scenarios.

7. Predicted wave heights at CDIP Station 006 where compared with the measurements for the period from January 1, 1993 to December 31, 1995. Offset and scale calibration coefficients were computed and applied to adjust the predictions and achieve the best correlation, in the least squares sense.

8. Calibration coefficients were applied to the wave height predictions at CDIP Station 006 from January 1, 1996 to September 22, 2001 to verify the quality of the agreement between predictions and measurements.

9. The calibration coefficients were applied to the wave hindcast at TLSB to obtain the adjusted hindcast to use in the computation of wave runup and TWL's.

Table 3 summarizes the combinations of peak periods (Tp) and mean wave directions (MWD) used in the wave simulations, which where performed at the three sea level rise scenarios listed in Table 2.

Table 3. Seas and swell conditions for the wave transformation simulations.

	Tp	MWD
Seas	4 to 12 seconds Every 1 second	180 to 330 degrees Every 10 degrees
Swell	8 to 24 seconds Every 2 seconds	180 to 330 degrees Every 10 degrees

Figure 36 and Figure 37 show the measured and predicted (hindcast adjusted) wave heights at the CDIP 006 location from 1993 to 2001 and the corresponding Q-Q plot. The agreement is very good, however a slight under-prediction of wave heights is noticed.

ATTACHMENT 8

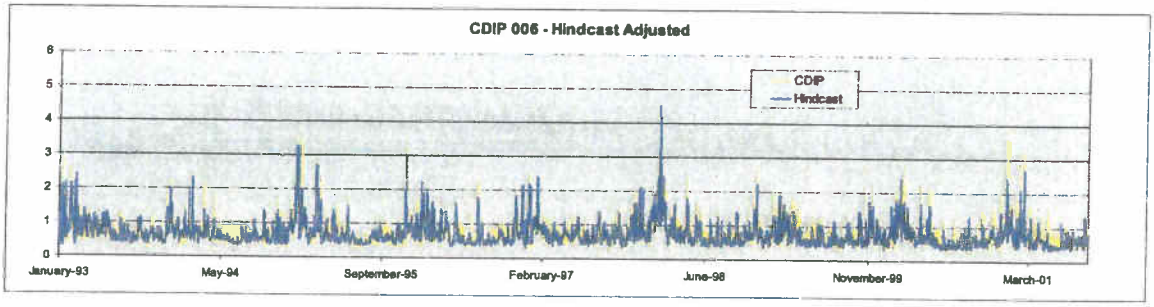


Figure 36. Measured and predicted (hindcast adjusted) wave heights at the CDIP 006 location from 1993 to 2001.

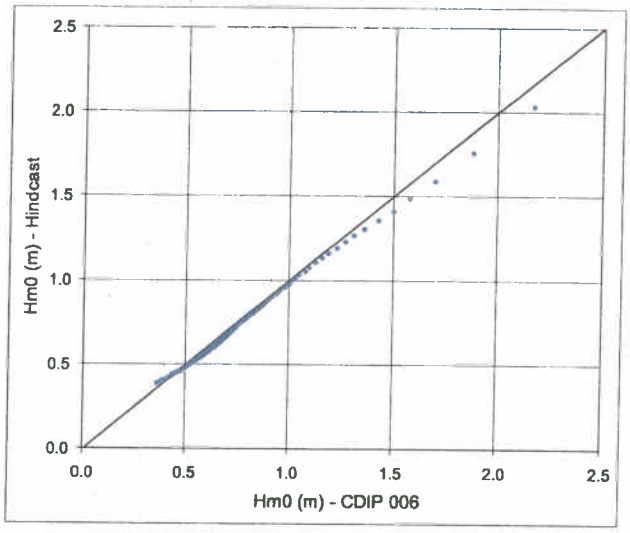


Figure 37. Q-Q plot of predicted (hindcast adjusted) versus measured wave heights at the CDIP 006 location from 1993 to 2001.

6.3 *Total Water Levels (TWL)*

The computation of the TWL's requires SWL's, wave and wave runup time histories. The SWL was computed adding the tide levels at Santa Cruz and the sea level anomaly at Monterey. Wind setup was computed using the formulation of Kamphius (2000) and the resulting elevation of the water level due to this effect added to the SWL. Wave runup time histories were computed using a parametric model since this type of models, driven by the wave parameters, are well suited for the application of the response based approach used in this study. Due to its simplicity and sound experimental background, the model developed by Stockdon et al. (2006) was used. The model is defined by the following equation:

ATTACHMENT 8

$$R_{2\%} = 1.1\left\{0.35\beta_f (H_0 L_o)^{1/2} + \frac{\left[H_o L_o \left(0.563\beta_f^2 + 0.004\right)^{1/2}\right]}{2}\right\} \text{ for } \xi_0 \geq 0.3$$
$$R_{2\%} = 0.043 (H_0 L_0)^{1/2} \text{ for } \xi_0 < 0.3 \quad (1)$$

where,

- $R_{2\%}$ is the runup at the 2% exceedance probability.
- β_f is the average offshore seabed slope.
- H_0 is the "equivalent" deep water wave height, i.e. the "de-shoaled", local wave height.
- L_0 is the deep water wave length (= $gT^2/2\pi$).
- T is the wave period.
- ξ_0 is the Iribarren number (= $\beta_f/(H_0/L_0)^{0.5}$).

The runup for typical beaches ($\xi_0 \geq 0.3$) consists of three components, as is seen in Eq. (1): the mean wave setup, incident swash (T < 20 sec) and infragravity swash (T > 20 sec) components. The runup is a function of the de-shoaled deep water wave height and length, and beach slope. For extremely dissipative conditions ($\xi_0 < 0.3$) the runup is a function of wave height and period and it is independent of the offshore slope.

For each sea level rise scenario, TWL's were computed for transects A-A', E-E' and FGH. Slopes for these transects were computed from the summer (nourished) profiles shown in Figure 7,

- 0.065 slope of profile A-A'
- 0.030 slope of profile E-E'
- 0.036 slope of profile FGH

Due to the lack of historical beach profiles and uncertainty in the accuracy of the winter (eroded) profiles, slopes for this condition were assumed to be the same as those of the summer (nourished) profiles. However, because for the selected sea level rise scenarios the winter (eroded) beach profiles would be mostly submerged, the TWL's computed for these accounted only for wave setup.

For each sea level rise scenario, 100-year TWL's at beach transects A-A', E-E' and FGH were computed by fitting the corresponding 39 annual TWL maxima for the summer

ATTACHMENT 8

(nourished) and winter (eroded) beach profiles to the Weibull distribution. Table 4 lists the 100-year TWL's at TLSB for transects A-A', B-B', E-E' and FGH in the summer (nourished) and winter (eroded) beach conditions, where the TWL at B-B' was computed averaging the A-A' and E-E' TWL's.

Table 4. 100-year TWL's at TLSB for transects A-A', B-B', E-E' and FGH.

	TWL (NGVD 29) m (feet)							
	Transects							
	A-A'		B-B' *		E-E'		FGH	
	Summer (nourished)	Winter (eroded)	Summer (nourished)	Winter (eroded)	Summer (nourished)	Winter (eroded)	Summer (nourished)	Winter (eroded)
No Global Warming, Year 2110	4.37 (14.3)	3.99 (13.1)	3.95 (13.)	3.72 (12.2)	3.53 (11.6)	3.45 (11.3)	3.68 (12.1)	3.55 (11.6)
Global Warming, Year 2060	4.87 (16.)	4.48 (14.7)	4.44 (14.6)	4.21 (13.8)	4.01 (13.2)	3.93 (12.9)	4.16 (13.6)	4.03 (13.2)
Global Warming, Year 2100	5.73 (18.8)	5.33 (17.5)	5.29 (17.4)	5.05 (16.6)	4.85 (15.9)	4.76 (15.6)	4.99 (16.4)	4.86 (15.9)

* average of transects A-A' and E-E'

Note in Table 4 that TWL's are higher when there is sand on the beach (summer, nourished) and that TWL's are higher along the A-A' transect than along the E-E' transect. When there is sand on the beach, the runup is composed of the wave setup and the swash (see Figure 31) while during the winter, when the beach is eroded (see Figure 7) and water levels are anywhere higher than MSL (or in sea level rise scenario due to global warming) the super-elevation of the water level due to waves would consist mainly of wave setup because the beach would be submerged and waves would be reaching the bluffs. Because transect E-E' is milder than transect A-A', runup at E-E' is less than along A-A' because waves loose momentum and dissipate faster on horizontal than on vertical travel. Figure 38 shows estimates of 100-year TWL contours for the three sea level rise scenarios selected. Beach contours were taken from the topography provided by the County and surveyed by RJA (2009). TWL contours between transects A-A' and E-E' were interpolated to provide a smooth transition in the area between the transects.

The TWL's presented in Table 4 can be considered representative, but they must also be considered as preliminary estimates given that:

- the beach topography and slopes used to derive the TWL predictions represent just one of the several configurations that these could adopt after beach nourishment; and
- the computation of TWL's is very sensitive to beach slopes.

More accurate TWL estimates in the project area would require detailed beach topographic surveys for both summer (nourished) and winter (eroded) beach conditions and analysis using a wave/hydrodynamic model.

No contours were produced for the winter (eroded) condition because no beach topography was available for this condition.

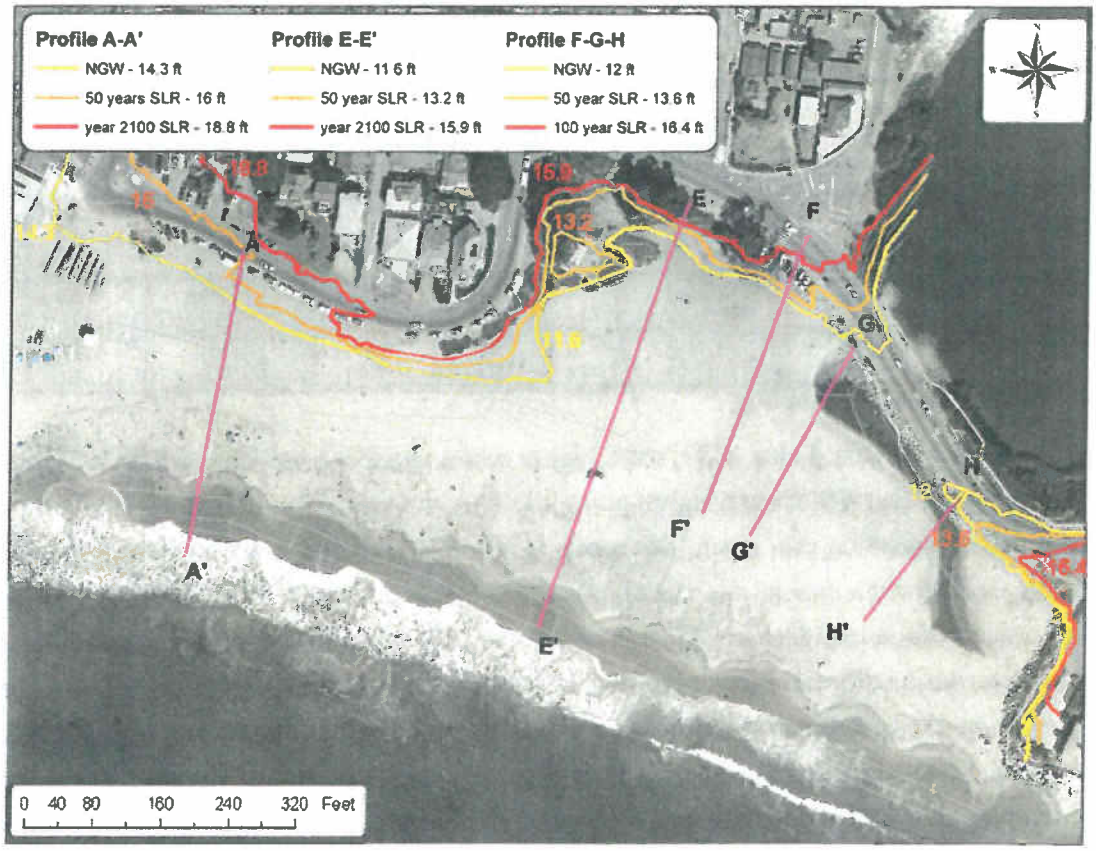


Figure 38. 100-year TWL's for the three selected sea level rise scenarios, summer (nourished) beach condition.

ATTACHMENT - 8

7 Comparison of Predicted and Observed TWL's

In order the verify the TWL predictions, comparisons between predicted TWL contours and observations were made. These comparisons are only qualitative because:

- the beach topography at the time of the storms was likely different than the one surveyed by RJA (2009) and used to plot the TWL contours,
- the beach erodes as the storm develops and slopes change, and
- observations are based on photographs for which time is unknown.

Photos of TLSB during four storms of interest were found and used for the comparisons:

- February 24, 2008
- January 29 - February 7, 1998
- January 5, 2008
- January 5, 1982

In addition, TWL contours for the storm of January 26, 1983, one of the worst storms on record in California, and representative of the 100-year TWL are presented.

7.1 Storm of February 24, 2008

Figure 39 shows a photograph of high water levels at the east end of TLSB by Schwan Lake during the storm of February 24, 2008. Figure 40 shows the predicted TWL contour during the peak TWL at transect FGH. The comparison is good as the TWL prediction shows water along most of the revetment and the photograph shows a water level slightly below the top of the road, with some rocks exposed, in the culverts area.

The predicted TWL in the Schwan Lake area is +8.95 feet NGVD 29, and the top of the road at the culvert outfall structure has an elevation of +10.11 feet NGVD 29 (County of Santa Cruz Public Works, 2010). The water flooding East Cliff Drive is likely due to wave overtopping. However, to the west of the inlet the photograph shows a flooded area larger than predicted. It is noted that the exact topography of the beach during the day of the storm is not known and that the beach may have eroded during the development of the storm providing for a larger floodable area.

ATTACHMENT 8

Figure 41 shows the significant wave height (Hm0) offshore TLSB, the SWL and TWL time histories during the storm. Note that if the storm would have arrived a couple of days earlier the maximum TWL could have reached 100-year levels as the storm would have coincided with a spring tide.

Estimated marine conditions during the peak TWL at transect FGH were:

- Peak TWL at 2/24/08 9:00 (GMT)
- Hm0 = 3.05 m (10.02 feet) (offshore TLSB)
- Tp = 17.7 seconds
- MWD = 209 degrees
- SWL = 0.78 m (2.57 feet) NGVD 29
- TWL (summer beach profile) = 3.32 m (10.9 feet) at transect A-A', 2.60 m (8.53 feet) at E-E', and 2.73 m (8.95 feet) at FGH.

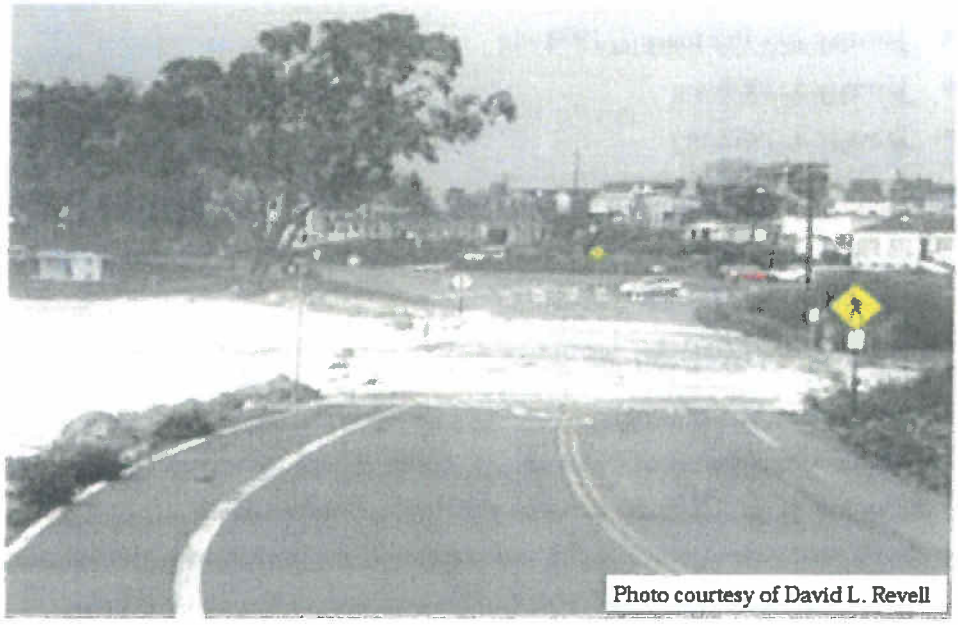


Figure 39. High water levels at the Schwan Lake inlet during the storm of February 24, 2008.

ATTACHMENT 8

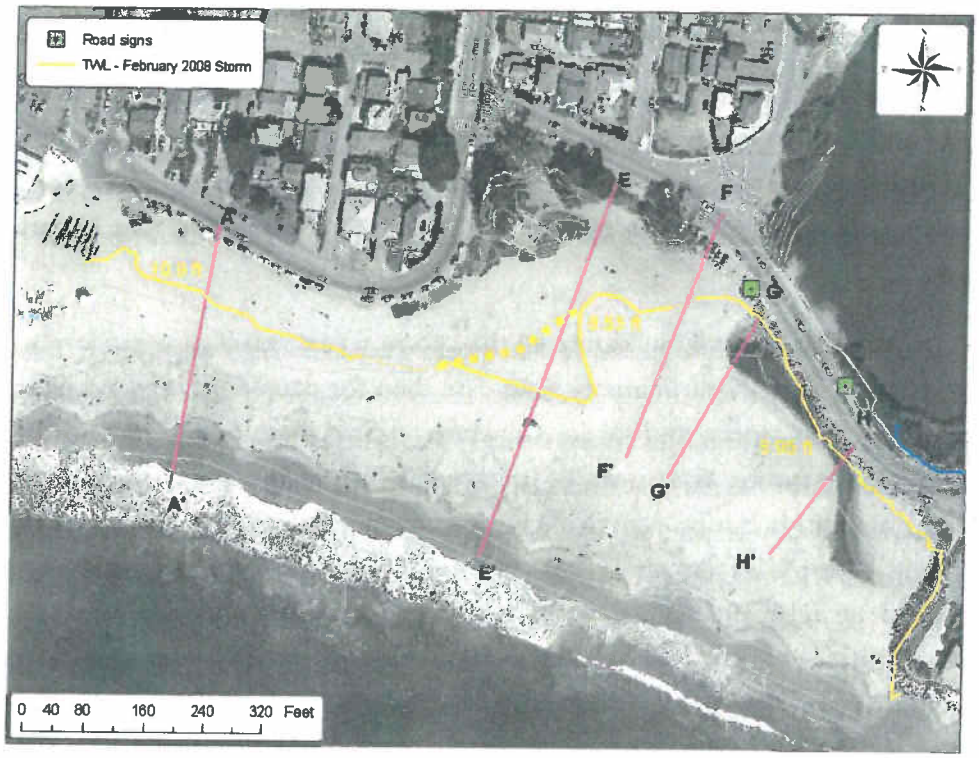


Figure 40. Predicted TWL during the peak of the storm of February 24, 2008 (dashed line shows location of local TWL contour after likely erosion of the berm to the southeast).

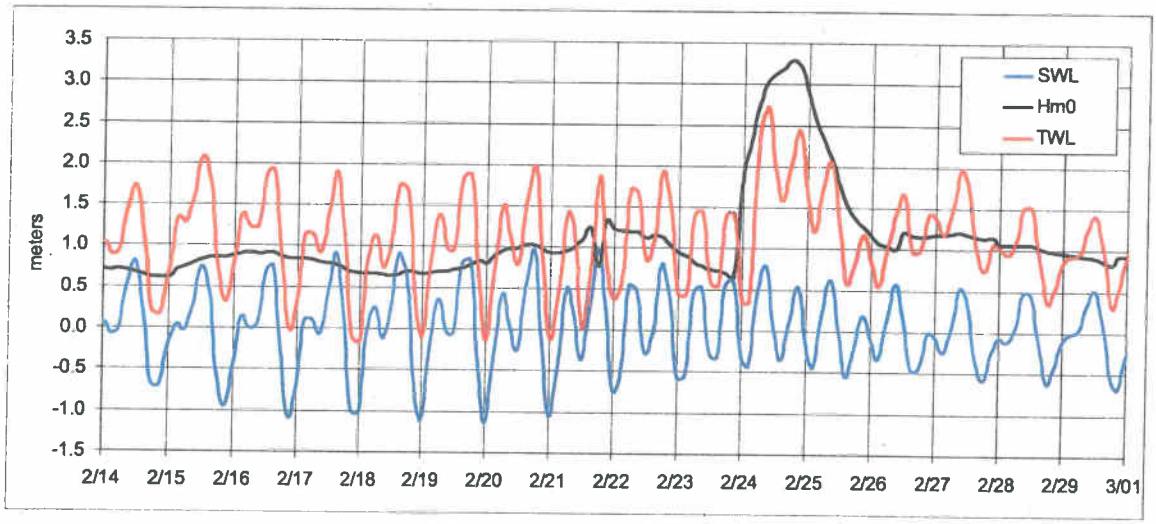


Figure 41. Significant wave height (Hm0) offshore TLSB, SWL and TWL (at transect FGH) during the storm of February 24, 2008 (GMT).

ATTACHMENT 8

7.2 Storms of January 29 - February 7, 1998

Figure 42 shows a view of TLSB on February 9, 1998 after several days of storm waves and high water levels that completely eroded TLSB. Figure 43 shows the predicted TWL contour during the peak TWL at transect A-A' on February 3. Figure 44 shows the significant wave height (Hm0) offshore TLSB, the SWL and TWL time histories during the storm.

It can be observed in Figure 44 that storm waves and high water levels lasted several days, from January 29 to February 3, to ease then for couple of days and increase again on February 6. This storm, and its consequences, demonstrate the importance of two aspects that are critical for the assessment of beach erosion: a) the combination of waves and SWL's, and b) duration. It can be seen in Figure 44 how relatively low waves when combined with relatively high SWL's (at times "t1" and "t2") can produce TWL's comparable to those generated by relatively higher waves occurring coincidentally with relatively low SWL's ("t3"). With respect to duration, the several days this storm lasted allowed to sustain an erosion power that eventually eroded the beach completely.

Estimated marine conditions during this storm were:

- Duration, from 1/29/98 to 2/7/98 (GMT)
- Hm0, ranged from 1 to 4.5 m (3.3 to 14.76 feet) (offshore TLSB)
- Tp, predominantly 15 seconds
- MWD, predominantly 210 degrees
- SWL, maximum approximately 1.25 m (4.1 feet) NGVD 29
- TWL (summer beach profile), approximately 3.5 m (11.4 feet) at transect A-A'.

Figure 42. View of TLSB to the northeast on February 9, 1998 (RJA, 2009).

ATTACHMENT 8

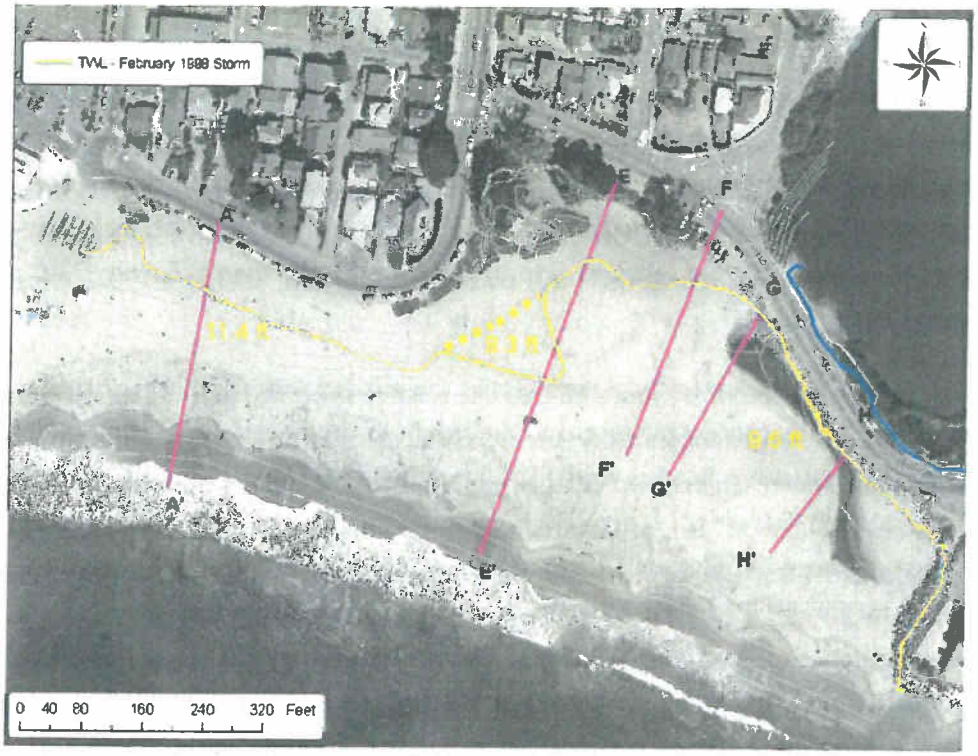


Figure 43. Predicted TWL on February, 1998 (dashed line shows location of local TWL contour after likely erosion of the berm to the southeast).

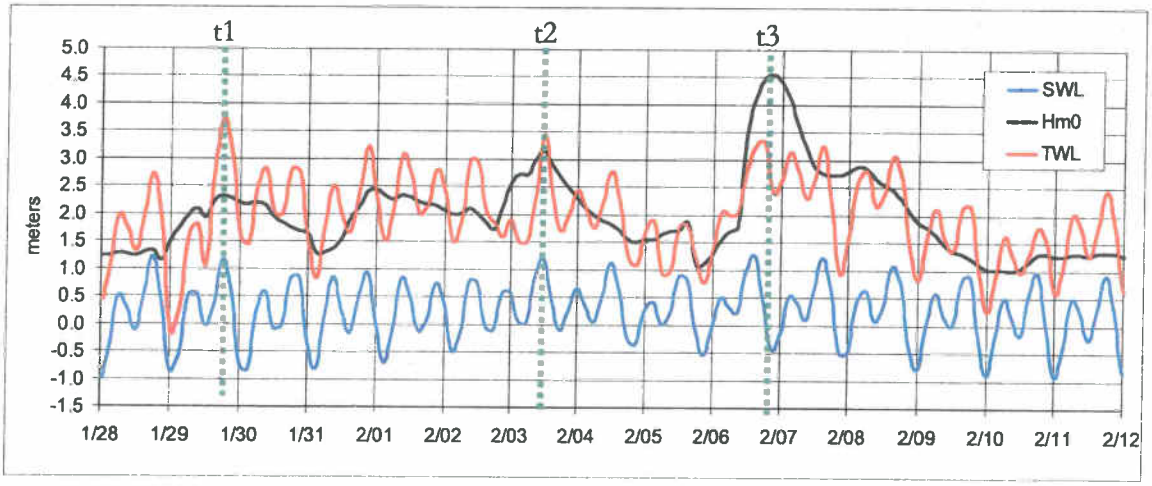


Figure 44. Significant wave height (Hm0) offshore TLSB, SWL and TWL (transect A-A') during the storm of February 1998 (GMT).

ATTACHMENT 8

7.3 Storm of January 5, 2008

Figure 45 shows a view of TLSB on January 7, 2008 after the storm of January 5. The beach eroded, but apparently not the point of exposing the bedrock. Some remaining beach sand can be observed forming a bluff along East Cliff Drive. Figure 46 shows the predicted TWL contour during the peak TWL at transect A-A' on February 5. Figure 47 shows the significant wave height (Hm0) offshore TLSB, the SWL and TWL time histories during the storm.

It can be observed in Figure 47 that the relative short duration of the storm, one day, was apparently not sufficient to erode the beach to the point of exposing the bedrock. Also, it is noted that wave heights and SWL's at times "t1" and "t2" are essentially the same. However, the TWL at "t2" is significantly higher than that at "t1". An inspection of the wave hindcast offshore TLSB showed that the peak wave period, Tp, at "t1" was approximately 9 seconds, while at "t2" it was 19 seconds; revealing the significant effect of wave period on the generation of wave runup. The location of TWL relative to East Cliff Drive in Figure 46 is consistent with the eroded shoreline (bluff line) shown in Figure 45 that resulted after the storm. A rough estimate of the location of the eroded shoreline was computed considering that the car on the photograph on East Cliff Drive had a 5-foot separation between the headlights. The resulting eroded shoreline position using this measure is approximately 90 feet from the center of East Cliff Drive eastbound lane, which is consistent with the approximately 100 feet location of the TWL relative to the road shown in Figure 46.

Estimated marine conditions during the peak TWL at transect A-A' were:

- Peak TWL at 1/5/08 15:00 (GMT)
- Hm0 = 2.25 m (7.4 feet) (offshore TLSB)
- Tp = 18.6 seconds
- MWD = 214 degrees
- SWL = 0.97 m (3.2 feet) NGVD 29
- TWL (summer beach profile) = 3.25 m (10.6 feet) at transect A-A', 2.61 m (8.6 feet) at E-E', and 2.72 m (8.9 feet) at FGH.

ATTACHMENT 8

Figure 45. View of TLSB to the west on January 7, 2008.

Figure 46. Predicted TWL on January 5, 2008 (dashed line shows location of local TWL contour after likely erosion of the berm to the southeast).

ATTACHMENT 8

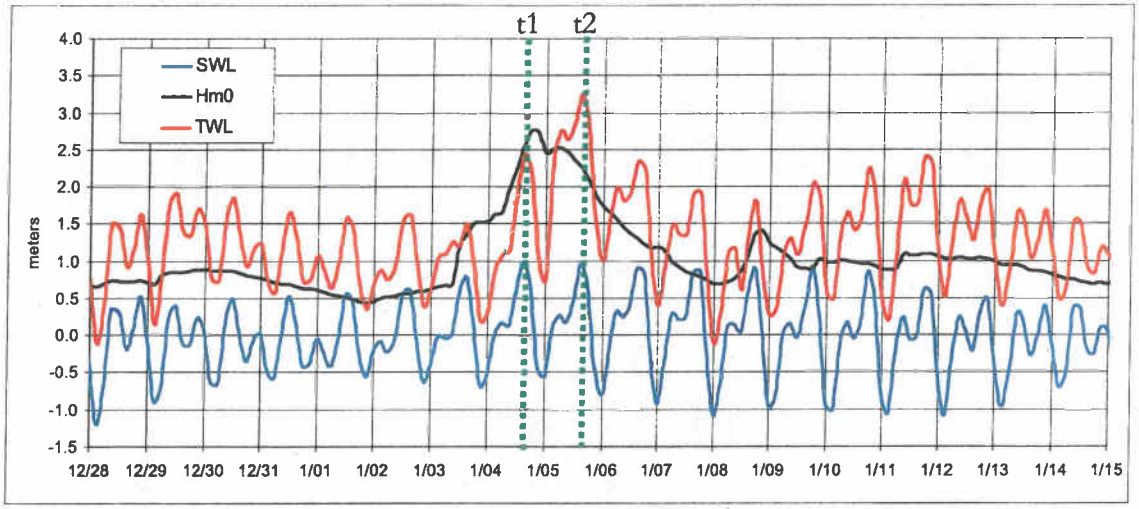


Figure 47. Significant wave height (Hm0) offshore TLSB, SWL and TWL (transect A-A') during the storm of January 5, 2008 (GMT).

7.4 Storm of January 5, 1982

The storm of January 5 of 1982 is remembered in Santa Cruz for the catastrophic impact of the rain it dropped between January 3 and 5, rather than by the effect of the waves on its coastline. As much as half the mean annual precipitation was recorded within a period of about 32 hours. It triggered landslides and floods throughout 10 counties in the vicinity of the San Francisco Bay. More than 18,000 of the slides induced by the storm transformed into debris flows that swept down hill slopes or drainages with little warning. Shortly after rainfall ceased, more than 459,000 m3 of earth and rock slid from a mountainside above the community of Love Creek in Santa Cruz County, burying 10 people in their homes (U.S. Geological Survey, 1988).

Nevertheless, this storm is worth of study because a significant amount of water accumulated in Schwan Lake was discharged to the ocean through the culverts, eroding and shaping the beach in the vicinity of the culvert outflow structure and possibly interacting with the waves in manner that could have affected the elevation of the TWL and final beach configuration.

Figure 48 shows an aerial view of TLSB on January 7, where the dashed line identifies the approximate location of the peak TWL. Figure 48 and Figure 49 show that waves reached the bluffs at Assembly Avenue.

ATTACHMENT 8

Figure 50 and Figure 51 show two views, to the east and south respectively, of the Schwan Lake discharge through the culverts. It is evident that wave conditions during the storm were not sufficient to significantly erode the beach, but the discharge was sufficiently strong to breach the beach and cut a channel to the ocean.

Figure 31 shows the predicted TWL contour during the peak TWL at transect A-A' on January 5. The predicted and observed TWL for this storm do not show a good agreement, leading to hypothesize that the water discharge of Schwan Lake may have had an important interaction with the waves and affected the resulting beach configuration. Figure 31 shows that in the absence of a discharge from Schwan Lake, seawater would have flooded the east end of TLSB.

Estimated marine conditions during the peak TWL at transect A-A' were:

- Peak TWL at 1/5/82 15:00 (GMT)
- Hm0 = 1.71 m (5.6 feet) (offshore TLSB)
- Tp = 10.4 seconds
- MWD = 209 degrees
- SWL = 0.92 m (3.01 feet) NGVD 29
- TWL (summer beach profile) = 2.22 m (7.28 feet) at transect A-A', 1.78 m (5.84 feet) at E-E', and 1.93 m (6.34 feet) at FGH.

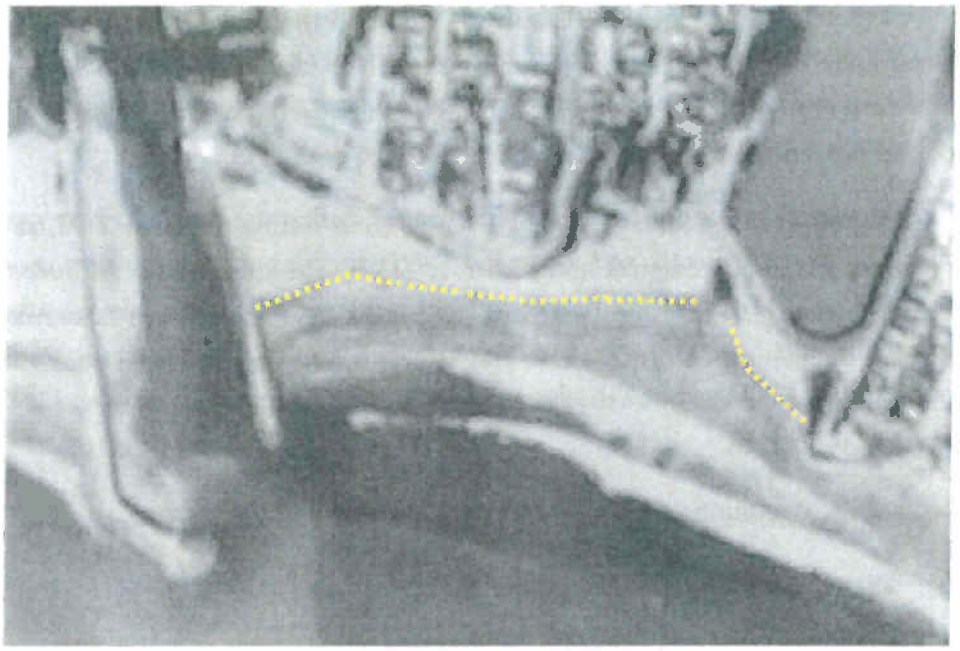


Figure 48. Aerial view of TLSB on January 7, 1982 (dashed line traces approximate location of peak TWL).

Figure 49. TLSB at Assembly Avenue during the storm of January 5, 1982.

ATTACHMENT 8

Figure 50. East view of Schwan Lake culvert outflow during the storm of January 5, 1982.

Figure 51. South view of Schwan Lake culvert outflow during the storm of January 5, 1982.

ATTACHMENT 8

Figure 52. Predicted TWL on January 5, 1982.

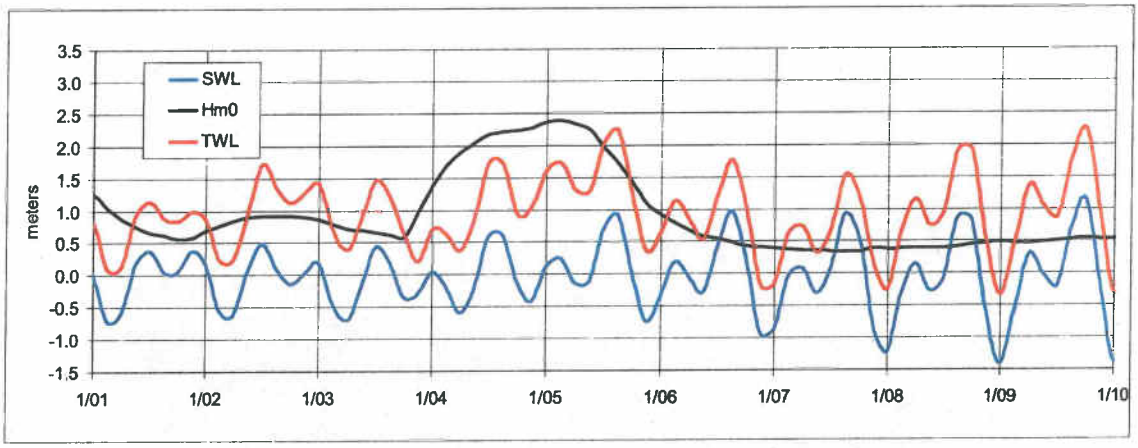


Figure 53. Significant wave height (Hm0) offshore TLSB, SWL and TWL (transect A-A') during the storm of January 5, 1982 (GMT).

7.5 Storm of January 26, 1983

The inspection of the 39 years of TWL's and wave height predictions at TLSB, showed, as expected, that the storm of January 26, 1983 which was one of the worst storms on record impacting the coast of California, produced the highest TWL between 1970 and

ATTACHMENT 8

2008. At 4.41 m NGVD 29 (14.45 feet), this TWL was of the same order of magnitude as the estimated 100-year TWL of 4.37 m for the sea level rise scenario with no global warming.

Figure 54 shows the significant wave height (Hm0), SWL and TWL time histories during the storm, and during the winter of 1983 where two additional storms and corresponding high TWL's events can be recognized. Note that a few hours after the peak TWL on January 26, waves reached heights of approximately 3.5 m, but because the SWL was lower (0.39 m, NGVD 29) than during the peak TWL, the TWL was not as extreme.

Estimated marine conditions during the peak TWL at transect A-A' were:

- Peak TWL at 1/26/83 15:00 (GMT)
- Hm0 = 2.83 m (9.3 feet) (offshore TLSB)
- Tp = 23 seconds
- MWD = 207 degrees
- SWL = 1.39 m (4.55 feet) NGVD 29
- TWL (summer beach profile) = 4.41 m (14.47 feet) at transect A-A', 3.55 m (11.64 feet) at E-E', and 3.70 m (12.15 feet) at FGH.

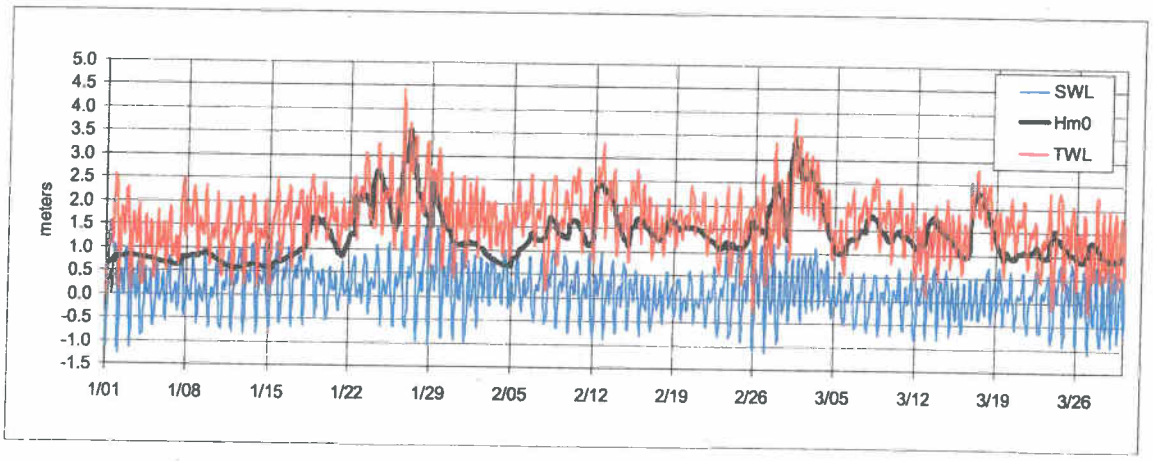


Figure 54. Significant wave height (Hm0), SWL and TWL (transect A-A') during the storms of January-March, 1983.

ATTACHMENT 8

Figure 55. Predicted TWL on January 26, 1983.

ATTACHMENT 8

8 Estimation of the Elevation of Protective Structures

High water levels and the eroded condition of the beach every winter, would allow for waves to reach further landward affecting the bluffs fronting TLSB. The purpose of the coastal protective structures would be, not only to protect the exposed coastline, but also to protect the planned facilities landward of the structures such as roads, walkways, parking, beach access, etc. Damage to these facilities may occur due to wave overtopping, which is the discharge of water over the crest of the structure produced by the wave running up the face in the case of sloped structures, or impacting on the face of vertical seawalls. Provided that the elevation of the crest of the planned structures is adequate, damage to the land facilities and amenities landward could be prevented or minimized.

In order to determine initial estimates of the required crest elevations of the protective structures, and to assess the water discharges for each sea level rise scenario in a winter (eroded) beach condition a preliminary overtopping analysis was performed. On the basis of an analysis of the marine conditions and in consultation with the County, RRM developed in March 2010 the architectural plan shown in Figure 56, which at the time contemplated improvements from 5th Avenue to 9th Avenue.

For purposes of the preliminary overtopping analysis, the TLSB was divided into five sections, namely I to V. The characteristics of each section are described below and the geologic characteristics of these sections are described in RJA (2009). For each section, the RRM team selected a type of structure or amenity that would blend the requirements of coastal protection with those relevant to the functionality of the planned improvements. Furthermore, due to the limitations of the empirical methods used to compute the overtopping discharges, simplified representations of the structures were used.

The preliminary wave overtopping analysis was performed using the methods published in the Overtopping of Sea Defences and Related Structures: Assessment Manual by EUROTOP (2007). The manual includes the latest developments in wave overtopping analysis and it has been developed from at least three manuals: the UK Environment Agency Manual on Overtopping, the TAW Technical Report on Wave Run-up and Wave Overtopping at Dikes, and the German Die Kuste. The EUROTOP manual is intended to revise, extend and develop the parts of those manuals discussing wave runup and overtopping. The manual also extends and/or revises the advice on wave overtopping predictions given in the CIRIA/CUR Rock Manual, The Revetment Manual, British Standard BS6349, the US Coastal Engineering Manual and ISO TC98.

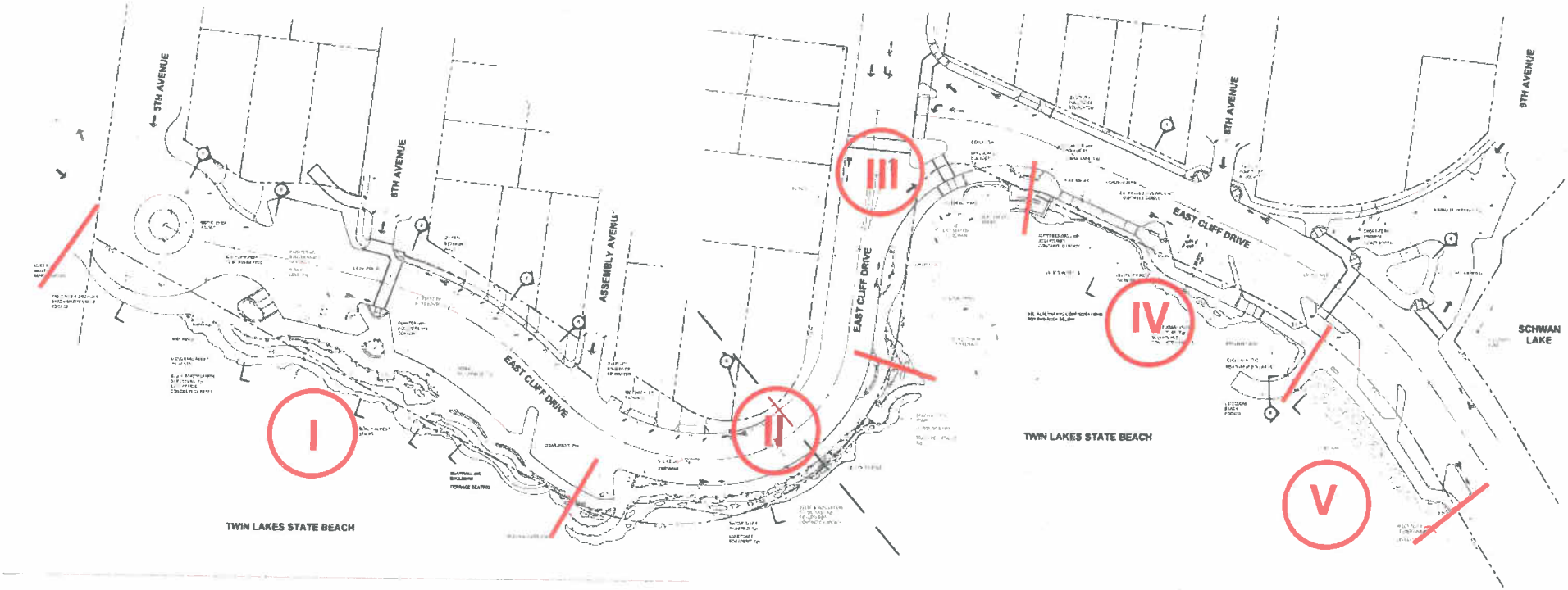


Figure 56. Twin Lakes Beachfront Improvements architectural plan of March 2010.

ATTACHMENT 8

Starting from the west end of TLSB at 5th Avenue, section I features an average top elevation of approximately +18 feet, sloping up from approximately +16 feet NGVD 29 at the west end to the east to approximately +20 feet NGVD 29 at Assembly Avenue. Bedrock underlies the beach sand in the range of +6 to +10 feet NGVD 29 at the location of the proposed improvements (see Figure 7, profiles A and B). In the past and as shown in Figure 42, bedrock in this area has been exposed after severe winter storms eroded the beach. Given the relative shallow elevation of bedrock in this section, it would be feasible and advantageous to found the protective structures on the bedrock. In this section and from west to east, the architectural plan featured a passenger drop-off/beach maintenance access area, terraces, followed by a meandering universal access pathway which cuts through a sculptured concrete stabilized bluff, and which would be surrounded by natural boulders. To the east, the universal access pathway blends into steps and terraces (see Figure 56). In the wave overtopping analysis, this section was modeled as a smooth 1V:2H slope.

Section II includes the headland at Assembly Avenue. It features an almost vertical bluff face drop from an elevation of approximately +20 feet NGVD 29 down to the toe on bedrock at approximately MSL (= +0 feet NGVD 29) in the winter (eroded) condition (see Figure 7, profiles B and C). This section is the most seaward and, therefore, most exposed section of the coastline. It was contemplated to stabilize and protect this section with buried caissons (or cells) and sculptured concrete. In the wave overtopping analysis this section was modeled as a vertical wall.

Running approximately in the south to north direction, approximately from the restroom facility to the intersection between East Cliff Drive and 7th Avenue where the Pump Station is located, Section III is the least exposed stretch of coastline. Historically, the beach in this area has not been eroded, as evidenced by the presence of well established vegetation (see Figure 38), no reported (Public Works Maintenance Records) or observed water damage to the facilities in that area, and by anecdotal evidence provided by a California State lifeguard during a site visit conducted on October 1st, 2010. The 100-year TWL predictions show no potential impacts in this area for at least the next 50 years.

In the event of extreme TWL's, waves would diffract around the headland at Assemble Avenue and, in combination with the shallow depths on the beach, wave heights would be reduced significantly by refraction and breaking. Based on these considerations and taking into account that a) the top elevation along this section is approximately +22 feet NGVD 29 and b) the bluff toe is at approximately MSL (see Figure 7, profiles C and D), this section of the coastline is considered well protected and was not analyzed for wave

ATTACHMENT 8

overtopping. On a preliminary basis, coastal protection for this section was considered unnecessary.

Section IV consists of the stretch of coastline from 7th to 9th Avenue. The top elevation of this section is approximately +22 feet at 7th Avenue sloping down to approximately +16 feet NGVD 29 at 9th Avenue. The elevation of bedrock in this section varies between MSL (=+0 NGVD 29) and -4 feet NGVD 29 (see Figure 7, profiles E and Figure 8, profile F). While this stretch of coastline is fronted by an extensive beach, the elevation of the beach is relatively lower than on the western sections of TLSB. Lower beach elevation, deeper bedrock, close proximity to the Schwan Lake inlet, and the predicted TWL's all make this area susceptible to erosion. Furthermore, Figure 39 shows the potential impact of high water levels and storm waves on this stretch of the coastline. Therefore, this section would need to be protected. In the wave overtopping analysis this section was modeled as a vertical wall.

The coastline at section V extends from 9th Avenue where the top elevation is approximately +16 feet NGVD 29 to the Schwan Lake culvert outfall structure at approximately +10 feet NGVD 29 (see Figure 8, profiles F and G). With a beach sand elevation at approximately +10 feet NGVD 29, and bedrock elevations ranging from approximately -5 feet to -15 feet NGVD 29, this area features a relatively thick veneer of sand which in future extreme TWL/high wave events could erode and provide the depth for relative large waves to reach the planned improvements. However, it is noted that just seaward of the culvert outfall structure an SSFM pipe in a concrete rectangular encasement with a top elevation at +0 feet NGVD 29 (=MSL) is buried in the sand running parallel to East Cliff Drive. According to a California State lifeguard interviewed during a visual inspection and an investigation by County of Santa Cruz Public Works engineers (email dated 10/8/10) there are no records of the SSFM been exposed due to beach erosion. Therefore, for the purposes of the wave overtopping analysis a minimum eroded beach elevation in this area of +1 feet NGVD 29 was selected.

Connecting the planned the TLSB improvements with the lagoon, this stretch of coastline will be protected with a rip-rap revetment to provide a transition between the planned improvements and the culvert outfall structure. In the wave overtopping analysis the rip-rap was modeled as an armored simple 1V:1.5H slope with 2 layers of rocks and impermeable core.

For each section described in Figure 56, and for each of the three sea level rise scenarios, the following parameters were used and defined in the overtopping analysis:

a) type of structure (simplified representation of proposed) and slope

ATTACHMENT 8

b) 100-year TWL

c) elevation of the toe of the structure

d) water depth

e) peak wave period (Tp)

f) depth-limited significant wave height (Hsb)

g) crest elevation of the structure

h) structure freeboard

i) street elevation

j) elevation of the crest of the structure above the existing street elevation necessary to produce an average 200 l/sec/m overtopping discharge during the corresponding 100-year TWL event.

Because the storm of January 26, 1983 produced 100-year TWL's, the wave conditions offshore TLSB during that storm were examined to determine a representative wave period for the overtopping analysis. Figure 57 shows the significant wave height and peak periods during that storm, and the storms that followed in February and March. A peak period of 16 seconds was selected for the overtopping analysis.

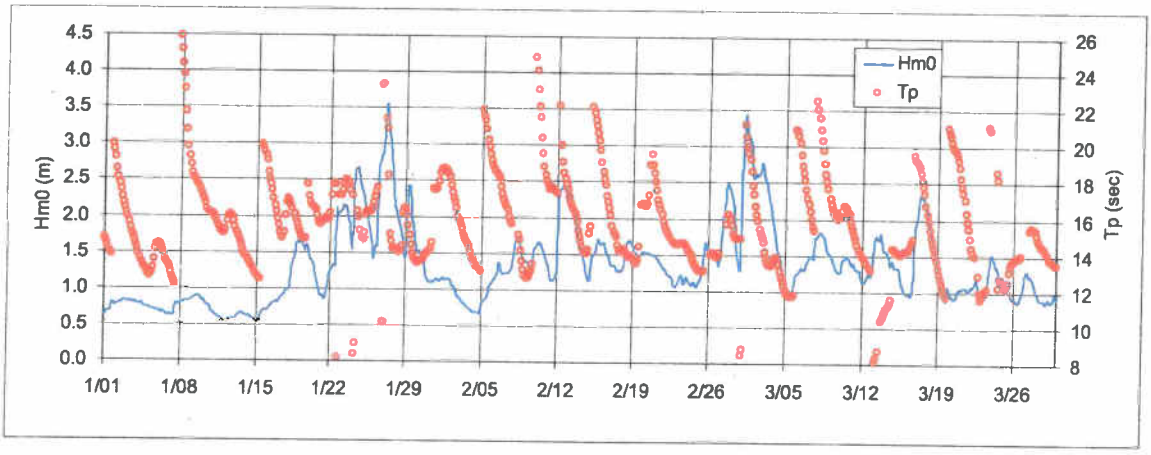


Figure 57. Significant wave height (Hm0) and peak period (Tp) offshore TWB during the storms of January through March of 1983.

Because heights are reduced by breaking as waves approach the shore as a function of the water depth, depth-limited wave heights at the toe of the structures were computed according to the following equation (Kamphuis, 2000):

ATTACHMENT

$$H_{sb} = d_b\, 0.56\, e^{3.5m} \qquad (2)$$

where Hsb is the significant depth-limited wave height, db is the water depth and m is the beach slope.

The 200 l/sec/m (per length of structure) average overtopping discharge is an engineering design guideline adopted to specify the limiting discharge where damage to the crest or rear slope of protective structures (i.e. embankments seawalls, promenade or revetment seawalls) is expected to occur if exceeded. Schematics of these structures are shown in Figure 58 and corresponding limits of overtopping for damage are shown in Table 5 (EUROTOP, 2007). Figure 59 shows the schematization of the protection structures considered for the preliminary overtopping analysis (EUROTOP, 2007). Table 6 shows the results of the preliminary overtopping analysis.

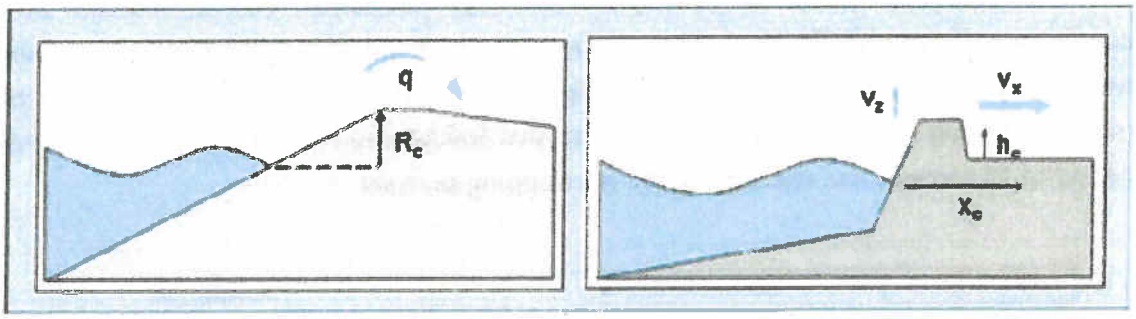
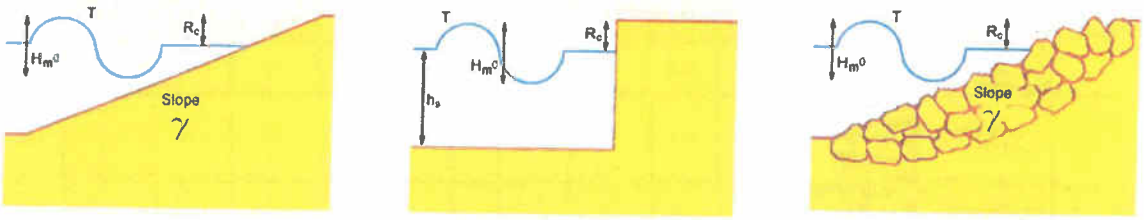


Figure 58. Embankment (left) and promenade (right) seawalls (EUROTOP, 2007).

ATTACHMENT 8

Table 5. Limits of overtopping for damage to crest or rear slope (EUROTOP, 2007).

Hazard type and reason	Mean discharge q (l/s/m)
Embankment seawalls/sea dikes	
No damage if crest and rear slope are well protected	50–200
No damage to crest and rear face of grass covered embankment of clay	1–10
No damage to crest and rear face of embankment if not protected	0.1
Promenade or revetment seawalls	
Damage to paved or armoured promenade behind seawall	200
Damage to grassed or lightly protected promenade or reclamation cover	50



Slope (section I) Vertical wall (section II and IV) Revetment (section V)

Figure 59. Schematization of protection structures for preliminary overtopping analysis (EUROTOP, 2007).

ATTACHMENT 8

Table 6. Preliminary wave overtopping analysis for 100-year winter TWL events.

Section / Location	Scenario	Structure	Foreshore Slope	100-year Winter TWL (feet)	*Structure Toe Elevation (feet)	Water Depth (feet)	Tp (sec)	Hsb (feet)	Structure Crest Elevation (feet)	Structure Freeboard (feet)	Existing Street Elevation (feet)	**Required Structure Crest Height above Existing Street Elevation (feet)	Q (l/s/m)
I 5th Avenue to Assembly Avenue	No Global Warming, Year 2110	Slope 1V:2H	0.065	13.1	8.0	5.1	16	3.6	18.0	5.0	18.0	0.0	22
	Global Warming, Year 2060 (50 years from 2010)	Slope 1V:2H	0.065	14.7	8.0	6.7	16	4.7	18.0	3.3	18.0	0.0	128
	Global Warming, Year 2100 (90 years from 2010)	Slope 1V:2H	0.065	17.5	8.0	9.5	16	6.7	22.1	4.7	18.0	4.1	201
II Assembly Avenue Headland	No Global Warming, Year 2110	Vertical Wall	0.047	12.2	0.0	12.2	16	8.1	20.5	8.3	20.0	0.5	196
	Global Warming, Year 2060 (50 years from 2010)	Vertical Wall	0.047	13.8	0.0	13.8	16	9.1	20.7	6.9	20.0	0.7	203
	Global Warming, Year 2100 (90 years from 2010)	Vertical Wall	0.047	16.6	0.0	16.6	16	10.9	28.2	11.6	20.0	8.2	196
III Restroom to Pump Station													
IV 7th to 9th Avenue	No Global Warming, Year 2110	Vertical Wall	0.030	11.3	5.5	5.8	16	3.6	19.0	7.7	19.0	0.0	14
	Global Warming, Year 2060 (50 years from 2010)	Vertical Wall	0.030	12.9	5.5	7.4	16	4.6	19.0	6.1	19.0	0.0	66
	Global Warming, Year 2100 (90 years from 2010)	Vertical Wall	0.030	15.6	5.5	10.1	16	6.3	19.8	4.2	19.0	0.8	202
V 9th Avenue to Lake Schwan Culvert Outfall Structure	No Global Warming, Year 2110	Armored 1V:1.5H slope, 2 Layers of Rocks and Impermeable Core	0.030	11.3	1.0	10.3	16	6.4	14.3	3.0	13.0	1.3	192
	Global Warming, Year 2060 (50 years from 2010)	Armored 1V:1.5H slope, 2 Layers of Rocks and Impermeable Core	0.030	12.9	1.0	11.9	16	7.4	16.57	3.67	13.0	3.6	200
	Global Warming, Year 2100 (90 years from 2010)	Armored 1V:1.5H slope, 2 Layers of Rocks and Impermeable Core	0.030	15.6	1.0	14.6	16	9.1	20.67	5.05	13.0	7.7	208

All elevations referred to NGVD 29 (=MSL)
All elevations, depths and freeboards are average
TWL = Total Water Level
Tp = peak period
Hsb = depth-limited significant wave height
Q = average overtopping discharge
* structure toe elevation at bedrock elevation or maximum beach erosion elevation
** required structure crest height above exisiting street level to achieve average overtopping discharge of 200 l/m/sec or less

Within the accuracy of the methods used and the assumptions made in this preliminary analysis, Table 6 shows that for the No Global Warming Year 2110 scenario, crest elevations of protective structures as those existing along East Cliff Drive would be adequate to prevent damage due to wave overtopping. Average discharges for this scenario would be about 200 l/sec/m or less along most of the road's alignment or minor rising of crest elevations above the existing street elevation would be necessary to achieve this level; except for section V. It is known by the County, and it has been observed as shown in

ATTACHMENT 8

Figure 39, that the stretch of coastline between 9th Avenue and the culvert outfall structure is susceptible to wave overtopping damage and that maintenance to the structure and road may be necessary if the road is not raised.

For the Global Warming Year 2100 scenario, the crest elevations required to achieve average discharges of 200 l/m/sec or less appear to be excessive and impractical.

Similarly to the No Global Warming Year 2110 scenario, the Global Warming Year 2060 scenario (50 years from 2010) crest elevations of protective structures as those existing along East Cliff Drive would be adequate to prevent damage due to wave overtopping. As noted previously, the stretch of coastline between 9th Avenue and the culvert outfall structure is relatively low and it would be susceptible to wave overtopping damage and maintenance would be required, unless the road is raised.

Upon consultation between the RRM team and the County, considering the uncertainty in the sea level rise predictions due to global warming, the relative short duration of wave overtopping events (a few hours) and assuming that the TLSB improvements will be performed in the near future, it was concluded that architectural plans featuring improvements and protective structures with crest elevations equal or marginally higher than the existing East Cliff Drive elevations would provide sufficient wave overtopping protection in a sea level rise scenario with global warming in the next 50 years.

ATTACHMENT 8

9 Analysis of Potential Protection Structures and Structural Systems

RRM developed architectural plans for the Twin Lakes Beachfront improvements, including several different concepts and aesthetic treatments of the coast such as concrete stairs, terraces, vertical walls, rip-rap revetments and faux rock simulation of natural bluffs. Halcrow was tasked with developing conceptual designs of structures and structural systems to support these architectural plans and the different concepts and aesthetic treatments that these included. Halcrow was also asked to consider incorporating, or otherwise accommodating, in the concept designs storm water runoff management features that would allow for the retention of runoff and percolation to address water quality from roadway runoff. The design alternatives were therefore developed to provide some flexibility for use in different architectural plans. Previously prepared geotechnical evaluations and of marine design conditions were utilized in the development of the conceptual designs for the structural alternatives.

In December 2009, and at the outset of the conceptual design of the structural alternatives effort, RRM presented the architectural plan shown in Figure 60. For the coastline from 5th Avenue to 9th Avenue, this architectural plan consisted of several different concepts for creating a new coastline hardscape, as follows:

- The stretch of coastline from 5th Avenue to Assembly Avenue was intended to be primarily concrete structures such as beach access stairs, large concrete sitting terraces and a meandering access pathway,
- the stretch of coastline from Assembly Avenue to approximately the location of the existing restroom was considered for either a vertical sea wall or a bluff stabilization structure consisting of a concrete treatment built to emulate the look of a natural rock bluff,
- the area behind the restroom was to remain a landscaped slope but with stabilization provided as needed, and
- the stretch of coastline from 8th Avenue to 9th Avenue would reconstruct the existing rip-rap revetment. In addition, a vehicle access ramp was planned east of the restroom.

The architectural plan of December 2009, evolved to a plan presented in March 2010, and shown in Figure 61. This plan contemplated:

ATTACHMENT 8

- bluff stabilization structures with concrete treatment built to emulate the look of a natural rock bluff, a universal access pathway, beach access stairs, boulders and terrace seating in the stretch of coastline from 5th Avenue to Assembly Avenue,
- predominantly bluff stabilization structures, plus beach access stairs and boulders from Assembly Avenue to the restrooms area,
- the area behind the restroom was to remain a landscaped slope but with stabilization provided as needed,
- beach access stairs, buttress supported retaining walls with sculptured concrete surface, bluff stabilization, and a vehicle access ramp, from 7th Avenue to 9th Avenue; and
- reconstruction of the existing rip-rap revetment from 9th Avenue to Schwan Lakes culvert outfall structure.

As the planning developed, the architectural plan continued to evolve utilizing bluff stabilization structures for the majority of the project. The architectural plan of March 2010 evolved to the architectural plan presented in November 2010 and shown Figure 62. This plan utilized primarily a concrete-based bluff stabilization concept for the purpose of creating a natural looking coastline. Furthermore, it included the stretch of coastline from 9th Avenue to 11th Avenue, along which a pedestrian pathway on the beach side is being considered by the County.

Subsequently the project was scaled back to accommodate a reduced project budget. The extents of the planned improvements will therefore be limited to East Cliff Drive from 5th Avenue to 7th Avenue. Also due to the budget considerations a lower cost stabilization alternative was developed that will provide the same level of protection, but which could be less durable than a concrete (either pre-cast or cast in place) structure. The aesthetic treatment will, however, remain the same.

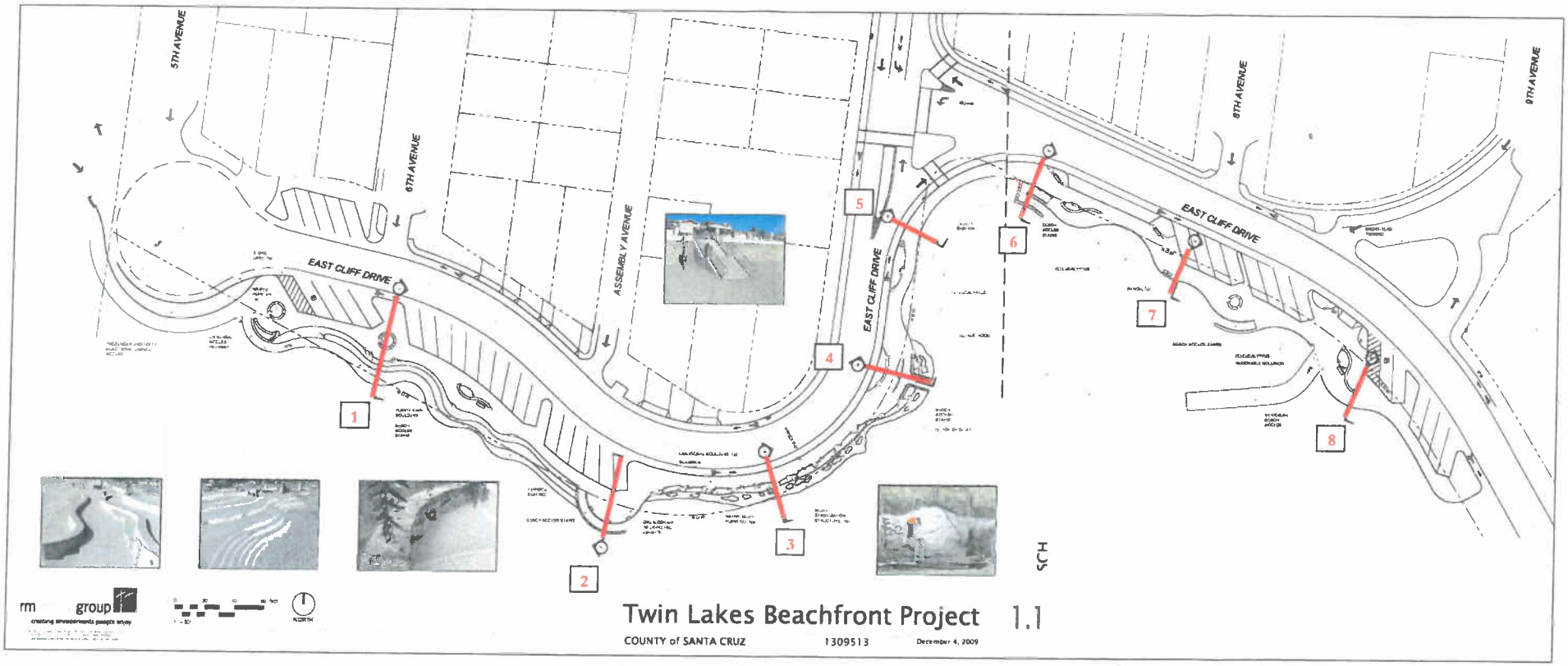


Figure 60. Twin Lakes Beachfront Improvements architectural plan of December 2009.

ATTACHMENT 8

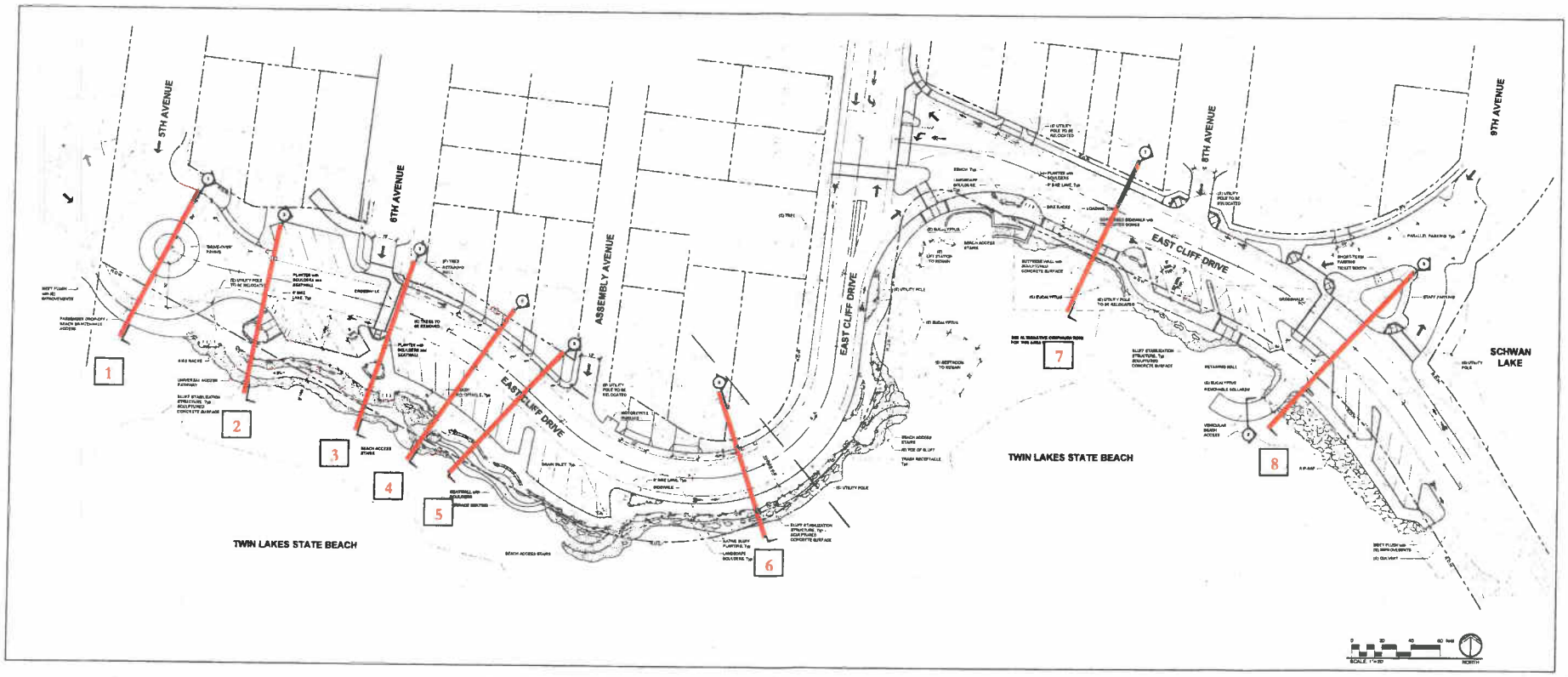


Figure 61. Twin Lakes Beachfront Improvements architectural plan of March 2010.

ATTACHMENT 8

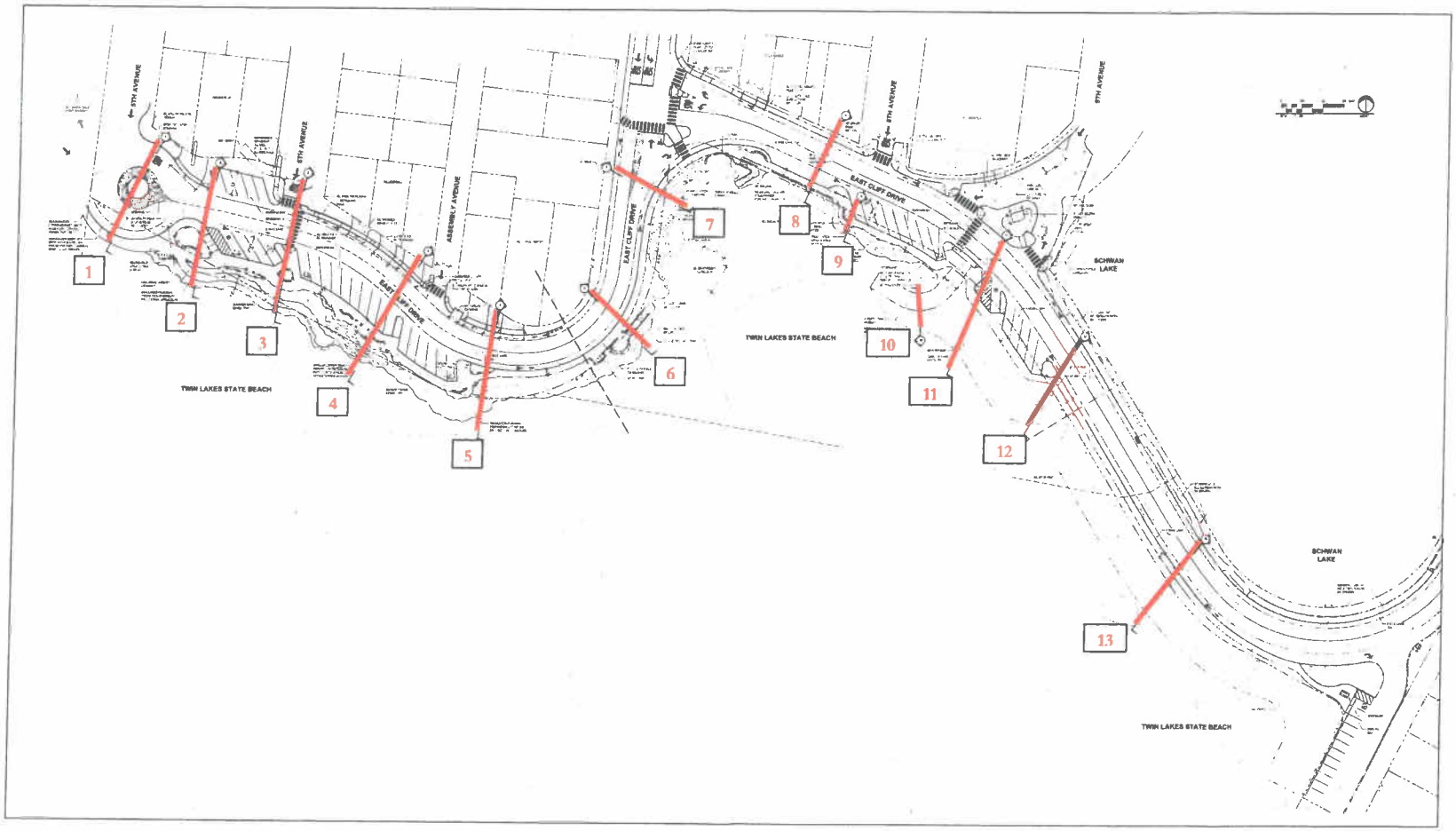


Figure 62. Twin Lakes Beachfront Improvements architectural plan of November 2010.

ATTACHMENT 8

Several factors that might influence the selection of protection structures and structural systems for the various architectural plans were identified. These included:

- The sand level at the time of construction
- Construction impact to the public
- Equipment access
- Speed of on-site construction (precast or cast-in-place)
- Cost of initial construction and long term maintenance
- Variable soil conditions: rock, dense sands, or liquefiable beach sands

Eight alternative structures/structural systems that would provide a foundation for the concepts and treatments developed by RRM were developed and evaluated. The structures/structural systems developed included:

- Monolithic Cast-in-place Concrete Structure
- Cast-in-place Concrete Retaining Wall
- Pre-cast Caisson
- Cement Deep Soil Mixing (CDSM)
- Combination of CDSM and Pre-cast Concrete Caisson
- Combination of CDSM and Cast-in-place Structure
- Rip-rap Revetment
- Mechanically Stabilized Earth (MSE)

To provide a basis for recommending a preferred alternative the alternatives were evaluated for:

- Constructability
- Impact on public access during construction, on road
- Impact on public access during construction, on beach
- Ability to accommodate storm drainage infiltration and retention
- Need to provide foundation directly on the bedrock
- Ability to accommodate natural sculpted (faux) rock "look"
- Relative Cost

Developing estimates of construction costs was outside the scope of this effort but, in order to provide a basis for the comparison, a relative range of costs was developed. Relative construction costs were assigned an index number on a scale of 1 to 10 with 1 being a low cost and 10 being a high cost.

In addition, other key issues or features of each alternative were considered and presented in Table 7.

9.1 Monolithic Cast-In-Place Concrete Structure

This alternative consists of large concrete elements cast-in-place to form structural elements. It is ideally suited for the construction of large concrete stairs and terraced benches where the structure can serve dual purposes as the stairs and benches, and as retaining walls. Figure 63 shows an example of beach access steps with cast-in-place concrete for section 5 of the architectural plan of March 2010. The following is noted about this alternative:

- Constructability. This alternative will require significant excavation or require that sand levels be at an eroded winter level during construction to minimize the amount of excavation. This alternative requires a longer on-site construction period than other structures and is labor intensive due to the need to construct formwork and finish work on the concrete surfaces.
- Impact on roadway public access will be relatively short and temporary during formwork and concrete delivery.
- Impact on beach public access will be greater for this alternative with the project site being fenced for a longer period of time during excavation, formwork construction, concrete placement and finishing work.
- Ability to accommodate storm water retention and infiltration. This alternative can be constructed as a box filled with gravel to receive storm water run-off and provide retention and infiltration through the gravel.
- Need to provide foundation on bedrock. This alternative does require a solid foundation on the bedrock formation.
- Ability to accommodate sculpted rock look. A shotcrete facing can be applied to vertical walls and shaped to look like natural rock.
- Relative cost: Index 6.

ATTACHMENT 8

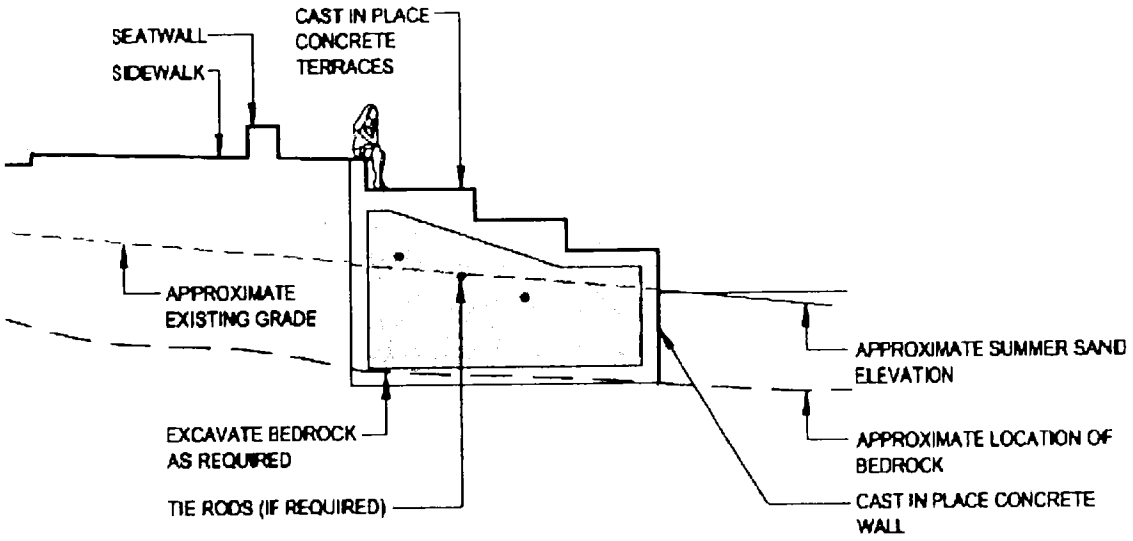


Figure 63. Example of beach access steps with cast-in-place concrete for section 5 of the architectural plan of March 2010.

9.2 *Cast-in-place Concrete Retaining Wall*

This alternative consists of a cast-in-place concrete wall consisting of either a cantilevered wall, a buttress wall or tie-back supported concrete wall. Figure 64 shows an example of the buttress wall option of this structure for section 7 of the architectural plan of March 2010. The following is noted about this alternative:

- Constructability. This alternative will require excavation or require that sand levels be at an eroded winter level during construction to minimize the amount of excavation. This alternative requires a longer on-site construction period than other structures and is labor intensive due to the need to construct formwork and do finish work on the concrete surfaces.
- Impact on roadway public access will be relatively short and temporary during formwork and concrete delivery.
- Impact on beach public access will be greater for this alternative with the project site being fenced for a longer period of time during excavation, formwork construction, concrete placement and finishing work.
- Ability to accommodate storm water retention and infiltration. It is not good practice to retain water behind this type of wall. Concrete retaining walls are typically designed with a free-draining layer of gravel behind them and weep

ATTACHMENT 2

For the project site, CDSM may be used to create a series of box cells within the existing sand to create a block of soil-cement that will stand up vertically and resist erosion. Figure 66 shows an example of a CDSM structure for section 3 of the architectural plan of December 2009. The following is noted about this alternative:

- Constructability. This alternative requires that the sand elevation be at a full summer elevation. Specialized construction equipment and a contractor with specific, unique qualifications are required to successfully install this structure. The installation also requires attentive construction oversight and quality control because the installation is underground and not readily visible. A temporary platform may have to be installed to support the Auger equipment and facilitate construction.
- Impact on roadway public access. The large Auger equipment and supporting slurry silos will have a significant impact on the roadway for a relatively long period of construction.
- Impact on beach public access. Construction will have minimal impact on beach access.
- Ability to accommodate storm water retention and infiltration. The CDSM installation creates relatively impermeable cellular walls that do not lend themselves to the retention and infiltration capabilities envisioned by RRM.
- Need to provide foundation on bedrock. The CDSM panels are built to a specified depth, so can readily penetrate down to bedrock.
- Ability to accommodate sculpted rock look. A shotcrete facing can be applied to the front face of the CDSM cells, but it is significantly more difficult to attach the shotcrete to the CDSM than to concrete structures.
- Relative cost: Index 7.

ATTACHMENT 8

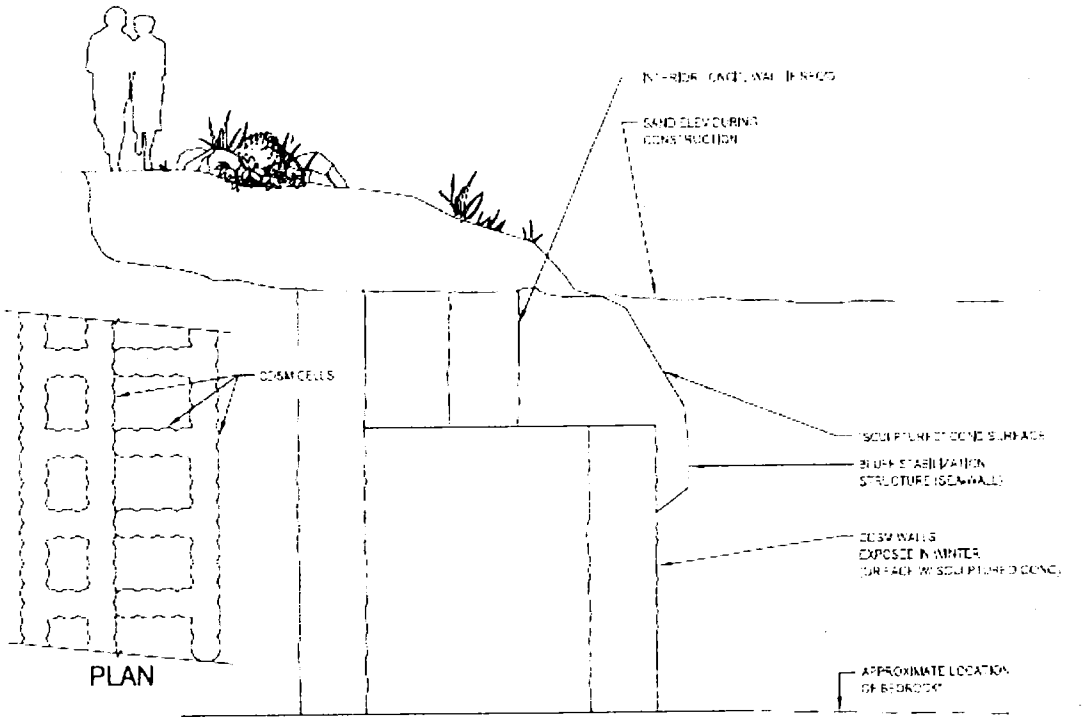


Figure 66. Example of CDSM for section 3 of the architectural plan of December 2009.

9.5 *Combination of CDSM and Pre-cast Concrete Caisson*

This alternative consists of CDSM cells installed below pre-cast concrete caissons. The CDSM serves as a foundation for the caissons so that they do not have to be founded on bedrock, thereby reducing the amount of caissons. Figure 67 shows an example of this structure for section 2 of the architectural plan of December 2009. The following is noted about this alternative:

- Constructability. This alternative accommodates variable sand elevation at the time of construction. Because the CDSM provides the foundation for the caissons this reduces the amount of excavation needed to install the overlying caissons. Specialized construction equipment and a contractor with specific, unique qualifications are required to successfully install this structure. The installation also requires attentive construction oversight and quality control because the installation is underground and not readily visible. A temporary platform may have to be installed to support the Auger equipment and facilitate construction.

- Impact on roadway public access. The large Auger equipment and supporting slurry silos will have a significant impact on the roadway for a relatively long period of construction. The period of this impact is shorter than the all CDSM alternative.
- Impact on beach public access. This alternative will have minimal impact on beach access.
- Ability to accommodate storm water retention and infiltration. The CDSM installation creates relatively impermeable cellular walls that do not lend themselves to the retention and infiltration capabilities envisioned by RRM, however the overlying gravel-filled caissons do provide for retention/infiltration.
- Need to provide foundation on bedrock. The CDSM panels are built to a specified depth; so can readily penetrate down to bedrock and eliminates the need to excavate down to bedrock to support the caissons.
- Ability to accommodate sculpted rock look. A shotcrete facing can be applied to the front face of the CDSM cells and to the face of the concrete caissons, but it is significantly more difficult to attach the shotcrete to the CDSM than to concrete structures.
- Relative cost: Index 8.

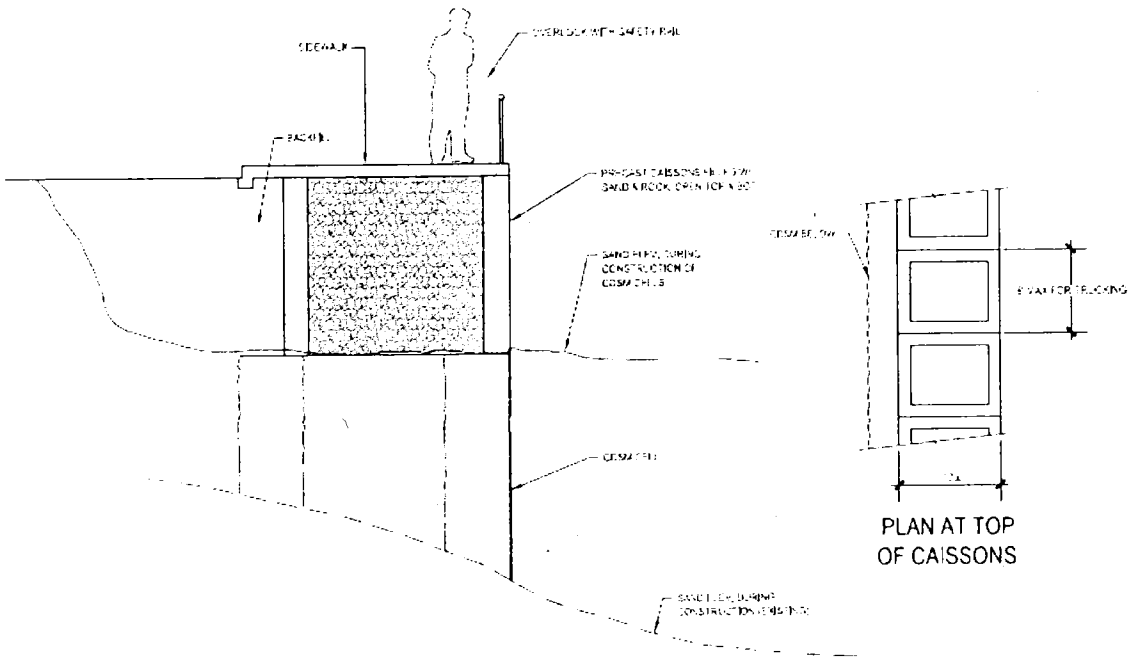


Figure 67. Example of CDSM and pre-cast concrete caisson for section 2 of the architectural plan of December 2009.

9.6 *Combination of CDSM and Cast-in-place Structure*

This alternative consists of CDSM cells installed below cast-in-place concrete structures (walls or monolithic structures such as stairways). The CDSM serves as a foundation for the concrete structures so that they do not have to be founded on bedrock. Figure 68 shows an example of this structure for section 2 of the architectural plan of December 2009. The following is noted about this alternative:

- Constructability. This alternative accommodates variable sand elevation at the time of construction. Because the CDSM provides the foundation for the concrete structures this reduces the amount of excavation needed to install the overlying caissons. Specialized construction equipment and a contractor with specific, unique qualifications are required to successfully install this structure. The installation also requires attentive construction oversight and quality control because the installation is underground and not readily visible. A temporary platform may have to be installed to support the Auger equipment and facilitate construction.
- Impact on roadway public access. The large Auger equipment and supporting slurry silos will have a significant impact on the roadway for a relatively long

period of construction. The period of this impact is shorter than the all CDSM alternative.

- Impact on beach public access. This alternative has a greater impact on the beach access with the project site being fenced for a longer period of time during formwork construction, concrete placement and finishing work.
- Ability to accommodate storm water retention and infiltration. The CDSM installation creates relatively impermeable cellular walls that do not lend themselves to the retention and infiltration capabilities envisioned by RRM. However, the overlying concrete structures can be gravel-filled to provide for retention/infiltration.
- Need to provide foundation on bedrock. The CDSM panels are built to a specified depth; so can readily penetrate down to bedrock and eliminates the need to excavate down to bedrock to support the concrete structures.
- Ability to accommodate sculpted rock look. A shotcrete facing can be applied to the front face of the CDSM cells and to the face of the concrete structures, but it is significantly more difficult to attach the shotcrete to the CDSM than to concrete structures.
- Relative cost: Index 9.

ATTACHMENT 8

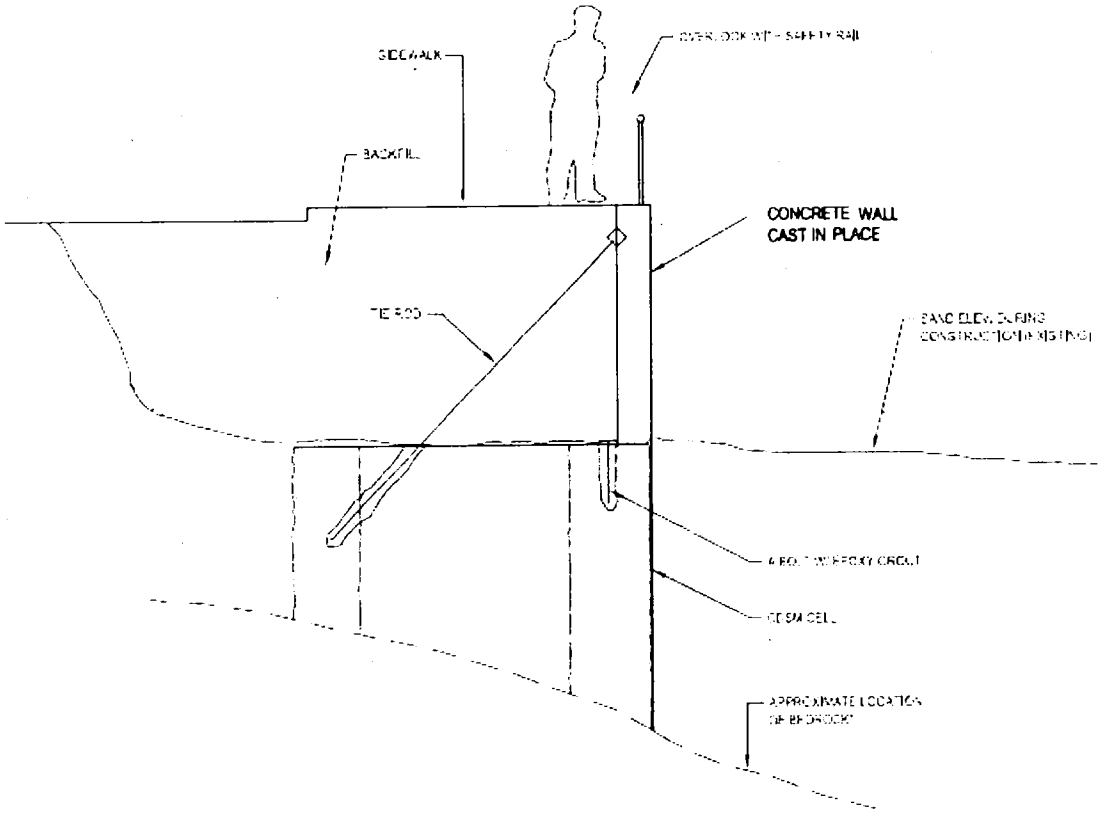


Figure 68. Example of CDSM and cast-in-place concrete wall for section 2 of the architectural plan of December 2009.

9.7 *Rip-rap Revetment*

This alternative consists of a slope of rocks which stabilize and protect the underlying soil by preventing erosion due to water flows. Typically a geotextile is placed on the soil covered with mid-sized rock and an armor layer of large rocks placed on top. Figure 69 shows an example of this structure for section 8 of the architectural plan of March 2010. The following is noted is noted about this alternative:

- Constructability. This alternative requires some excavation to place the rocks at bottom of the slope at the expected depth of scour. The armor rocks have to be placed individually (not just dumped), but overall construction is relatively quick and easy. Construction can be staged either from the beach (with rock stockpiles placed there) or from the road (with the rock handled from trucks on the road).
- Impact on roadway public access. Large cranes and trucks operating on the road during rock placement will affect traffic.

- Impact on beach public access. This alternative will have some impact on the beach during excavation and rock placement, but is less than the others.
- Ability to accommodate storm water retention and infiltration. Water would be allowed to percolate through the rock layers. This alternative does not provide retention.
- Need to provide foundation on bedrock. This alternative does not need to be founded on bedrock, unless the beach is expected to erode down to bedrock elevation. The revetment is inherently flexible structure and therefore it will accommodate some settlement.
- Ability to accommodate sculpted rock look. This structure does not lend itself to applying a shotcrete facing since any settlement will result in cracking of the shotcrete surface. This alternative, on the other hand, has a relatively "natural look" particularly if the rock is selected to blend with the color of the natural rock at the site.
- Relative cost: Index 3.

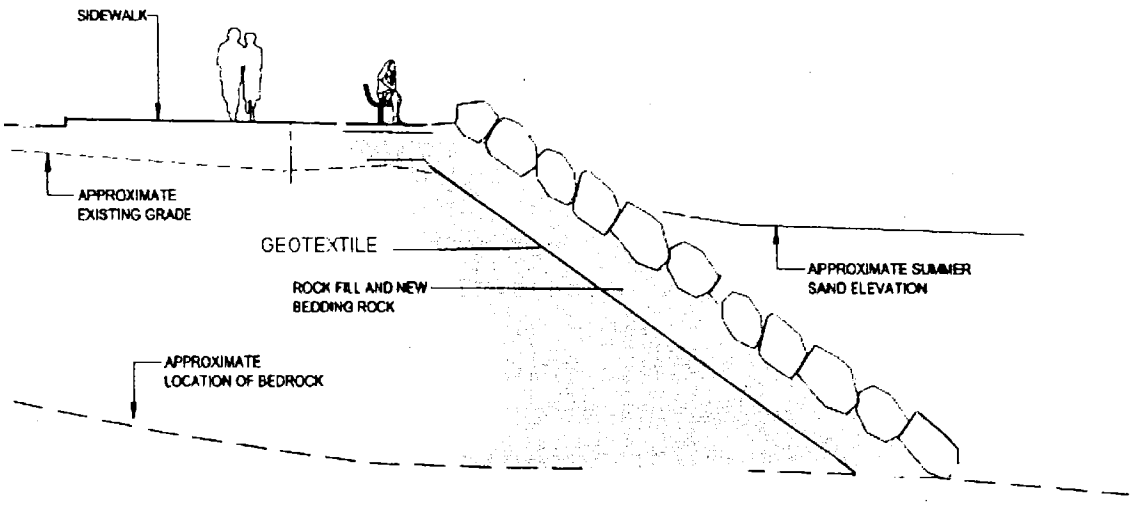


Figure 69. Example of rip-rap revetment section for section 8 of the architectural plan of March 2010.

1.8 Mechanically Stabilized Earth (MSE)

Mechanically stabilized earth (MSE) retaining walls combine geotextile-reinforced earth layers, such as geogrids or layers of soil sandwiched in geotextile fabric, and a fascia of reinforced concrete to create high-strength, versatile earth retention systems. The geotextile fabric reinforces the soil while the fascia protects the wall face. The installation of this

ATTACHMENT 8

alternative would involve excavation of the soil and subsequent reconstruction by sandwiching layers of the excavated soil in the geotextile fabric. The facing of the embankment would consist of a reinforced concrete layer tied back into the reinforced soil which can then be faced with the faux rock finish. This alternative is more economical than either the pre-cast or cast in place concrete structural alternatives. However, the fabric is not as durable as concrete, it must be installed carefully and be protected from exposure to sunlight, which can degrade the fabric. Figure 70 shows an example of this structure for section 4 of the architectural plan of November 2010. The following is noted is noted about this alternative:

- Constructability. This alternative requires somewhat more excavation than the caisson alternative, but the excavated soil is used to reconstruct the embankment with the geotextile fabric. Construction utilizes standard and readily available construction equipment. Will require attentive construction oversight to assure proper placement of geotextile.
- Impact on roadway public access. This alternative would have minor impact on roadway public access with most of the excavation occurring within the footprint of roadway or walkway improvements that will already be affected by their construction.
- Impact on beach public access. Construction will impact beach access at the back of the beach during excavation and reconstruction of the embankment.
- Ability to accommodate storm water retention and infiltration. Water retention within the MSE should be minimized to reduce the potential for soil liquefaction.
- Need to provide foundation on bedrock. This is not a significant issue along the 5th to 7th Avenue coastline because of shallow depth of bedrock. The MSE should, however be built from bedrock up with the reinforced concrete fascia keyed into the bedrock to increase stability..
- Ability to accommodate sculpted rock look. A shotcrete facing can be applied to the front face of the reinforced concrete fascia.
- Relative cost: Index 3.

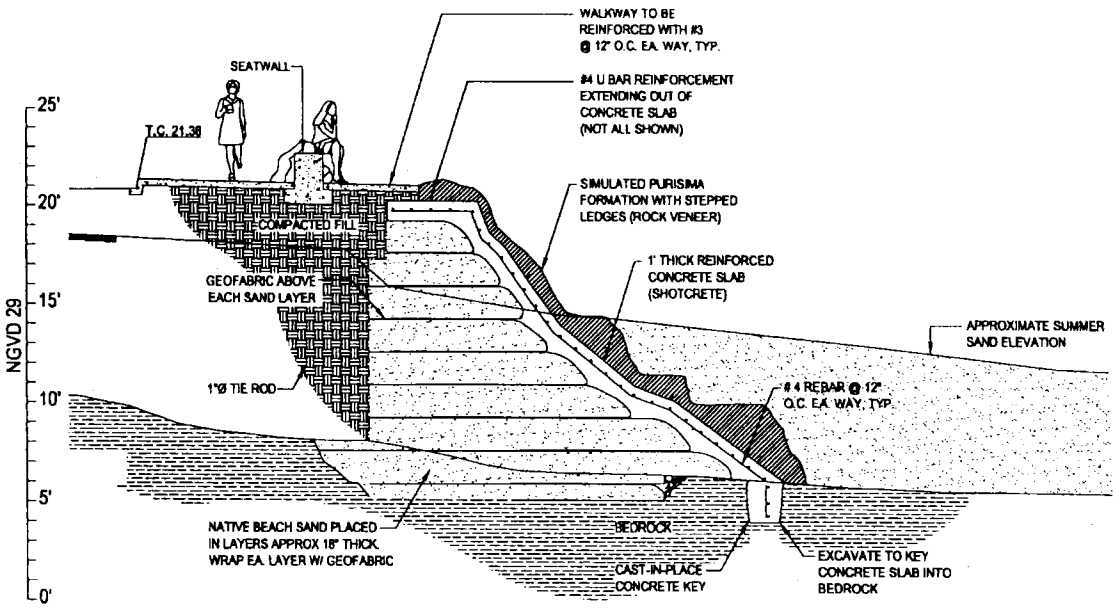


Figure 70. Example of MSE for section 4 of the architectural plan of November 2010.

Table 7 provides a comparison of the alternatives from various perspectives.

ATTACHMENT 8

Table 7. Comparison structures/structural systems alternatives.

Alternative	Description	Constructability	Impact on Public Access During Construction		Accommodate Storm Drainage Infiltration/Retention	Require Foundation on Bedrock	Accommodate "Natural" Sculptured "Look"	Relative Cost 1-10	Additional Comments
			Impact on Road	Impact on Beach					
1	Monolithic Cast-in-Place Concrete Structure	Requires excavation and/or winter eroded beach profile. Longer on-site construction period. Labor intensive, formwork and finishing.	Temporary impact during formwork and concrete delivery.	Project site will have to be fenced for a longer period, access restricted during forming and concrete placement and finishing.	Can be incorporated into design similar to caissons.	Yes	Could be applied on vertical surfaces.	6	Monolithic structure for stairs or ramp. More workers on site due to labor-intensive forming/finishing will require parking.
2	Cast-in-Place Concrete Retaining Wall	Requires excavation and/or winter eroded beach profile. Longer on-site construction period.	Temporary impact during formwork and concrete delivery.	Site fenced for a longer period, access restricted during forming and concrete placement and finishing.	Not good practice to retain storm drainage behind retaining walls.	Yes	Could be applied on vertical surfaces.	5	More workers on site due to labor-intensive forming/finishing will require parking.
3	Pre-Cast Caisson	Requires excavation and/or winter eroded beach profile. Caissons can be standardized for cost effective construction at casting yard.	Construction of caissons is off-site. On-site impact is reduced. Least time of impact compared with other alternatives. Large crane on road.	Construction of caissons is off-site. On-site impact is reduced.	Gravel filled caissons will accommodate storm drainage infiltration/ retention.	Yes	Can be applied to form terraced or sloping surface.	5	
4	Cement Deep Soil Mixing (CDSM)	Requires summer sand level in place. Requires specialized construction equipment. May need temporary platform for drilling on slope.	Longer impact on road/traffic during installation. Large drilling equipment on road.	Minimal impact on beach access.	Not readily.	CDSM drilled to bedrock.	Can be applied to form terraced or sloping surface. More difficult to attach in field, requires deeper anchors and more anchors due to weak material.	7	Will generate waste drilling product.
5	Combination CDSM and Concrete Caisson	Accommodates variable sand level, minimizes excavation. Requires specialized construction equipment. May need temporary platform for drilling on slope.	Construction of caissons is off-site. On-site impact is reduced.	Construction of caissons is off-site. On-site impact is reduced.	Gravel filled caissons will accommodate storm drainage infiltration/ retention. Less volume of retention than all caisson solution because caissons are smaller for this alternative.	CDSM drilled to bedrock, Caissons founded on CDSM.	Can be applied to form terraced or sloping surface.	8	Will generate waste drilling product.
6	Combination CDSM and Cast-in-Place Structure	Accommodates variable sand level, minimizes excavation. May need temporary platform for drilling on slope.	Similar but reduced impact compared with all CDSM alternative.	Construction of caissons is off-site. On-site impact is reduced.	Gravel filled caissons will accommodate storm drainage infiltration/ retention. Less volume of retention than all caisson solution because caissons are smaller for this alternative.	CDSM panels are built to a specified depth, can penetrate down to bedrock, eliminates need to excavate down to bedrock	Can be applied to form terraced or sloping surface.	9	Will generate waste drilling product.
7	Rip-Rap Revetment	Requires some excavation.	Cranes will affect road during rock placement.	Will impact back of beach during excavation for revetment replacement.	No retention.	No	No	3	County has stockpile of rock in storage, and could re-use some of the existing rock at the beach.
8	Mechanically Stabilized Earth	Requires somewhat more excavation than the caisson alternative, but the excavated soil is used to reconstruct the embankment with the geotextile fabric.	Minimal.	Will impact back of beach during excavation.	Not good practice to retain storm drainage behind retaining walls.	Yes	Yes	3	

10 Selection of Preferred Protection Structures

As the architectural plans developed, the design effort focused on the primary objective of creating a natural looking bluff treatment, minimizing the use of obviously man-made concrete structures. The architectural plan of November 2010, shown in Figure 62, shows how a compromise between this idea, the requirements of the project and the conditions of the marine environment was achieved.

The development of the architectural plans paid particular attention to the marine conditions along the project coastline. The area between 5th Avenue and 7th Avenue is the most exposed to wave action and therefore it has seen the most erosion, down to the relatively shallow bedrock. The area between 7th Avenue and 8th Avenue, with established vegetation and large trees, is more protected from the waves and historically it has not been eroded (RJA, 1995). The area between 8th Avenue and 9th Avenue is currently fronted by a relatively low elevation (+/- 3 feet) large rock revetment. This is not an engineered revetment and, although relatively stable at this time, it shows signs of some underlying erosion from both waves and flooding originated from Schwan Lake outflows. The existing revetment protecting the East Cliff Drive causeway is bisected by a three-culvert outfall structure used to allow Schwan Lake overflows into the ocean. The bedrock runs significantly deeper along this stretch of coastline which would significantly affect cost and the constructability of alternatives that require supporting the structure on bedrock.

Therefore, the approach to the coastal protection of the TLSB improvements was broken down into three segments with a recommended structural alternative for each as follows:

- 5th Avenue to 7th Avenue
- 7th Avenue to 9th Avenue
- 9th Avenue to 11th Avenue

10.1 5th Avenue to 7th Avenue

The architectural plan for this segment focused on creating a natural looking bluff similar to the nearby East Cliff Drive Bluff protection project. Because the bedrock is relatively shallow in this stretch of coastline and given the budgetary constraints of the project the use of MSE alternative is recommended as it is the least costly alternative that can accommodate construction of the faux rock treatment. The fabric reinforced soil layers will be faced with a steel reinforced concrete facia that will be tied back to the MSE and

ATTACHMENT 5

covered with the faux rock finish. The reinforced concrete facia will further be keyed in to the bedrock to protect the underlying MSE from exposure when the beach erodes to winter levels and to provide additional stabilization at the toe of the structure. The faux rock finish can be attached to the reinforced concrete facia with rebar U-pins, similar to large staples. The faux finish will consist of a steel mesh reinforced concrete that is textured to emulate the natural rock. The concrete is applied by spraying a quick set concrete known as shotcrete. Although somewhat less durable than the concrete structural alternatives, the MSE alternative will provide a long-term solution that, if properly constructed and maintained, can provide a design life in the order of 50 years. In order to achieve this design lifetime the following must be achieved:

- select and install the appropriate geotextile fabric
- install the fabric to assure that it is taut and free of wrinkles during the placement of the sand layers
- achieve full compaction of the sand layers
- avoid damaging the fabric during placement and replace if damaged
- design the MSE with adequate embedment (bringing the fabric deep enough into the filled area) to prevent pullout
- protect the fabric from long term exposure to sunlight by keeping it covered by the concrete facia and overlying roadway/sidewalk improvements
- manage storm water to minimize saturation of the sand layers

Figure 71 to Figure 76 show sections 1 to 6 of the November 2010 architectural plan, featuring the pre-cast concrete caissons.

ATTACHMENT 8

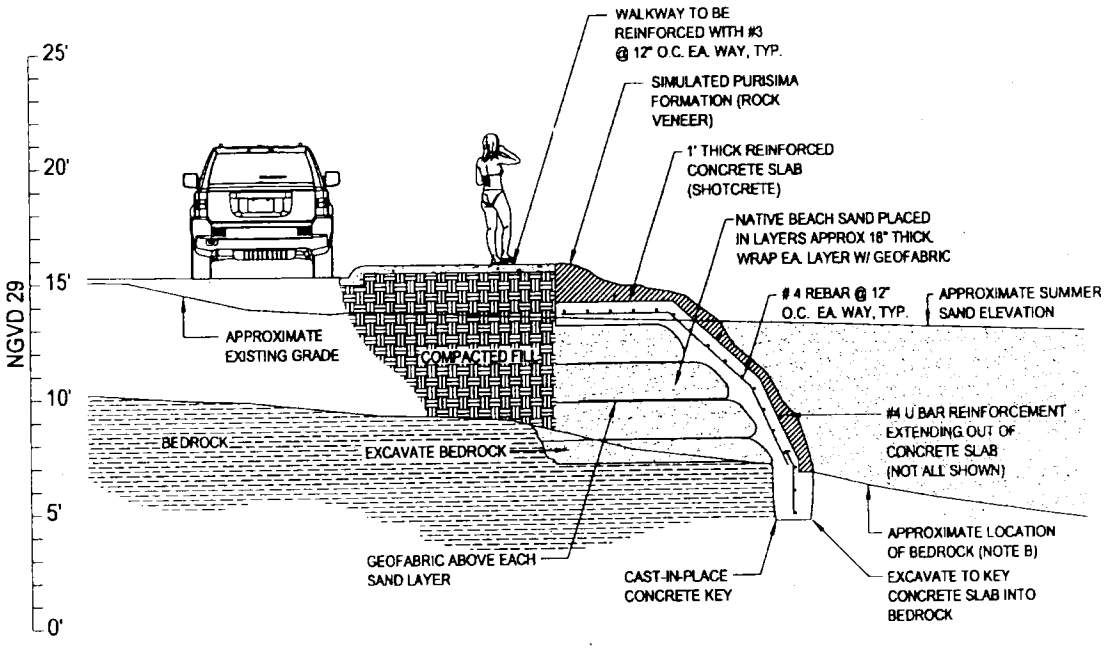


Figure 71. Schematic of section 1 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.

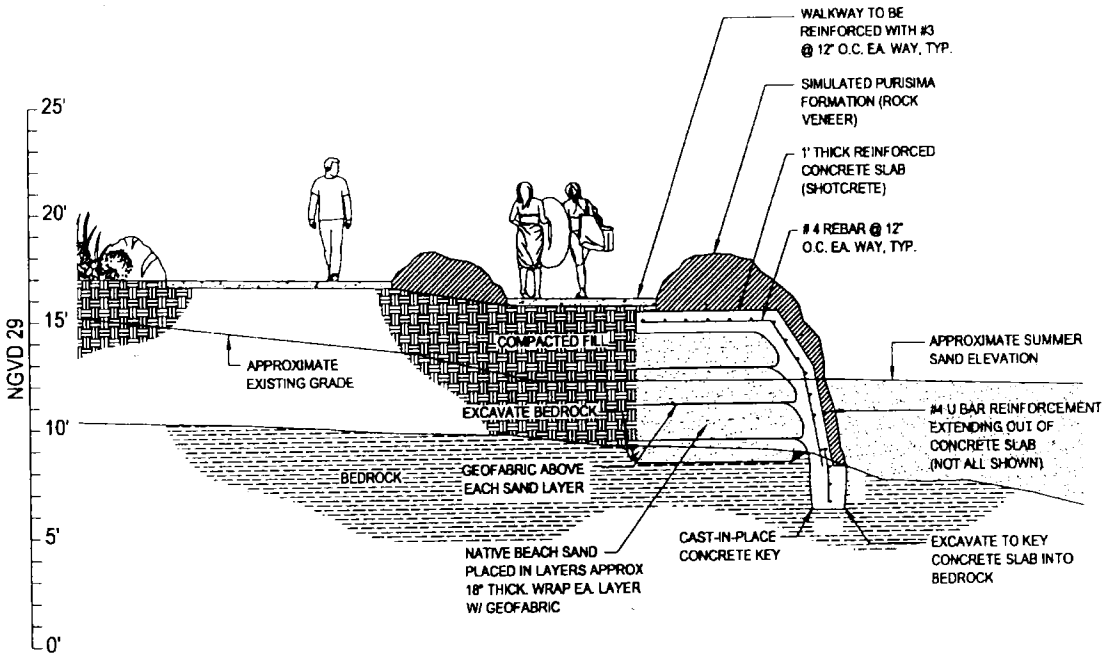


Figure 72. Schematic of section 2 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.

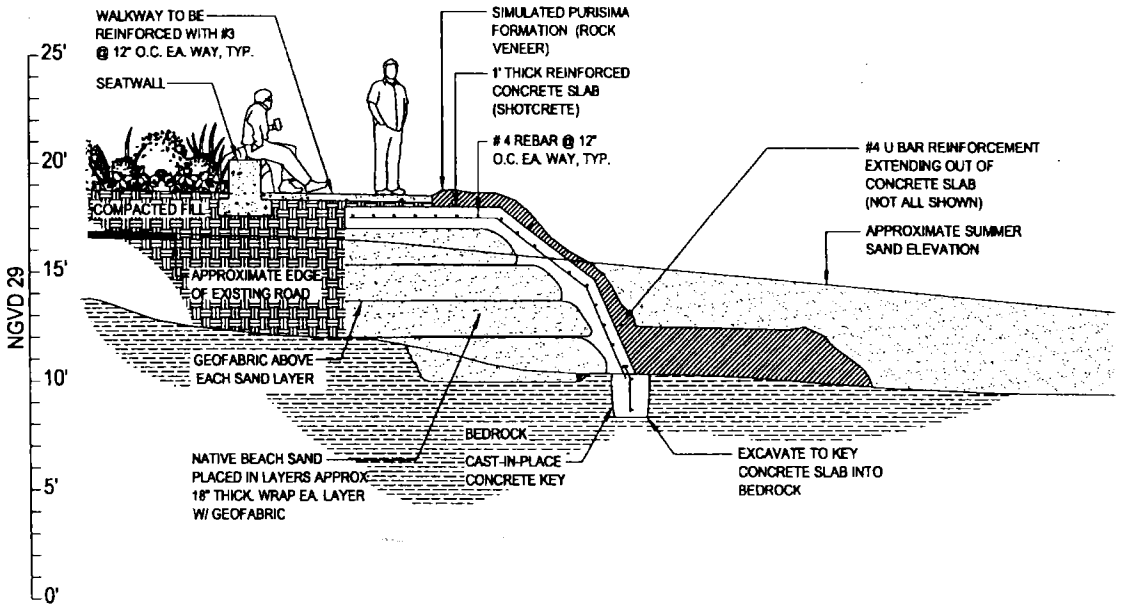


Figure 73. Schematic of section 3 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.

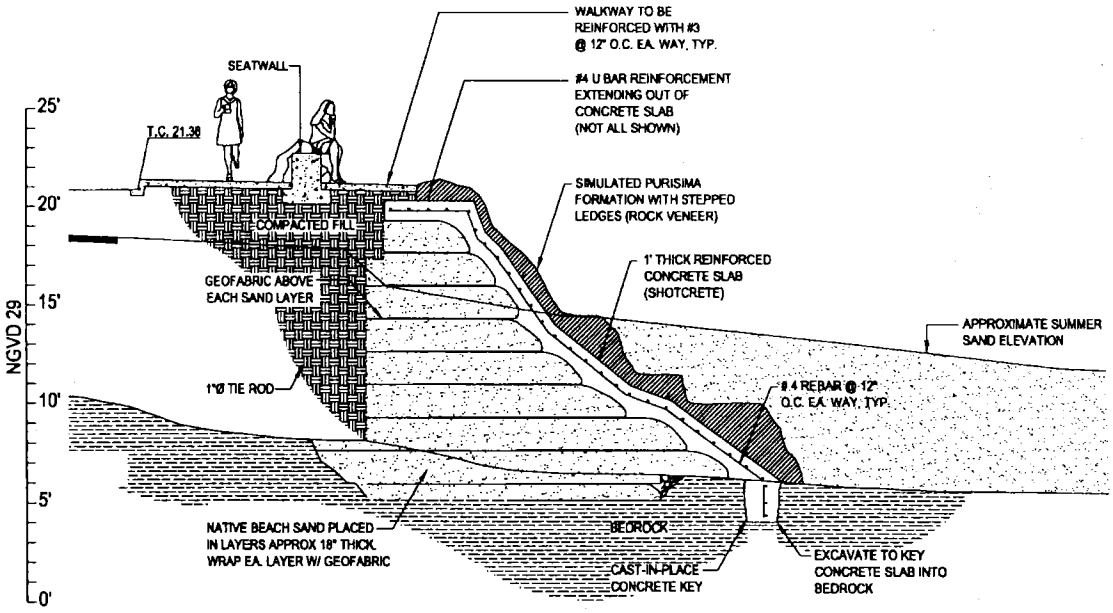


Figure 74. Schematic of section 4 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.

ATTACHMENT 7

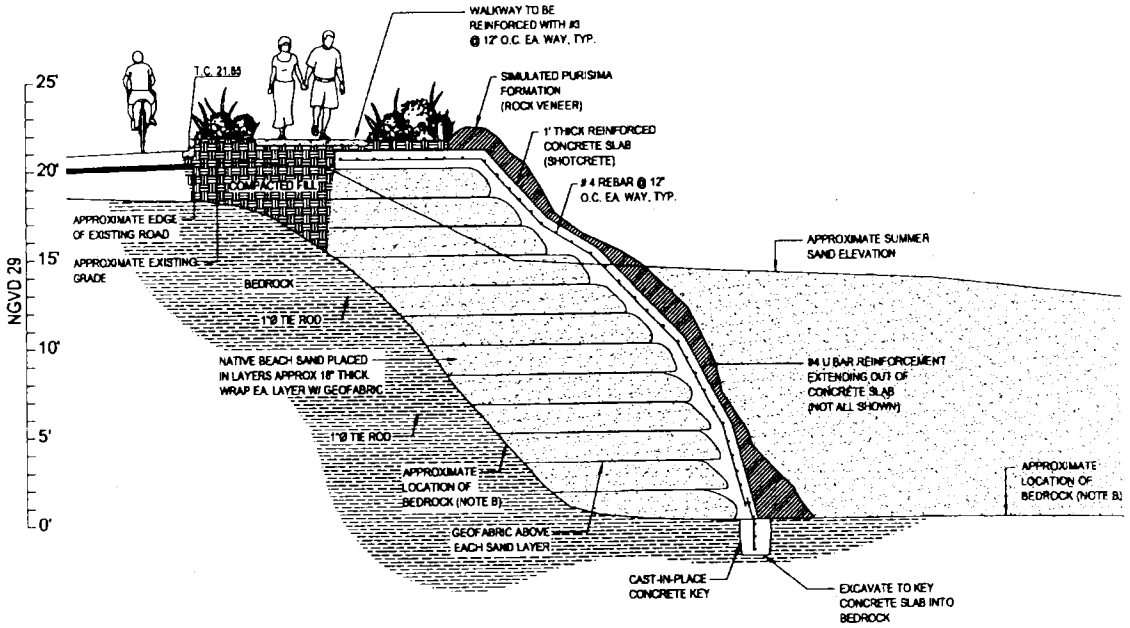


Figure 75. Schematic of section 5 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.

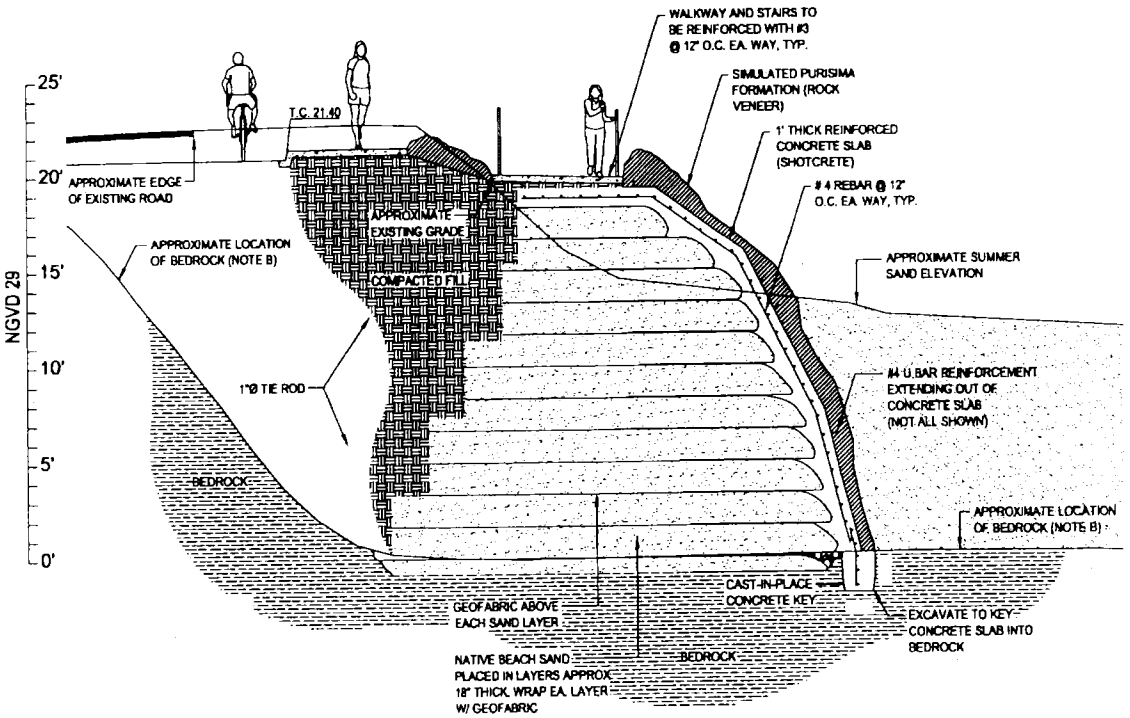


Figure 76. Schematic of section 6 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.

The stretch of coastline running approximately in the north-south direction from the restroom area to the Pump Station has no exposure to waves and therefore it does not experience erosion. It also features a mature landscape that County would like to preserve. Therefore, no structural improvements are proposed for this area.

10.2 7th Avenue to 9th Avenue

This stretch of coastline is currently protected by a non-engineered rip-rap revetment. Some of the rocks appear to have been displaced, with some of the smaller rocks being washed into the culvert outfall structure. The County has reported that there are potential long term plans to improve the roadway to resolve the occasional flooding in that area during winter storms. Therefore, there is a desire to minimize the cost of the protection works. Consequently, three types of structures were recommended for this area:

- From 7th Avenue to 9th Avenue the coastline would feature a) a pre-cast concrete wall with a Purisima formation finish; and b) pre-cast caissons with a Purisima formation finish; and
- At 9th Avenue a rip-rap revetment.

The assessment of marine and site conditions in this area indicated that erosion below an elevation of +0 feet NGVD 29 is not expected and that the revetment should extend to a depth of approximately -6 feet NGVD 29 to prevent scouring due to wave action. The bedrock in this stretch of coastline dips from slightly higher than elevation -6 feet NGVD 29 to slightly deeper, so the recommended rip-rap revetment should extend down to bedrock or to an elevation -6 feet NGVD 29, whichever is shallower. Considering a water depth of approximately 10 feet in a beach eroded condition and a depth-limited wave height computed per Eq. (2) of 6 feet, a revetment consisting of a geotextile, a one-layer 230 lbs rock underlayer and a one-layer 2,300 lbs rock armor layer is recommended.

The area at the Schwan lake culvert structure is at a relatively low elevation (i.e. +10 feet NGVD 29) and it is subjected to flooding during high rain events due to the overflowing of Schwan Lake. Debris can also be washed up onto the road by waves during sever winter storms. The proposed rip-rap will be designed to withstand the waves, but it could also be enhanced by extending the elevation of the crest to provide a screen for waves to keep debris from washing up onto the road from the beach during severe winter storms. This may also provide some degree of protection against more frequent high waves in the event that sea level rise projections due to global warming realize. It is estimated that a minimum crest elevation of +13 feet NGVD 29 will provide reasonable protection.

Schematics of the recommended structures for this stretch of coastline are shown in Figure 77 to Figure 80.

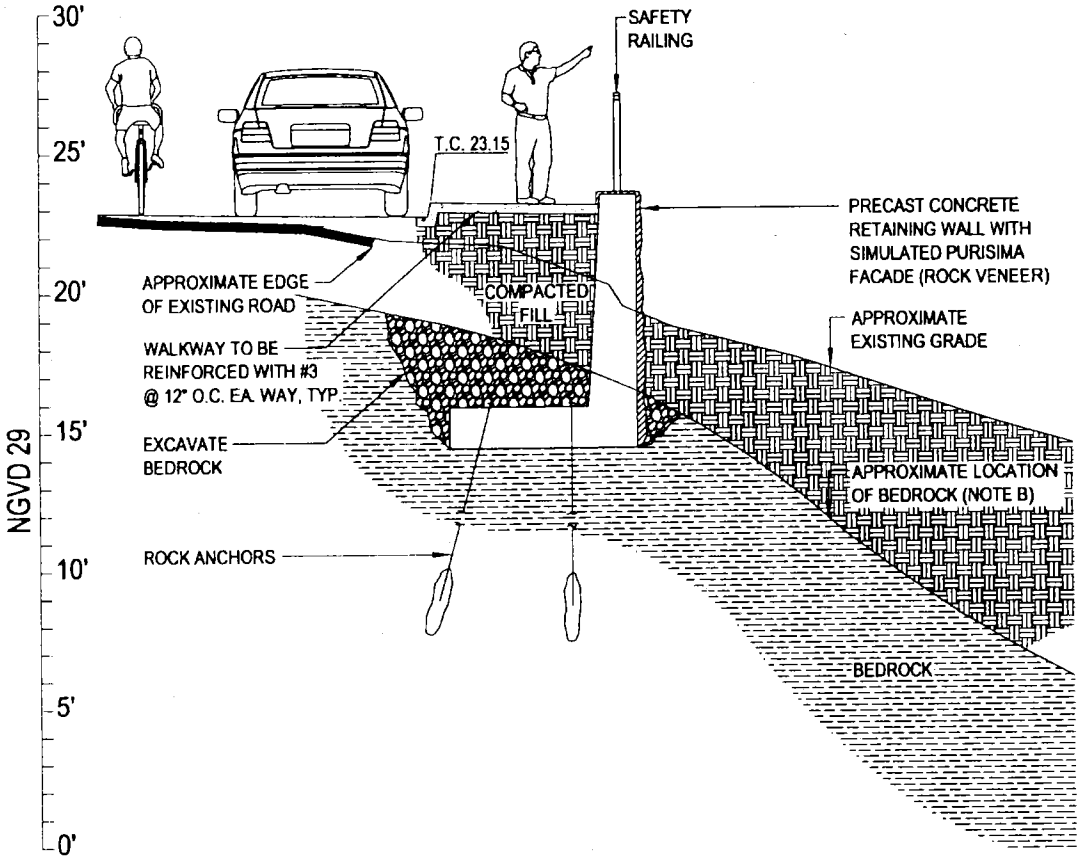


Figure 77. Schematic of section 8 featuring pre-cast concrete retaining wall and simulated Purisima formation finish, November 2010 architectural plan.

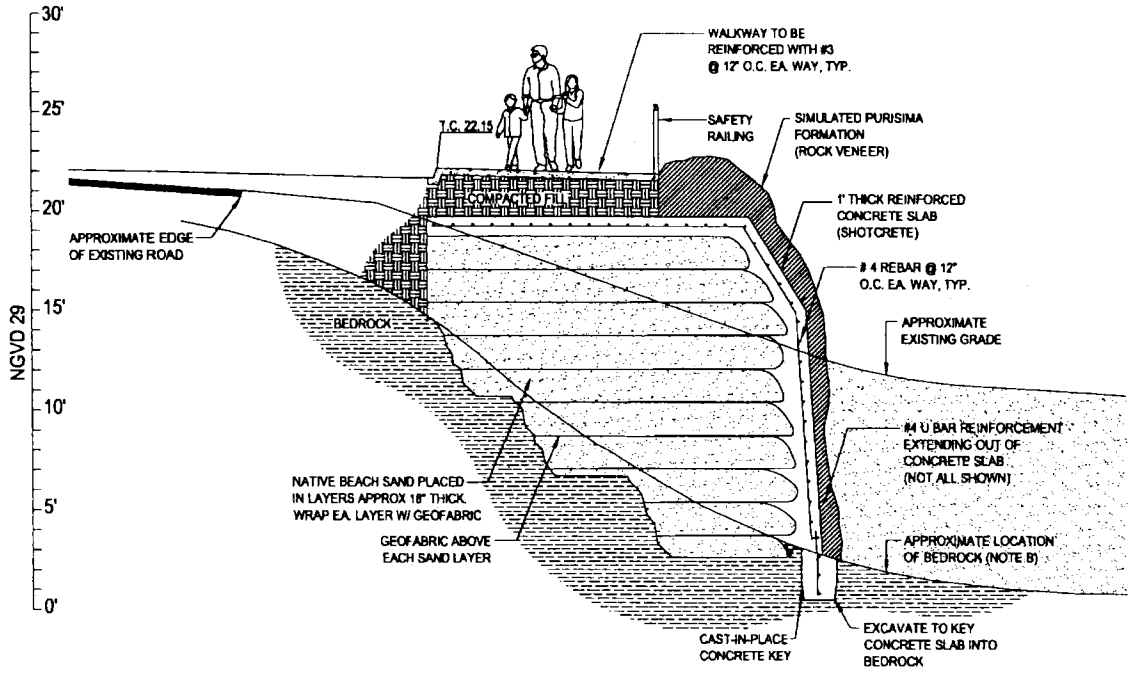


Figure 78. Schematic of section 9 featuring MSE and simulated Purisima formation finish, November 2010 architectural plan.

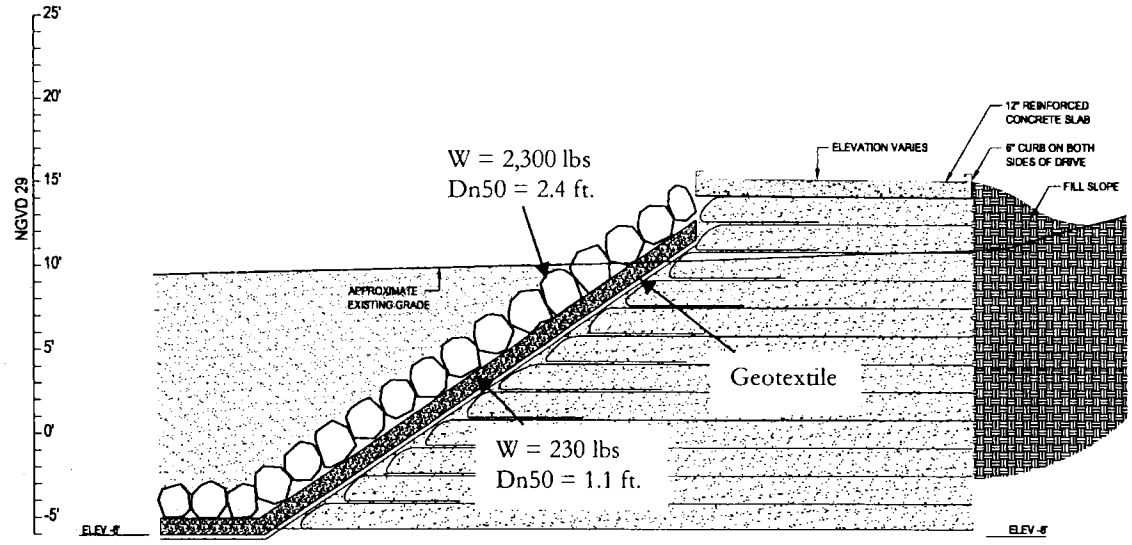


Figure 79. Schematic of section 10 featuring rip-rap revetment, November 2010 architectural plan.

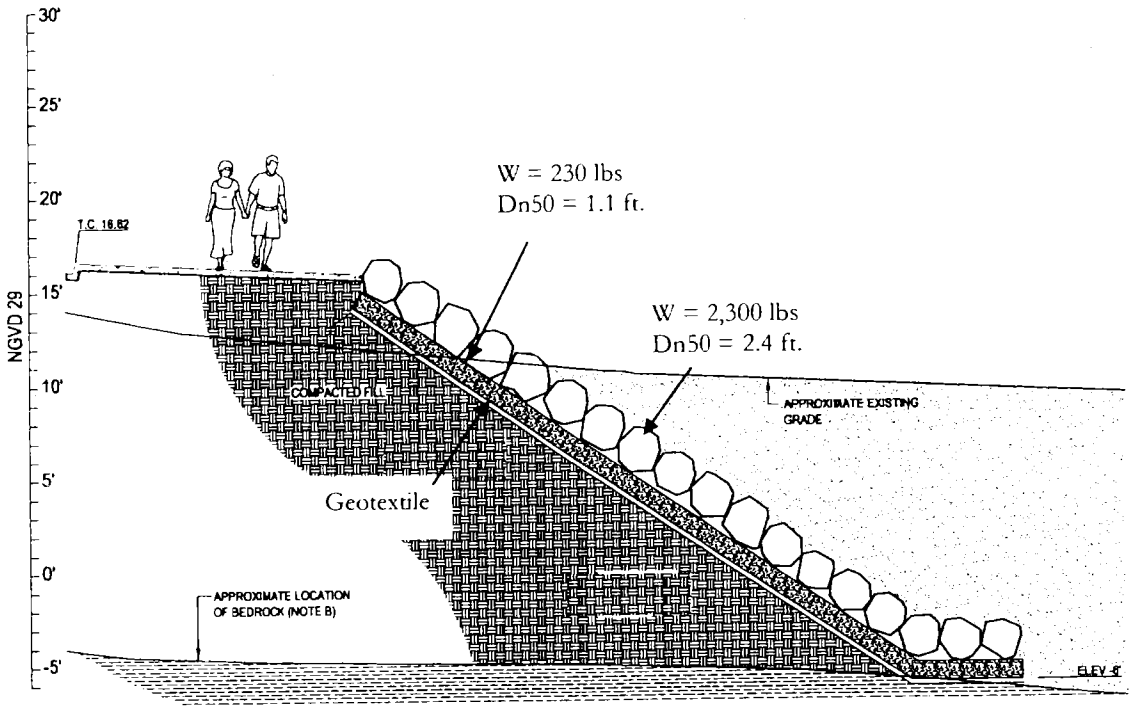


Figure 80. Schematic of section 11 featuring rip-rap revetment, November 2010 architectural plan.

10.3 9th Avenue to 11th Avenue

The County is considering the construction of a pedestrian pathway on this stretch of coastline, on the beach side of East Cliff Drive along the causeway that spans the Schwan Lake inlet. Currently the road is wide enough to accommodate two-way traffic lanes and a shoulder on each side. Using fill material, the County plans to widen the causeway to the beach side to provide the necessary space for the pathway.

During winter storms, and in periods when beach nourishment is interrupted or insufficient, high water levels and waves would impact the exposed slope that would result from the causeway widening. Unless this slope is protected, the foundations of the pedestrian pathway and the road will be subjected to erosion and their structural stability will be jeopardized.

The existing causeway is currently protected by a rip-rap revetment which appears to have performed satisfactorily in the last few years. Therefore, it is reasonable to assume that a similar structure would provide adequate protection to the pedestrian pathway and widened causeway. However, during visual inspection of the structure conducted on October 1st, 2010 it was noted that the existing revetment is not an engineered structure. It

ATTACHMENT 6

lacks of a geotextile filter and, in addition, displaced armor rocks were observed as well as voids exposing the causeway's foundation.

Concept designs for protecting the slope in this area were prepared and presented in a meeting to the County on October 8th, 2010. The options considered included caisson and rip-rap revetment alternatives. The direction from the County was to focus on the least cost alternative, to not significantly deviate from the current visual condition of the area, and to provide for a smooth transition to the adjacent private property. The rip-rap revetment was therefore chosen as the most viable to use in this area.

The concept design of the rip-rap revetment for this area considered the following:

- The top elevation of East Cliff Drive along the beach side from 9th Avenue to 11th Avenue ranges between +16 and +10 feet NGVD 29, with the head wall elevation of the culvert outfall structure located at +10.1 feet NGVD 29.
- The range of elevation of the nourished beach profiles at this location is approximately +4 to +9 feet NGVD 29.
- During the visual inspection of the revetment, Halcrow and the County reviewed drawings that showed the presence of an SSFM pipe crossing seaward of the culvert outfall, and buried under the beach sand. The top of the encasement of the SSFM, a concrete rectangular structure, is located approximately at +0 feet NGVD 29, which is the coincident with the Mean Sea Level (MSL).
- According to a California State lifeguard interviewed during the visual inspection of the existing revetment, and an investigation by County of Santa Cruz Public Works engineers (email dated 10/8/10) the SSFM has never been exposed due to beach erosion.
- In an extreme 100-year wave event and in an eroded beach scenario where the beach profile could be down to approximately +1 foot NGVD 29 (i.e. no SSFM exposed), and the TWL in front of the structure could be in the order of +11 feet NGVD 29, the depth-limited wave height in front of the causeway is estimated to be approximately 6 feet. Given the flat slope of the uniform beach fronting the Schwan Lake inlet, waves reaching the revetment would be non-breaking waves.
- It would be beneficial to minimize the encroachment of the structure on the beach.

Based on these considerations, the revetment would consist of three layers: a geotextile, a 230 lbs one-layer (Dn50 = 1.1 foot) rock underlayer, and a 2,300 lbs one-layer

(Dn50 = 2.4 feet) armor layer. The revetment would extend down to -6 feet NGVD 29 (potential scour depth = 1 wave height) and would feature a "Dutch" type toe, extending approximately 6 feet (1 wave height) in front of the structure. In order to minimize the encroachment on the beach a 1V:1.5H revetment slope is recommended. Figure 81 and Figure 82 show the recommended sections and characteristics of the revetment to protect the pedestrian pathway and causeway from 9th Avenue to 11th Avenue.

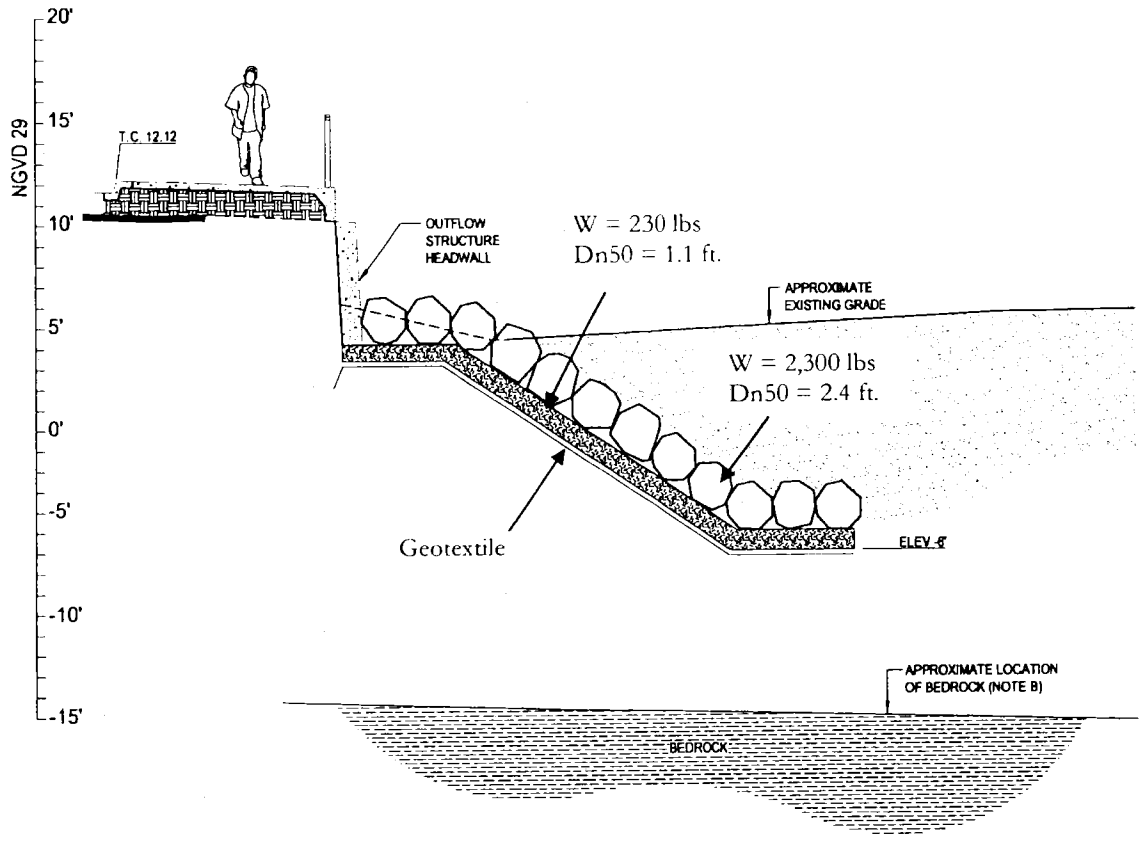


Figure 81. Schematic of section 12 featuring rip-rap revetment, November 2010 architectural plan.

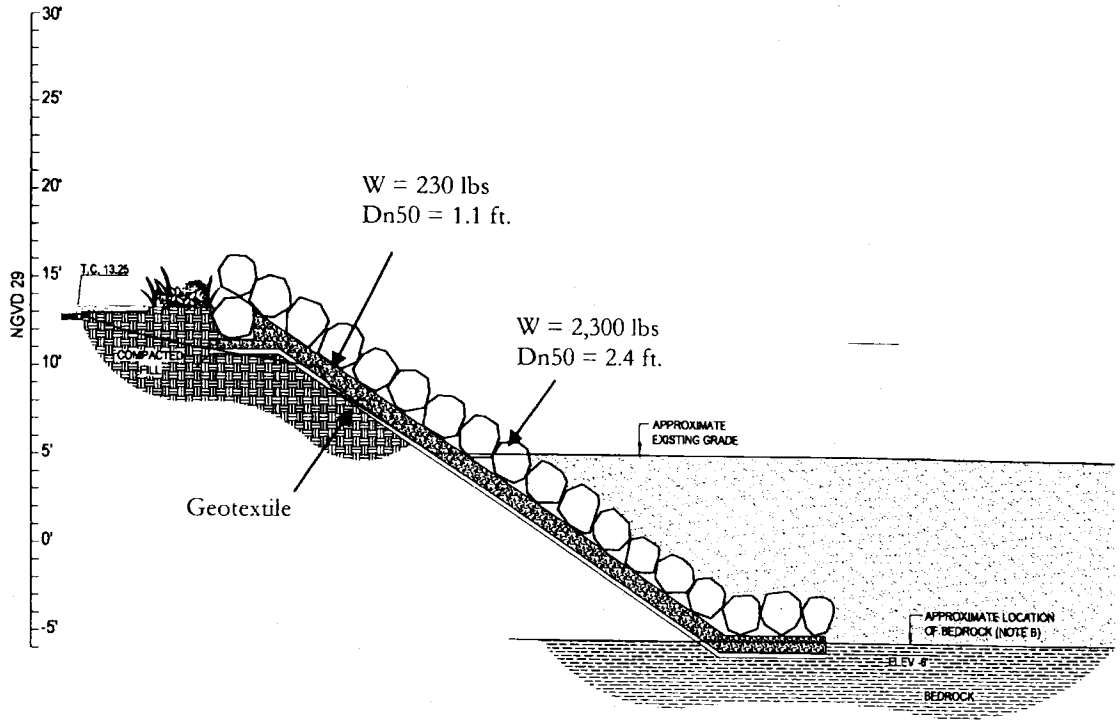


Figure 82. Schematic of section 13 featuring rip-rap revetment, November 2010 architectural plan.

The culvert outfall structure consists of three 66-inch diameter concrete pipes with a concrete head wall. This culvert has been observed to be partially blocked by a significant amount of sand and rocks that have accumulated due to wave action. This may be primarily due to the fact that the existing revetment is not engineered and undersized rock used in the adjacent slopes may have been displaced by waves. It is expected that the new revetment utilizing a proper rock gradation and construction would eliminate this problem.

The design of the culvert will need to provide a bedding of large rocks in front of and below the culvert to protect against erosion from both the outfall flow from the lake and from wave action, particularly when the culvert locks are closed (waves reflecting from culvert instead of passing through alleviating reflection when the locks are open). Depending on the results of a detailed topographic survey the proposed rock slope on each side of culvert may simply transition down to the rock 'bed' in front the culvert or may require construction of a small wing wall to retain some of the new rock slope and therefore keep the culvert pipes free from obstruction from the descending rock slope on each side.

11 Wave Overtopping Assessment

With the objective of estimating mean overtopping discharges for each of the sections in the November 2010 architectural plan (shown in Figure 62) wave overtopping calculations were performed. Use was made of NN_OVERTOPPING, a neural network-based prediction tool developed by Delft Hydraulics as part of the CLASH project (Crest Level Assessment of Coastal Structures by full scale monitoring, neural network prediction and Hazard analysis on permissible wave overtopping). NN_OVERTOPPING predicts mean discharges based on 8372 input-output combinations obtained from measurements performed in hydraulic scale models.

As opposed to the simplified representation of the structures (i.e. type of structure) used in section 8 to estimate the elevation of structures on the basis of mean overtopping discharges using empirical formulations, the representation of the structure and wave conditions in NN_OVERTOPPING is achieved by means of a set of 15 parameters, shown in Figure 83. Figure 84 shows an example of parametrization for section 4.

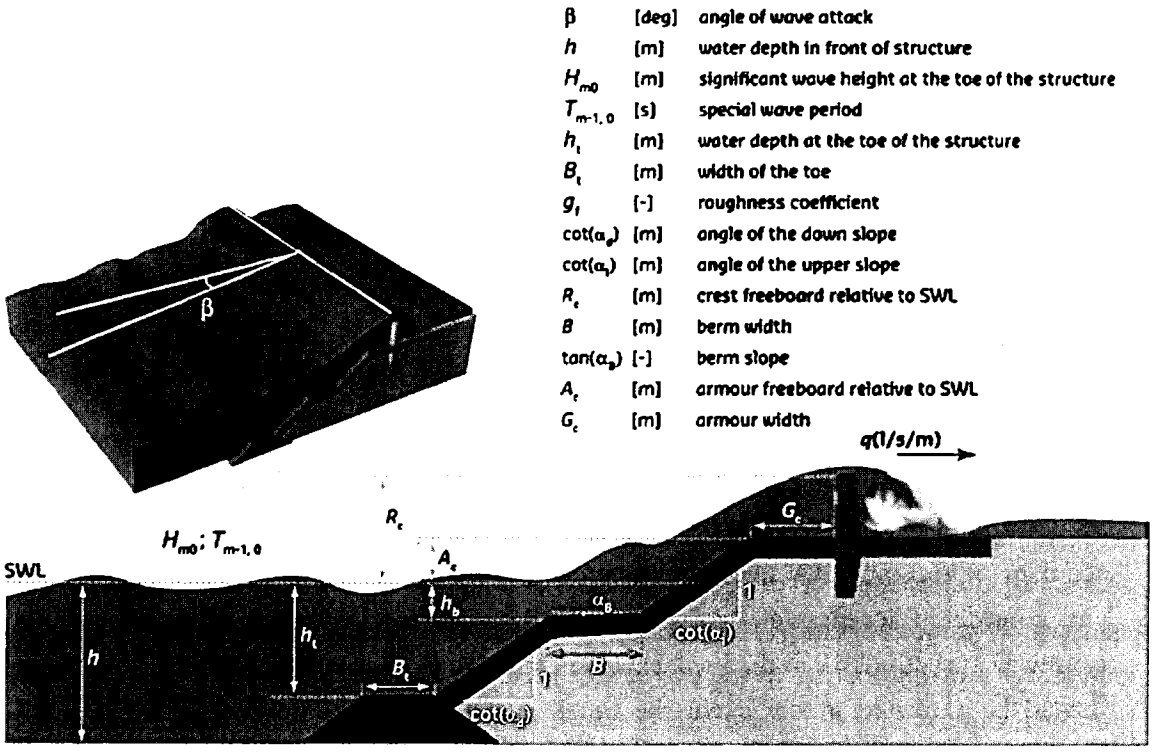


Figure 83. Parameters used to represent structures for overtopping discharge calculations with NN_OVERTOPPING.

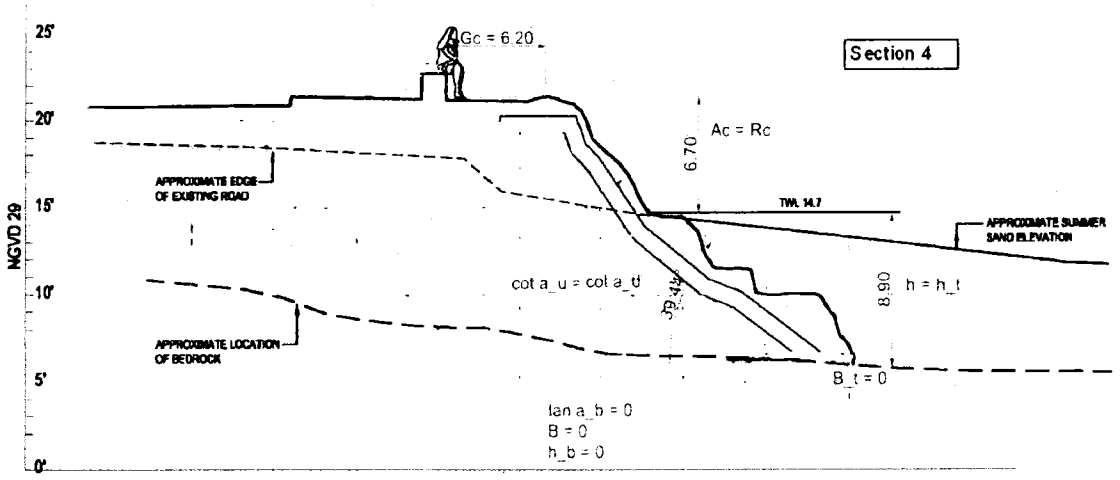


Figure 84. Example of parametrization of section 4 for NN_OVERTOPPING, November 2010 architectural plan.

For the stretch of coastline from 5th Avenue to 7th Avenue, sections 1 through 4 were analyzed using the 14.7 feet 100-year TWL for the Global Warming Year 2060 scenario, winter beach profile scenario obtained for the A-A' beach transect. Sections 5 and 6 were analyzed for the same scenario but for the 13.8 feet 100-year TWL obtained at the B-B' beach transect. No analysis was performed for section 7 because, as previously noted, this section is not exposed to waves. For the stretch of coastline from 8th to 9th Avenue, sections 8 and 9 were analyzed for the 12.9 feet 100-year TWL for the Global Warming Year 2060 scenario, winter beach profile scenario obtained for the E-E' beach transect. Sections 10 to 13 were analyzed using the 11.6 feet 100-year TWL for the No Global Warming scenario, summer beach profile because a) this stretch is a low elevation area that is currently affected by overtopping, and b) there is no evidence of beach erosion in this area.

Table 8 shows the mean overtopping discharges for each section. Highlighted sections indicate those were the 200 l/s/m guideline is exceeded However, within the accuracy of the estimates overtopping at sections 2 and 5 is marginally above 200 l/m/sec and considered acceptable. As expected, in the event of high water level and waves, the causeway at sections 12 and 13 will experience severe overtopping. At section 1, overtopping should be expected in the event the beach is eroded (winter beach profile) in that area. However, it must be pointed out that a winter profile at section 1 is hypothetical, and it is a scenario that has not been observed in the recent past.

On the basis of these initial findings and on a preliminary basis it can be concluded that existing adjacent properties and structures will not be negatively impacted by the proposed improvements.

Table 8. Mean overtopping discharges (Q) at various sections of architectural plan of November 2010.

Section	Scenario	TWL (feet NGVD 29)	*Wave Angle (deg)	Water Depth (feet)	**Wave Height (feet)	***Wave Period (sec)	Q (l/m/sec)
1	Global Warming Year 2060, Winter Beach Profile	14.7	0	8.3	5.8	14.3	341
2	Global Warming Year 2060, Winter Beach Profile	14.7	0	7.4	5.2	14.3	219
3	Global Warming Year 2060, Winter Beach Profile	14.7	0	5.1	3.6	12.1	40
4	Global Warming Year 2060, Winter Beach Profile	14.7	0	8.9	6.2	14.3	88
5	Global Warming Year 2060, Winter Beach Profile	13.8	0	13.8	9.7	15.4	218
6	Global Warming Year 2060, Winter Beach Profile	13.8	45	13.6	8.4	15.4	167
7							
8	Global Warming Year 2060, Winter Beach Profile	12.9	0	6.2	3.8	14.3	0
9	Global Warming Year 2060, Winter Beach Profile	12.9	0	11.9	7.4	14.3	70
10	No Global Warming Year 2110, Summer Beach Profile	11.6	0	10.6	6.7	14.3	127
11	No Global Warming Year 2110, Summer Beach Profile	11.6	0	10.6	6.7	14.3	116
12	No Global Warming Year 2110, Summer Beach Profile	11.6	0	10.6	6.7	14.3	626
13	No Global Warming Year 2110, Summer Beach Profile	11.6	0	10.6	6.7	14.3	299

* wave angle relative to normal of the structure
** depth-limited wave height
*** mean period Tm1-0 = Tpeak / 1.1

The wave overtopping predictions presented in this study are preliminary and were used only as a initial guidance for determining the adequacy of the elevation of the proposed structures. They are not intended to be used for detailed design. It is recommended to assess the performance of the proposed structures and development of the detailed design on the basis of hydraulic model tests.

ATTACHMENT 8

12 References

County of Santa Cruz Public Works, 2010. Email communication October 7, 2010.

EUROTOP, 2007. Wave Overtopping of Sea Defences and Related Structures: Assessment Manual. http://www.overtopping-manual.com

FEMA, 2004. Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States, Appendix D.4.2. November 2004.

Griggs, G. B. and Johnson, R.E., 1976. Effects of the Santa Cruz Harbor on Coastal Processes of Northern Monterey Bay. California, Environmental Geology, Vol. 1, pp. 299-312.

Griggs, G. B. and Johnson, R.E., 1983. Impact of 1983 Storms on the Coastline Northern Monterrey Bay Santa Cruz County. California Geology, Vol. 36, pp. 163-174.

Haro, Kasunich and Associates, Inc., 1995. Geotechnical and Coastal Engineering Investigation - East Cliff Drive Improvements - Santa Cruz Harbor to Schwan Lake. December 1995.

Haro, Kasunich and Associates, Inc., 2009. Update, Geotechnical and Coastal Engineering Investigation for the Twin Lakes Beachfront Project, Santa Cruz Harbor to Schwan Lake, Santa Cruz County, California. June 2009.

Herberger, M., Cooley H., Herrera P., Gleick P., and Moore E., 2009. The Impacts of Sea-Level Rise on the California Coast. Sacramento. California Climate Change Center.

Intergovernmental Panel on Climate Change, 2000. Special Report on Emissions Scenarios. Cambridge University Press, UK.

Kamphuis, J. W., 2000. Introduction to Coastal Engineering and Management. World Scientific Publishing.

NOAA Technical Memorandum NESDIS NGDC-20, 2009. Digital Elevation Model of Monterey, California: Procedures, Data Sources and Analysis.
http://www.ngdc.noaa.gov/mgg/inundation/tsunami/data/monterey_ca/monterey_ca.pdf

Rogers E. Johnson & Associates, 1995. Geologic Report, Proposed Improvements to East Cliff Drive, Santa Cruz Harbor to Schwan Lake, Santa Cruz County, California. REJA Job No. C95033-68. October 1995.

Rogers E. Johnson & Associates, 2009. Updated Geologic Investigation, Proposed Improvements to Twin Lakes Beachfront, East Cliff Drive – 5th Avenue to Schwan Lake Santa Cruz, California. REJA Job No. C09001-54. June 2009.

Stockdon, H.F., Holman, R.A., Howd, P.A., and Sallenger Jr., A.H., 2006. Empirical Parameterization of Setup, Swash, and Runup. Coastal Engineering, 53(7), pp. 573-588.

U.S. Geological Survey, 1988. Landslides, Floods, and Marine Effects of the Storm of January 3-5, 1982, in the San Francisco Bay Region, California. Edited by Stephen D. Ellen and Gerald F. Wieczorek. Professional Paper 1434.

Antonella Gentile

From: Hornick, Michael [Michael.Hornick@fema.dhs.gov]
Sent: Thursday, January 19, 2012 9:26 AM
To: Antonella Gentile
Subject: Fw: Twin Lakes Beachfront Improvement Project

Antonella.....this just in from Ed Curtis. It should suffice as a "peer" review. See you later.

From: Curtis, Edward
Sent: Wednesday, January 18, 2012 09:31 PM
To: Hornick, Michael
Subject: Twin Lakes Beachfront Improvement Project

Michael –

I reviewed the August 2011 Final Report prepared by Halcrow, Inc. (Halcrow) titled "County of Santa Cruz Twin Lakes Beachfront Improvements – Conceptual Design of Coastline Protection Structures". The methodology used by Halcrow to determine 1% annual chance (100-year) Total Water Levels for various sea level rise scenarios is in accordance with the FEMA Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States (FEMA Guidelines). The FEMA Region IX California Open Pacific Coast study is using the same FEMA Guidelines to analyze and re-map the Santa Cruz County for an update of the Flood Insurance Rate Map panels along the county coastline. FEMA's Production and Technical Services contractor, BakerAECOM LLC, will apply the same basic approach as Halcrow, but will start with base map data (topography, tidal data, and wave hindcast data) current to the year 2010 rather than 2008 data used for the Halcrow study. I believe that both studies will be based on the same set of bathymetry data. The FEMA study will not include any forecast sea level rise, so the resulting FIRM panels will be based on 1% annual chance TWLs for current (2010) shore and sea level conditions.

Please contact me if you need additional information.

Ed Curtis, P.E., CFM
Risk Analysis Branch
FEMA Region IX
(510) 627-7207 - office
(510) 295-5249 - mobile

As of November 30 my e-mail address changed to "edward.curtis@fema.dhs.gov". Addresses ending in "@dhs.gov" or "@fema.gov" will no longer function and you will likely see a bounce-back error message. Please update my email address in your Contacts list. Thank you.

ATTACHMENT

Halcrow, Inc.
6700 E. Pacific Coast Highway, Suite 180
Long Beach, CA 90803
Tel: (562) 493-8300
www.halcrow.com

Halcrow

February 23, 2012

Mr. Mike Sherrod, ASLA, LEED AP
RRM Design Group
3765 South Higuera St., Suite 102
San Luis Obispo, CA 93401

RE: Twin Lakes Beachfront Improvement Project
Design Development Review

Dear Mr. Sherrod:

After reviewing the Design Development Concepts drawings dated February 10, 2012 developed by RRM Design Group, it appears that the proposed design development is consistent with the recommendations provided in our Conceptual Design of Coastline Protection Structures report, dated August 1, 2011.

Sincerely,

HALCROW, INC.

Claudio Fassardi
Principal

Robert Andrews, P.E.
Vice President
Civil Engineer, CA #45405
Exp. 9/30/12

ATTACHMENT 10

DRAINAGE REPORT FOR

Public Right-of-Way and Road Improvements for East Cliff Drive at Twin Lakes Beachfront

Santa Cruz, California
County of Santa Cruz

Prepared for
County of Santa Cruz - Public Works

Prepared by

rrmdesigngroup

creating environments people enjoy®

November 22, 2011

ATTACHMENT 1 1

This report has been prepared under the direction of the Registered Engineer

November 22, 2011

Sean J. Brown — Date
Registered Engineer

ENGINEER OF RECORD:

DATE:

ATTACHMENT

TABLE OF CONTENTS

INTRODUCTION 4

BASIS OF CALCULATIONS 4
DESCRIPTION OF SITE DRAINAGE PATTERNS 5

ANALYSIS & DISCUSSION 6

HYDROLOGY (OVERLAND FLOW) 6
GUTTER CAPACITY CHECK 6
HYDRAULIC CAPACITY CHECK 6
WATER QUALITY TREATMENT UNITS 6

SUMMARY OF RESULTS 7

CONCLUSIONS 7

CALCULATIONS AND PROJECT DATA

PROJECT DRAINAGE MAPS 8
RATIONAL METHOD CALCULATIONS – 10 YEAR STORM EVENT 9
RATIONAL METHOD CALCULATIONS – 25 YEAR STORM EVENT 10
WATER QUALITY TREATMENT CALCULATIONS AND DETAILS 11
SANTA CRUZ COUNTY DRAINAGE DESIGN APPENDICES 12

ATTACHMENT 1 1

1.0 INTRODUCTION

The proposed project is located on East Cliff Drive between the cross streets of 5th Avenue and 7th Avenue in the Leona Creek Drainage Basin of Flood Zone 5 in Santa Cruz County. Project improvements cover an area of approximately 1.71 acres. The project consists of bluff stabilization and coastal armoring along the Twin Lakes beach front, along with an all new parking configuration and multi-use path layout. The new parking configuration along the beach front will lend itself to a slightly revised road alignment and additional storm drainage facilities with an infiltration component to accommodate first flush storm runoff. Impacts to site drainage will be minimal due to project construction with only a minimal increase in impervious area and an overall upgrade and enhancement to the existing storm drainage system. This report covers the drainage system within the project site area as well as the upstream watershed between 5th Avenue and 7th Avenue. Refer to *the Stormwater Management Report for Schwan Lake Pedestrian Improvements – East Cliff Drive – 9th Ave to 12th Ave.* for analysis of watersheds between 7th Avenue and 12th Avenue.

2.0 BASIS OF CALCULATIONS

The **Rational Formula** is used to determine surface flow rates:

$Q=CiA$

Where:

Q= Estimated Peak Surface Runoff Coefficient (CFS)
Ca= Antecedent Moisture Facture (Unitless)
C= Runoff Coefficient (Unitless)
i_a= Rainfall Intensity Adjustment Factor (Unitless)
i= Rainfall Intensity (in/hr)
A= Area of Site (Acres)

ATTACHMENT 1.1

3.0 DESCRIPTION OF SITE DRAINAGE PATTERNS

Existing Conditions	
Basin	
A	Basin drains down 5th Ave. to E. Cliff Drive to surface flow west towards harbor. This basin drains offsite and will does not affect proposed improvements.
B	Basin drains primarily east to road side berm/channel where existing culvert structure passes drainage below existing park road and on to defined swale/creek.
C	Basin drains down 7th Ave. and east down E. Cliff Dr. to existing catch basin with 15" CMP outlet to beach.
D	Basin drains down 7th Avenue towards E. Cliff Dr. intersection and in to existing catch basin at return.

Proposed Conditions	
Basin	
B1	Area drains to parking bay with proposed infiltration and standard catch basin adjacent to roundabout and bluff improvements.
B2	Area drains to central proposed parking bay equipped with proposed infiltration and standard catch basins
B3	Area drains to parking bay with proposed infiltration catch basin and standard catch basin with outlet
B4	Area drains to proposed catch basin on north side of roundabout adjacent to parking bay
B5	Area drains to proposed catch basin at eastern corner of 6th Ave. and E. Cliff Dr. intersection
C	Area drains to existing catch basin with 15" CMP outlet to beach
D	Basin drains down 7th Avenue towards E. Cliff Dr. intersection and in to existing catch basin at return.

Refer to "Project Drainage Basin" Maps for delineated areas

ATTACHMENT 1

4.0 ANALYSIS & DISCUSSION

HYDROLOGY (OVERLAND FLOW):

Calculations for project post-development overland flows are shown in the "Hydrology Calculations" section of the report. Overland flows were calculated for all sub-basins individually for the 10 and 25 year storm events. These values are used for further analysis in subsequent of the report. A table summarizing these calculations is shown in Section 5.0

GUTTER CAPACITY CHECK

Calculations for gutter capacity check are located within the Hydraflow Storm Sewers analysis "Inlet Report" spreadsheet under the spread heading. Sub-basin B4 calculations show a large gutter spread width due to inadequate storm drain infrastructure upstream of the project area. The installation of additional inlets is recommended in the upper portions of Basin B to reduce drainage impacts and gutter spread within the proposed project area.

HYDRAULIC CAPACITY CHECK

Calculations for project post-development hydraulic capacity for existing and proposed storm drain infrastructure within the project area are shown on the Hydraflow Storm Sewers analysis spreadsheets. Hydraulic capacity was checked for 10 and 25-year storm events and proposed systems have been designed to adequately handle a 25-year storm event. Calculations show that all inlets and pipes will handle a 25-year storm event with additional freeboard in the system. It should be noted that existing storm drain pipes within the project boundary show evidence of reduced effectiveness due to lack of maintenance and clogging. All existing pipes should be maintained or replaced during project construction.

WATER QUALITY TREATMENT UNITS

A secondary storm drain system designed to capture first flush flows will be utilized alongside the standard storm drain system. The secondary system will capture the more heavily polluted dry weather and initial storm event runoff, and route to an infiltration system that will filter and cleanse the water. The proposed storm drain facilities are designed as a flow based BMP for infiltration of first flush flows through the gravel bed and surrounding sandy soils, in-lieu of draining untreated run-off directly to the beach. The Uniform Intensity Approach where the flow of runoff from a rain event equal to at least 0.2 inches per hour intensity has been used to size the facilities. The proposed

ATTACHMENT 1 1

facilities are very similar to the Santa Cruz County Standard – Fig. SWM-12 "Water Quality Treatment Unit for Small Drainage Areas" and will perform in a comparable fashion. Actual infiltration rates will be dependent on soil conditions surrounding the treatment unit. A treatment drain box of larger dimensions can be used as a method of storing a larger volume of water if deemed necessary. An appropriate sand and gravel mixture will need to be determined that will be able to filter and cleanse the water at a rate able to handle the Standard California Water Quality Treatment Intensity of 0.2 inches per hour. Storm water will simply back up out of the secondary catch basin and into the adjacent primary storm drain system once capacity of the secondary system occurs. Please refer to the details and product cut-sheets within this report for more information.

5.0 SUMMARY OF RESULTS

The table below summarizes all storm runoff data and water quality treatment flows.

STORMWATER FLOW SUMMARY				
Sub-Basin	Area (ac)	Q10 (CFS)	Q25 (CFS)	Q_{WQ} (CFS)
A	2.90	4.72	6.23	0.51
B	4.75	7.71	10.18	0.84
B1	0.08	0.15	0.19	0.01
B2	0.09	0.16	0.22	0.02
B3	0.06	0.11	0.14	0.01
B4	4.48	8.18	9.6	0.72
B5	0.17	0.31	0.41	0.03
C	1.35	2.19	2.89	0.22
D	0.15	0.27	0.36	0.03

Q10 = Post Development flow for a 10-Year Storm Event
Q25= Post Development flow for a 25-Year Storm Event
Qwq = Required treatment flow based on California Water Quality Standards

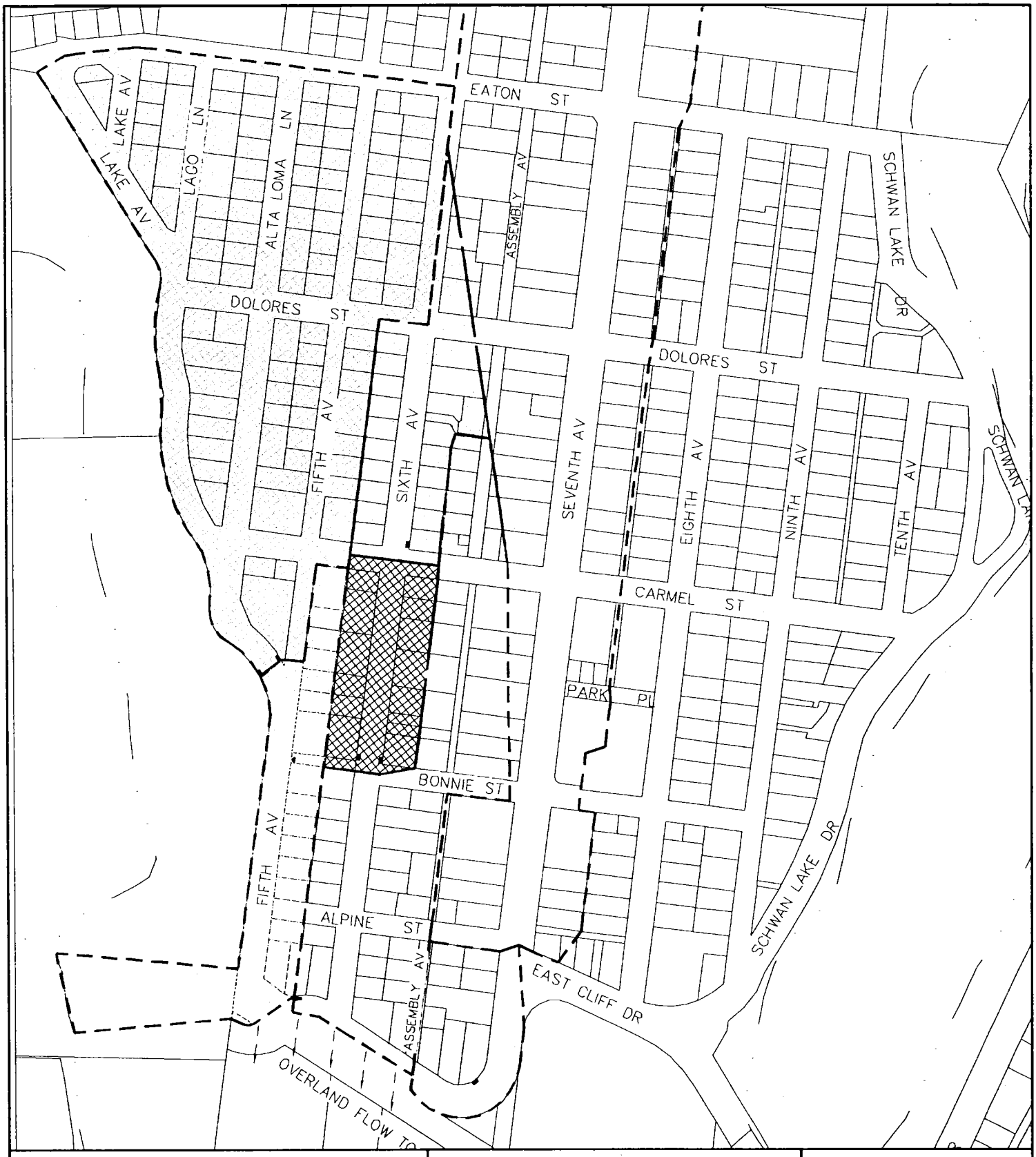
6.0 CONCLUSIONS

Based on analysis shown in this report, all storm drain components have been checked to adequately handle a 25 year design storm event. In addition, the proposed storm drain infiltration system will effectively re-route and improve the water quality of a portion of these flows before they reach Twin Lakes Beach and adjacent coast waters.

ATTACHMENT 1

Project Drainage Maps

ATTACHMENT 1 1



PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

PRE-DEVELOPMENT DRAINAGE MAP

rrmdesigngroup

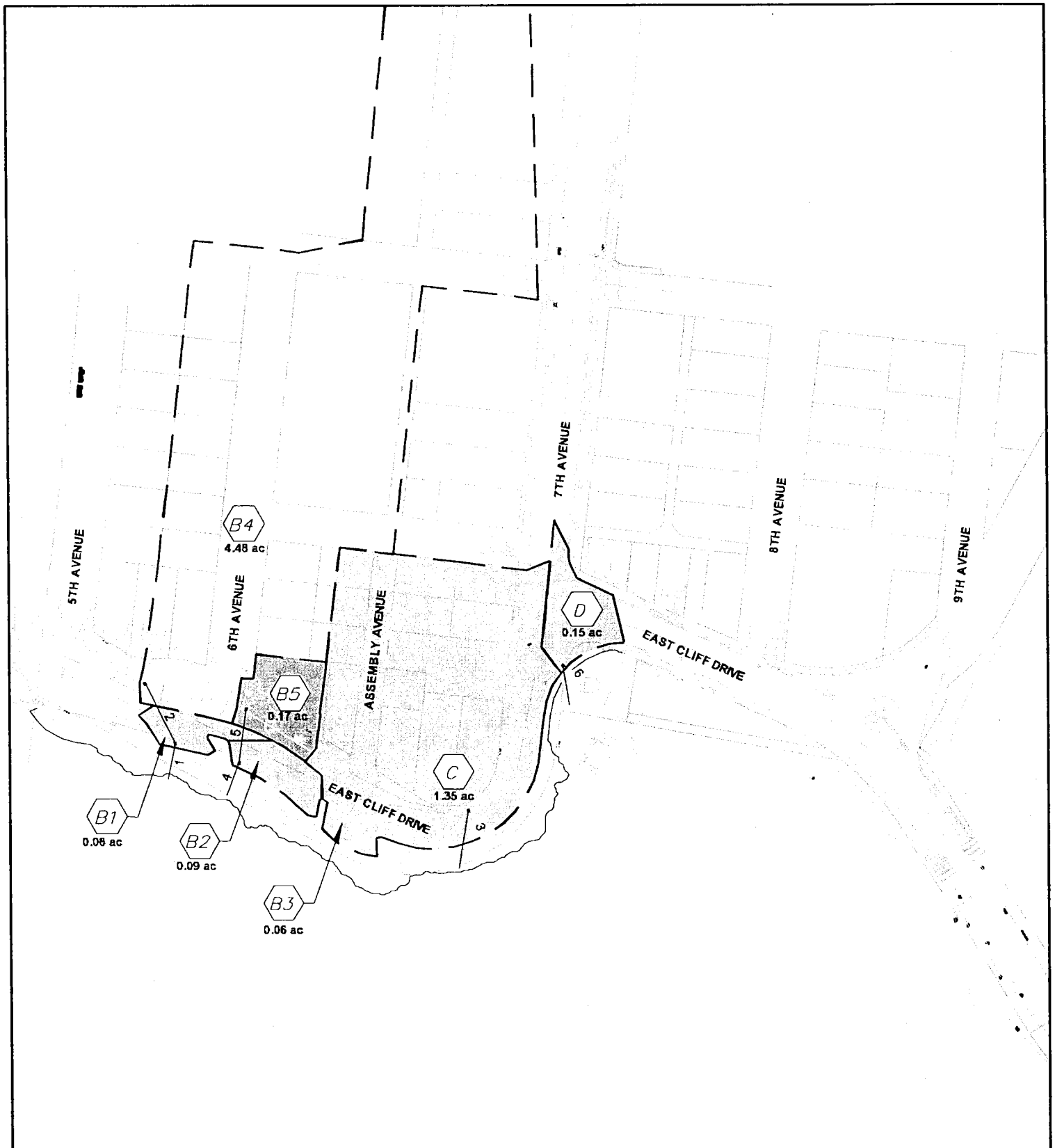
creating environments people enjoy®

3765 South Higuera St., Ste. 102, San Luis Obispo, CA 93401
P: (805) 543-1794 | F: (805) 543-4609 | www.rrmdesign.com

A California Corporation | Victor Montgomery, Architect #C11-090 | Jerry Michael, PE #39895, LS #6278 | Jeff Ferber, LA #2844

DRAWN BY:	SJB
CHECKED BY:	SJB
DATE:	7-19-11
JOB NO.:	1309513
SCALE:	N.T.S.
SHEET NO.:	--

ATTACHMENT 1



PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

POST-DEVELOPMENT DRAINAGE MAP

rrmdesigngroup

creating environments people enjoy®

3765 South Higuera St., Ste. 102, San Luis Obispo, CA 93401
P: (805) 543-1794 | F: (805) 543-4609 | www.rrmdesign.com
A California Corporation | Victor Montgomery, Architect #C31090 | Jerry Michael, PE #38896, LS #6278 | Jeff Ferber, LA #2844

DRAWN BY:	SJB
CHECKED BY:	SJB
DATE:	7-19-11
JOB NO.:	1309513
SCALE:	N.T.S.
SHEET NO.:	

ATTACHMENT

Rational Method Calculations
10-Year Storm Event

ATTACHMENT 1

DRAINAGE CALCULATIONS FOR:
PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS:
EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT - 5th Ave -7th Ave
July 19, 2011

Project Drainage Basins - Flow Rate Calculations for 10 Year Event

DRAINAGE AREAS AND RATIONAL COEFFICIENTS					
Sub-Basin	Total Area (SF)	Existing C	Added Impervious (SF)	Area (AC)	Avg C
A	126500	0.8	0	2.90	0.8
B	206850	0.8	0	4.75	0.8
C	58780	0.8	0	1.35	0.8
D	6642	0.9	0	0.15	0.9

Ia and Ca Modifcation Factors		
Return Period	Ia	Ca
2	0.64	1.00
5	0.85	1.00
10	1.00	1.00
15	1.09	1.00
25	1.20	1.10
50	1.35	1.20
100	1.50	1.25

Basis of Calculation

I = ((4.29112)*(1.1952P60)/tc^((0.60924)*(0.78522P60)) * Ia

Q=C*Ca*I*A

Intensity for Storm

Return Period=	10	Years
P60 Isopleth=	1.4	(Based on Location - See County P60 Isopleths Map)
Ia=	1	(Based on Return Period - See Above)
Ca=	1	(Based on Return Period - See Above)

RUNOFF FLOW CALCULATIONS					
Sub-Basin	Area (ac)	C	Tc (min)	I (in/hr)	Q (cfs)
A	2.90	0.8	10	2.03	4.72
B	4.75	0.8	10	2.03	7.71
B1	0.08	0.9	10	2.03	0.15
B2	0.09	0.9	10	2.03	0.16
B3	0.06	0.9	10	2.03	0.11
B4	4.48	0.9	10	2.03	8.18
B5	0.17	0.9	10	2.03	0.31
C	1.35	0.8	10	2.03	2.19
D	0.15	0.9	10	2.03	0.27

ATTACHMENT 1 1

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.	Junction Type
1		7.42	24	Cir	38.836	11.70	12.50	2.060	12.76	13.46	n/a	13.46 j	End	Grate
2		7.28	24	Cir	69.704	12.60	14.00	2.008	13.46	14.96	0.38	14.96	1	Combination
3		2.35	15	Cir	63.117	14.50	17.00	3.961	15.17	17.61	n/a	17.61	End	Combination
4		0.44	15	Cir	36.774	15.00	15.77	2.094	15.29	16.04	n/a	16.04	End	Grate
5		0.27	15	Cir	56.638	15.87	17.00	1.995	16.04	17.21	n/a	17.21	4	Combination
6		0.28	15	Cir	21.090	15.00	20.00	23.708	16.12	20.21	n/a	20.21	End	Combination

Project File: 10 Year-7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

NOTES: Known Qs only ; j - Line contains hyd. jump.

ATTACHMENT 1 J

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	B1	0.14*	0.00	0.14	0.00	Grate	0.0	0.00	6.00	3.00	2.00	Sag	2.00	0.050	0.020	0.013	-0.07	-1.43	0.04	0.34	2.0	Off
2	B	7.28*	0.00	4.17	3.11	Comb	6.0	3.00	0.00	3.00	2.00	0.025	2.00	0.083	0.020	0.013	0.34	10.90	0.38	10.52	2.0	Off
3	C	2.35*	0.00	2.35	0.00	Comb	6.0	3.00	6.00	3.00	2.00	Sag	2.00	0.083	0.040	0.013	0.16	1.92	0.24	1.95	2.0	Off
4	B2	0.17*	0.00	0.17	0.00	Grate	0.0	0.00	6.00	3.00	2.00	Sag	2.00	0.050	0.020	0.013	0.02	0.34	0.04	0.65	1.0	Off
5	B5	0.27*	0.00	0.27	0.00	Comb	6.0	3.00	0.00	3.00	2.00	0.050	2.00	0.083	0.020	0.013	0.10	1.25	0.11	1.09	2.0	4
6	D	0.28*	0.00	0.28	0.00	Comb	8.0	3.00	6.00	3.00	2.00	Sag	2.00	0.083	0.050	0.013	-0.04	-0.49	0.06	0.45	2.0	Off

Project File: 10 Year-7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

NOTES: Inlet N-Values = 0.016 ; Known Qs only; * Indicates Known Q added. All curb inlets are Horiz throat.

INNOVYZE

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Min los
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
	(in)	(cfs)									(ft)											(K)	(ft
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24
1	24	7.42	11.70	12.76	1.06	1.69	4.39	0.30	13.06	0.354	38.836	12.50	13.46 j	0.96**	1.50	4.95	0.38	13.85	0.487	0.420	n/a	0.99	n/a
2	24	7.28	12.60	13.46	0.86	1.30	5.59	0.49	13.95	0.688	69.704	14.00	14.96	0.96**	1.48	4.91	0.38	15.33	0.484	0.586	n/a	1.00	0.3
3	15	2.35	14.50	15.17	0.00	0.00	0.00	0.00	15.17	0.000	63.117	17.00	17.61	0.00**	0.00	0.00	0.00	17.61	0.000	0.000	0.000	1.00	n/a
4	15	0.44	15.00	15.29	0.00	0.00	0.00	0.00	15.29	0.000	36.774	15.77	16.04	0.00**	0.00	0.00	0.00	16.04	0.000	0.000	0.000	0.50	n/a
5	15	0.27	15.87	16.04	0.00	0.00	0.00	0.00	16.04	0.000	56.638	17.00	17.21	0.00**	0.00	0.00	0.00	17.21	0.000	0.000	0.000	1.00	n/a
6	15	0.28	15.00	16.12	0.00	0.00	0.00	0.00	16.12	0.000	21.090	20.00	20.21	0.00**	0.00	0.00	0.00	20.21	0.000	0.000	0.000	1.00	n/a

Project File: 10 Year-7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

Notes: ; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

ATTACHMENT 11

Hydraflow HGL Computation Procedure

General Procedure: Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Rational Method Calculations
25-Year Storm Event

DRAINAGE CALCULATIONS FOR:
PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS:
EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT - 5th Ave -7th Ave
July 19, 2011

Project Drainage Basins - Flow Rate Calculations for 25 Year Event

DRAINAGE AREAS AND RATIONAL COEFFICIENTS					
Sub-Basin	Total Area (SF)	Existing C	Added Impervious (SF)	Area (AC)	Avg C
A	126500	0.8	0	2.90	0.8
B	206850	0.8	0	4.75	0.8
C	58780	0.8	0	1.35	0.8
D	6642	0.9	0	0.15	1.8

Ia and Ca Modifcation Factors		
Return Period	Ia	Ca
2	0.64	1.00
5	0.85	1.00
10	1.00	1.00
15	1.09	1.00
25	1.20	1.10
50	1.35	1.20
100	1.50	1.25

Basis of Calculation

I = ((4.29112)*(1.1952P60)/tc^((0.60924)*(0.78522P60)) * Ia

Q=C*Ca*I*A

Intensity for Storm

Return Period=	25	Years
P60 Isopleth=	1.4	(Based on Location - See County P60 Isopleths Map)
Ia=	1.2	(Based on Return Period - See Above)
Ca=	1.1	(Based on Return Period - See Above)

RUNOFF FLOW CALCULATIONS						
Sub-Basin	Area (ac)	C	Tc (min)	I (in/hr)	Q (cfs)	
A	2.90	0.8	10	2.44	6.23	(Offsite)
B	4.75	0.8	10	2.44	10.18	
B1	0.08	0.9	10	2.44	0.19	
B2	0.09	0.9	10	2.44	0.22	
B3	0.06	0.9	10	2.44	0.14	
B4	4.48	0.8	10	2.44	9.60	
B5	0.17	0.9	10	2.44	0.41	
C	1.35	0.8	10	2.44	2.89	
D	0.15	0.9	10	2.44	0.36	

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.	Junction Type
1		9.79	24	Cir	38.836	11.70	12.50	2.060	12.81	13.61	n/a	13.61 j	End	Grate
2		9.60	24	Cir	69.704	12.60	14.00	2.008	13.61	15.10	0.46	15.10	1	Combination
3		2.89	15	Cir	63.117	14.50	17.00	3.961	15.18	17.68	n/a	17.68	End	Combination
4		0.63	15	Cir	36.774	15.00	15.77	2.094	15.32	16.09	n/a	16.09	End	Grate
5		0.41	15	Cir	56.638	15.87	17.00	1.995	16.09	17.26	n/a	17.26	4	Combination
6		0.36	15	Cir	21.090	15.00	20.00	23.708	16.19	20.24	n/a	20.24	End	Combination

Project File: 25 Year 7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

NOTES: Known Qs only ; j - Line contains hyd. jump.

ATTACHMENT 1

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	B1	0.19*	0.00	0.19	0.00	Grate	0.0	0.00	6.00	3.00	2.00	Sag	2.00	0.050	0.020	0.013	-0.06	-1.27	0.04	0.42	2.0	Off
2	B	9.60*	0.00	4.97	4.63	Comb	6.0	3.00	0.00	3.00	2.00	0.025	2.00	0.083	0.020	0.013	0.37	12.30	0.41	11.97	2.0	Off
3	C	2.89*	0.00	2.89	0.00	Comb	6.0	3.00	6.00	3.00	2.00	Sag	2.00	0.083	0.040	0.013	0.19	2.58	0.27	2.58	2.0	Off
4	B2	0.22*	0.00	0.22	0.00	Grate	0.0	0.00	6.00	3.00	2.00	Sag	2.00	0.050	0.020	0.013	0.02	0.49	0.05	0.78	1.0	Off
5	B5	0.41*	0.00	0.41	0.00	Comb	6.0	3.00	0.00	3.00	2.00	0.050	2.00	0.083	0.020	0.013	0.12	1.46	0.13	1.28	2.0	4
6	D	0.36*	0.00	0.36	0.00	Comb	8.0	3.00	6.00	3.00	2.00	Sag	2.00	0.083	0.050	0.013	-0.03	-0.37	0.07	0.52	2.0	Off

Project File: 25 Year 7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

NOTES: Inlet N-Values = 0.016 ; Known Qs only; * Indicates Known Q added. All curb inlets are Horiz throat.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minc loss
			Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf		Invert elev	HGL elev	Depth	Area	Vel	Vel head	EGL elev	Sf	Ave Sf	Enrgy loss		
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(%)	(ft)	(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	9.79	11.70	12.81	1.11	1.79	5.47	0.46	13.27	0.530	38.836	12.50	13.61 j	1.11**	1.79	5.48	0.47	14.07	0.533	0.532	n/a	0.99	n/a
2	24	9.60	12.60	13.61	1.01	1.59	6.05	0.57	14.18	0.701	69.704	14.00	15.10	1.10**	1.77	5.44	0.46	15.56	0.529	0.615	n/a	1.00	0.46
3	15	2.89	14.50	15.18	0.00	0.00	0.00	0.00	15.18	0.000	63.117	17.00	17.68	0.00**	0.00	0.00	0.00	17.68	0.000	0.000	0.000	1.00	n/a
4	15	0.63	15.00	15.32	0.00	0.00	0.00	0.00	15.32	0.000	36.774	15.77	16.09	0.00**	0.00	0.00	0.00	16.09	0.000	0.000	0.000	0.50	n/a
5	15	0.41	15.87	16.09	0.00	0.00	0.00	0.00	16.09	0.000	56.638	17.00	17.26	0.00**	0.00	0.00	0.00	17.26	0.000	0.000	0.000	1.00	n/a
6	15	0.36	15.00	16.19	0.00	0.00	0.00	0.00	16.19	0.000	21.090	20.00	20.24	0.00**	0.00	0.00	0.00	20.24	0.000	0.000	0.000	1.00	n/a

Project File: 25 Year 7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

Notes: ; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure: Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Water Quality Treatment Calculations and Details

ATTACHMENT 1 1

DRAINAGE CALCULATIONS FOR:
PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS:
EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT - 5TH Ave -7TH Ave

Stormwater Infiltration/Treatment Calculations

DRAINAGE AREAS AND RATIONAL COEFFICIENTS					
Sub-Basin	Total Area (SF)	Existing C	Added Impervious (SF)	Area (AC)	Avg C
A	126500	0.8	0	2.90	0.8
B	206850	0.8	0	4.75	0.8
C	58780	0.8	0	1.35	0.8
D	6642	0.9	0	0.15	0.9

Basis of Calculation

$Q_{WQ}=C*I*A$

Q_{WQ}=Water Quality Treatment Flow Rate

C=Runoff Coefficient

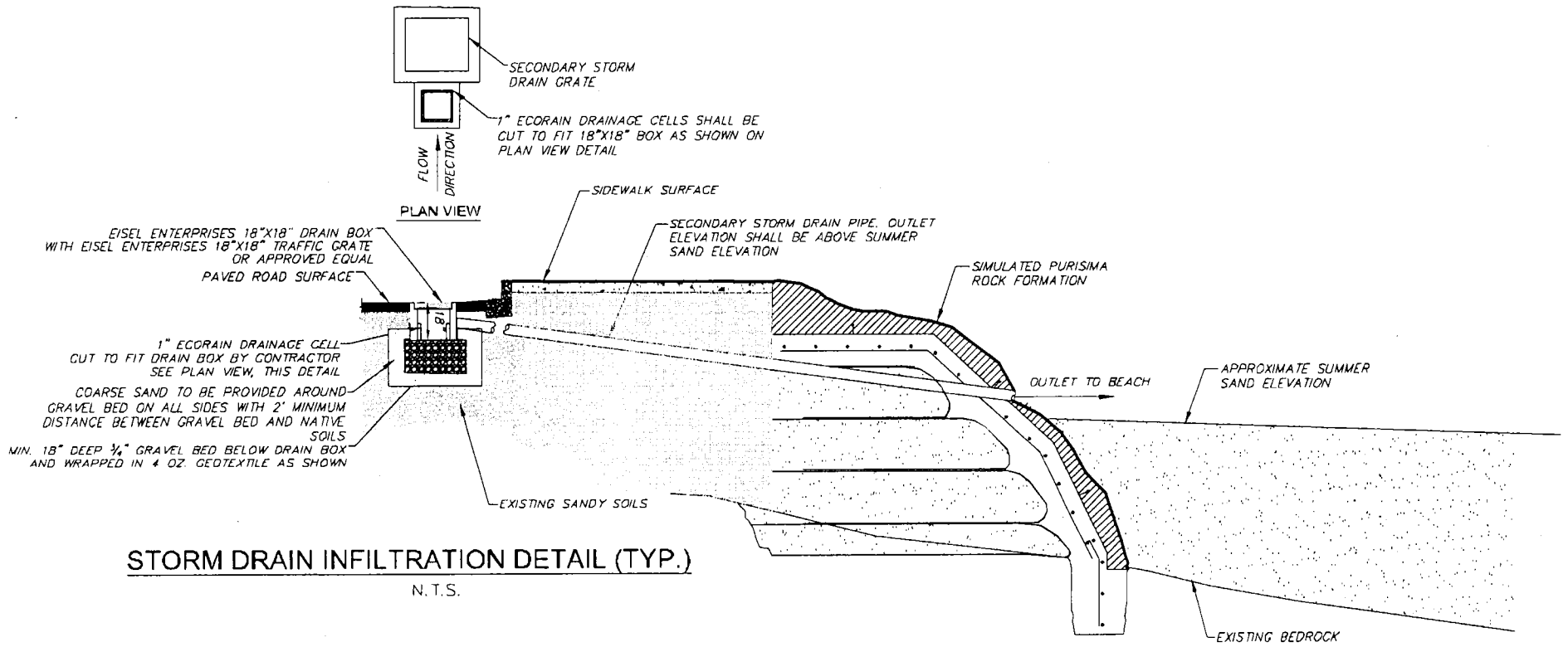
I=0.2 in/hr (Standard California Water Quality Treatment Intensity)

A=Tributary Drainage Area

RUNOFF FLOW CALCULATIONS					
Sub-Basin	Area (ac)	C	Tc (min)	I (in/hr)	Q_{WQ} (cfs)
A	2.90	0.8	10	0.20	0.51
B	4.75	0.8	10	0.20	0.84
B1	0.08	0.9	10	0.20	0.01
B2	0.09	0.9	10	0.20	0.02
B3	0.06	0.9	10	0.20	0.01
B4	4.48	0.8	10	0.20	0.72
B5	0.17	0.9	10	0.20	0.03
C	1.35	0.8	10	0.20	0.22
D	0.15	0.9	10	0.20	0.03

Notes: The calculations above assume that all water entering the project site will be treated.

ATTACHMENT 11



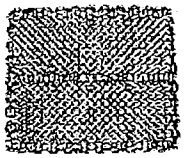
STORM DRAIN INFILTRATION DETAIL (TYP.)

N.T.S.

SIMPLE SOLUTIONS THAT REALLY WORK

City of Los Angeles Approved R & R number

EcoRain™
1"(25 mm)
DRAINAGE CELL



SPECIFICATION SHEET

EcoRain Systems
QUALITY STORMWATER SYSTEMS

- Home
- About Us
- Services
- EcoRain Tanks
- EcoRain Tank Specs
- EcoRain Tank Sizing
- EcoRain Tank Shed Tests
- EcoRain Drainage Cell
- EcoRain Drainage Cell Specs
- EcoRain Porous Pavers
- EcoRain Porous Pavers Specs
- Projects
- Contact Us

	Standard Used	Metric	Imperial
Width		500 mm	1,64'
Length		600 mm	1,97'
Height		25 mm	1.0'
Surface Area		50 to 70% void	
Material		100% recycled polypropylene	
Biological & Chemical Resistance		Unaffected by moulds and algae, soil-bourne chemicals, bacteria and bitumen	
Service Temperature		5 -30°C to 120°C	-22°F to 248°F
Compressive Strength/ Ultimate Load	ASTM D1621	±151.28 t/m2	±306.80 psi
Flow Rate per unit width	ASTM D4716		>27.73 gals/min

NOTE: All EcoRain Products and Systems are WORLD wide PATENT PENDING & DESIGN REGISTEREDS

Disclaimer: All information provided in this publication is correct to the best knowledge of the company and is given out in good faith. This information is intended only as a general guide, no responsibility can be accepted for any errors, omissions or incorrect assumption. As each project is unique, and as EcoRain Systems, Inc and its distributors and agents world wide have no direct control over the methods employed by the user in specifying, installing or supervising of its products hence no responsibility is accepted by EcoRain Systems, Inc and its distributors and agents world wide. Users should satisfy themselves as to the suitability of the product for their purpose.

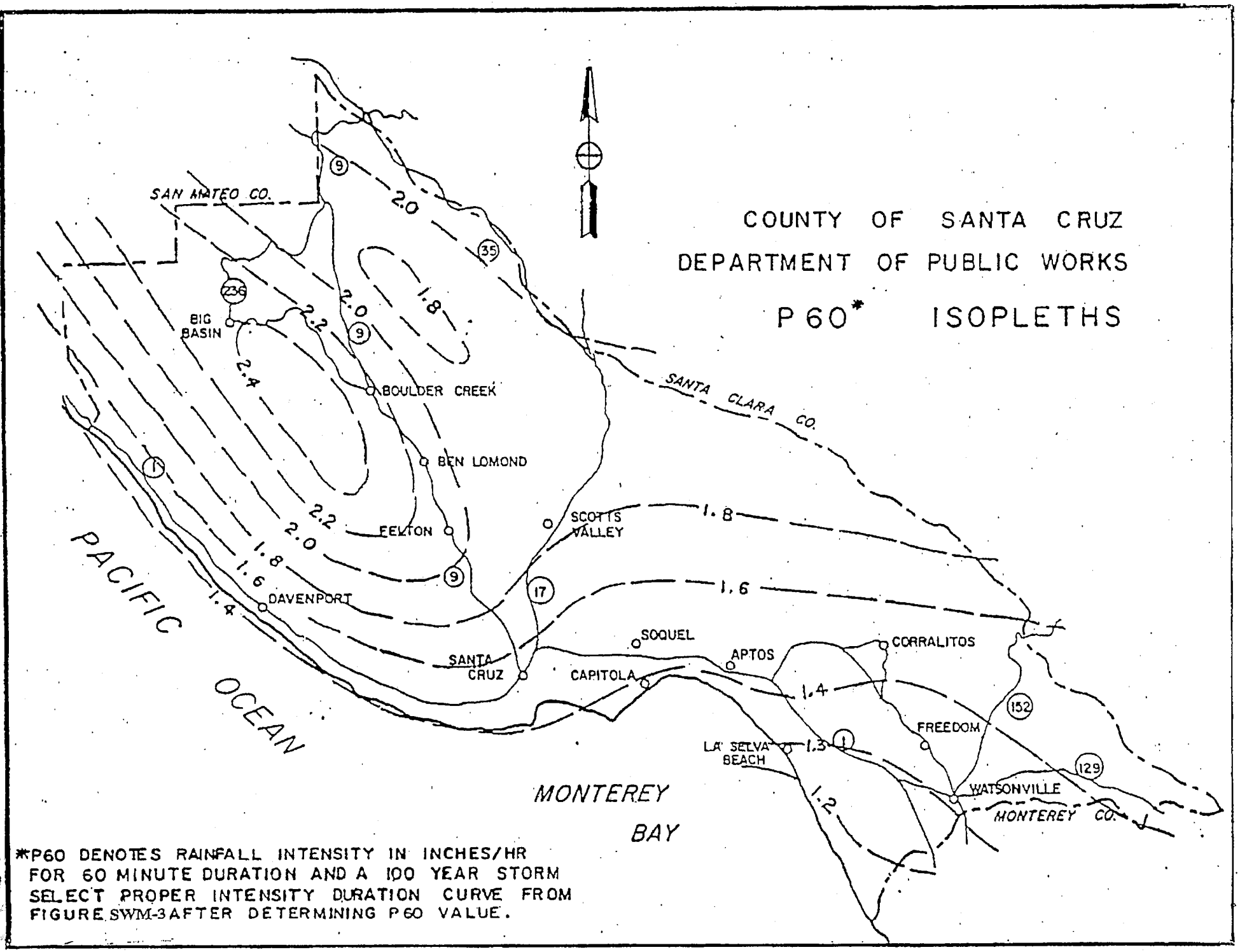
Spanish

For USA and Canada
sales@EcoRain.com Telephone: 318 905 7145 Toll Free: 1 866 991 RAIN (7246)
www.EcoRain.com EcoRain Systems Inc. 14320 Ventura Blvd #402 Sherman Oaks, CA 91423

Design: www.arangue.cl

Santa Cruz County Design Calculation Appendices

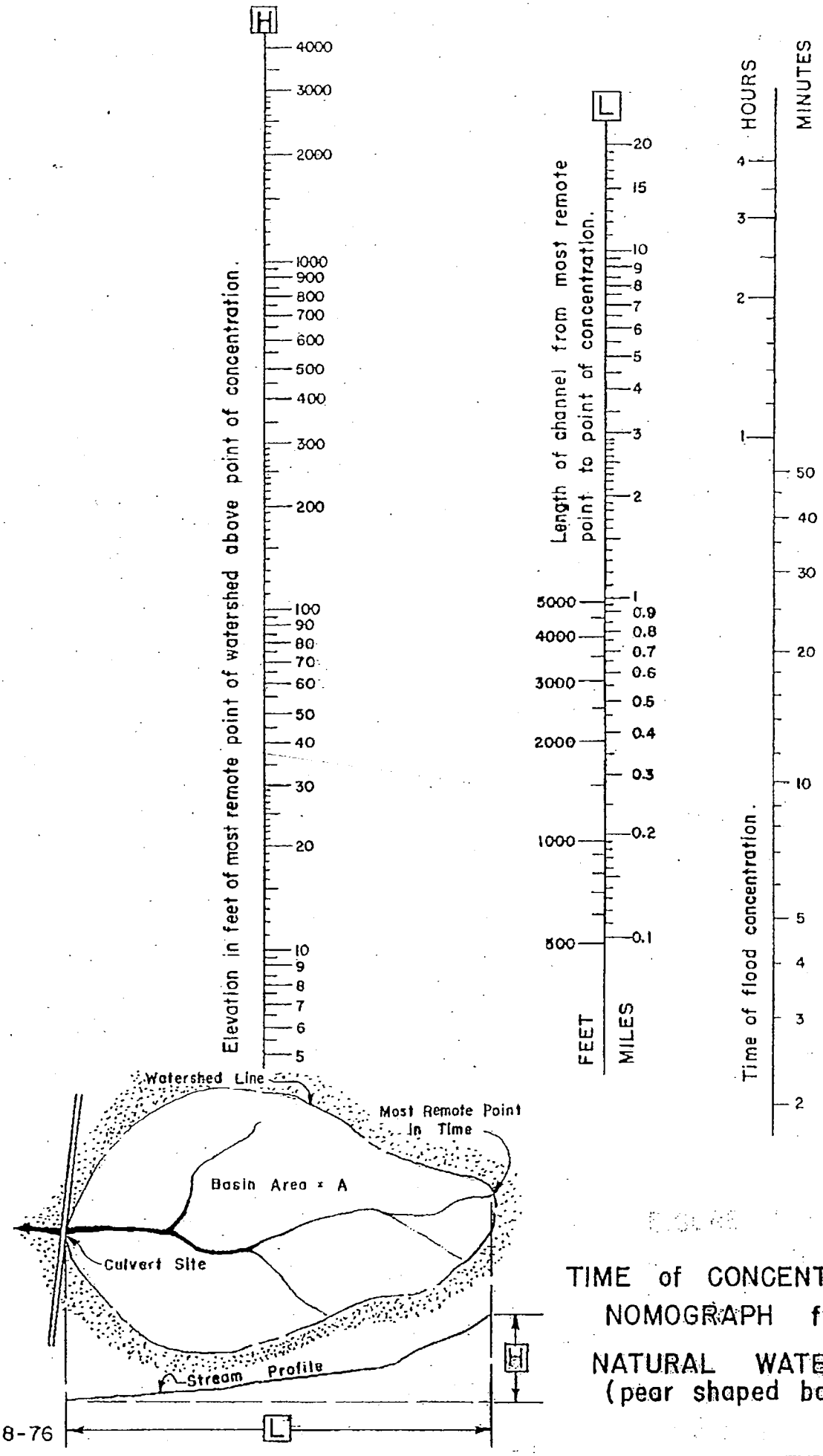
ATTACHMENT 11



*P60 DENOTES RAINFALL INTENSITY IN INCHES/HR FOR 60 MINUTE DURATION AND A 100 YEAR STORM SELECT PROPER INTENSITY DURATION CURVE FROM FIGURE SWM-3 AFTER DETERMINING P60 VALUE.

FIG. SWM-2

COUNTY OF SANTA CRUZ



TIME of CONCENTRATION
NOMOGRAPH for
NATURAL WATERSHEDS
(pear shaped basins)

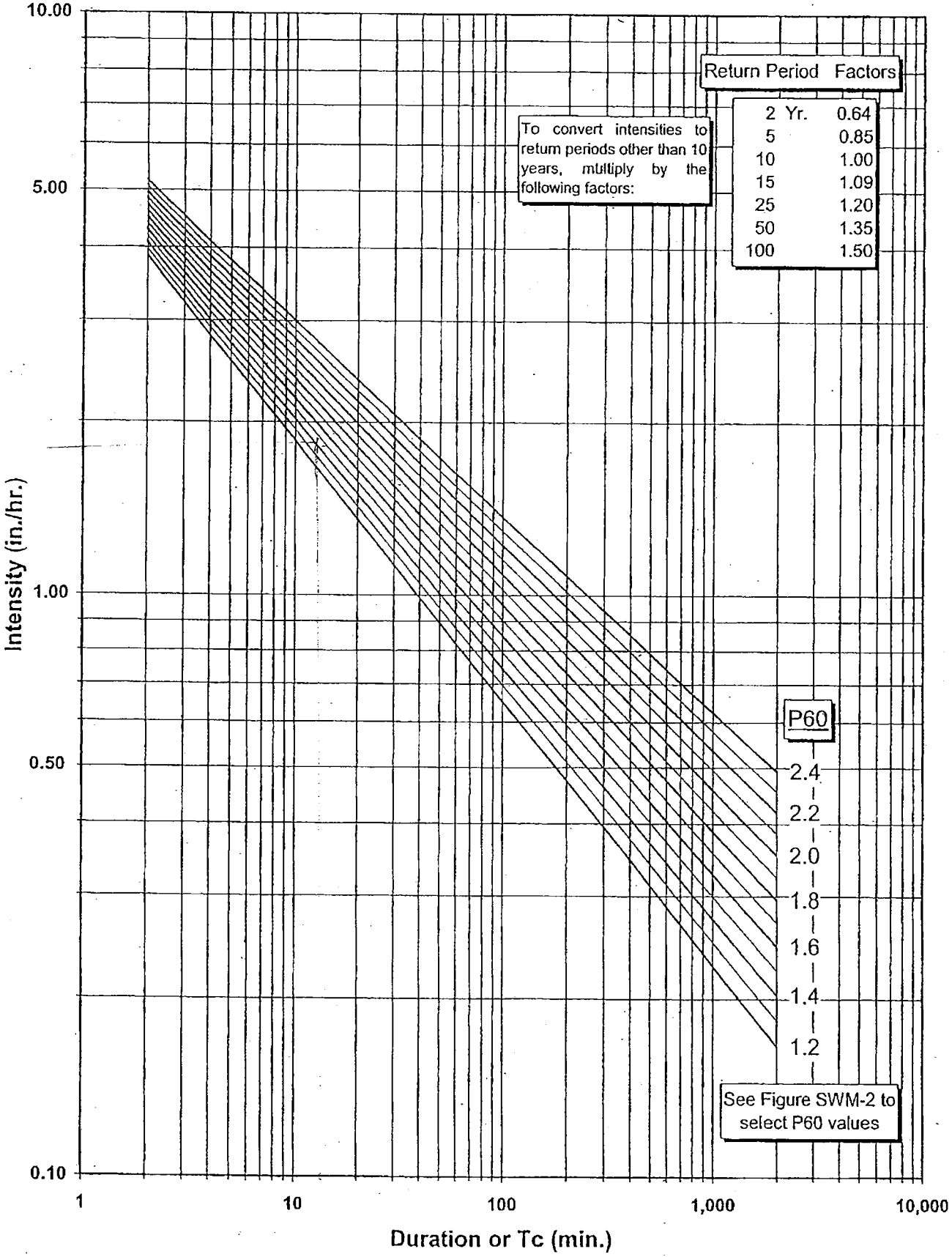
REV. 8-76

FIG. SWM-4

ATTACHMENT 11

Rainfall Intensity - Duration Curves
10 Yr. Return Period

((4.29112)*(1.1952)^P60_VALUE)/(DURATION^((0.60924)*(0.78522)^P60_VALUE))



Rev. 11-05

FIG. SWM-3

ATTACHMENT 1

DRAINAGE REPORT FOR

Public Right-of-Way and Road Improvements for East Cliff Drive at Twin Lakes Beachfront

Santa Cruz, California
County of Santa Cruz

Prepared for
County of Santa Cruz - Public Works

Prepared by

rrmdesigngroup

creating environments people enjoy®

July 19, 2011

ATTACHMENT 11

This report has been prepared under the direction of the Registered Engineer

July 19, 2011

Sean J. Brown Date
Registered Engineer

ENGINEER OF RECORD:

DATE:

ATTACHMENT 11

TABLE OF CONTENTS

INTRODUCTION 4

BASIS OF CALCULATIONS 4
DESCRIPTION OF SITE DRAINAGE PATTERNS 5

ANALYSIS & DISCUSSION 6

HYDROLOGY (OVERLAND FLOW) 6
GUTTER CAPACITY CHECK 6
HYDRAULIC CAPACITY CHECK 6
WATER QUALITY TREATMENT UNITS 6

SUMMARY OF RESULTS 7

CONCLUSIONS 7

CALCULATIONS AND PROJECT DATA

PROJECT DRAINAGE MAPS 8
RATIONAL METHOD CALCULATIONS – 10 YEAR STORM EVENT 9
RATIONAL METHOD CALCULATIONS – 25 YEAR STORM EVENT 10
WATER QUALITY TREATMENT CALCULATIONS AND DETAILS 11
SANTA CRUZ COUNTY DRAINAGE DESIGN APPENDICES 12

ATTACHMENT 11

1.0 INTRODUCTION

The proposed project is located on East Cliff Drive between the cross streets of 5th Avenue and 7th Avenue in the Leona Creek Drainage Basin of Flood Zone 5 in Santa Cruz County. Project improvements cover an area of approximately 1.71 acres. The project consists of bluff stabilization and coastal armoring along the Twin Lakes beach front, along with an all new parking configuration and multi-use path layout. The new parking configuration along the beach front will lend itself to a slightly revised road alignment and additional storm drainage facilities with an infiltration component to accommodate first flush storm runoff. Impacts to site drainage will be minimal due to project construction with only a minimal increase in impervious area and an overall upgrade and enhancement to the existing storm drainage system. This report covers the drainage system within the project site area as well as the upstream watershed between 5th Avenue and 7th Avenue. Refer to *the Stormwater Management Report for Schwan Lake Pedestrian Improvements – East Cliff Drive – 9th Ave to 12th Ave.* for analysis of watersheds between 7th Avenue and 12th Avenue.

2.0 BASIS OF CALCULATIONS

The **Rational Formula** is used to determine surface flow rates:

$Q=CiA$

Where:

Q= Estimated Peak Surface Runoff Coefficient (CFS)
Ca= Antecedent Moisture Facture (Unitless)
C= Runoff Coefficient (Unitless)
i_a= Rainfall Intensity Adjustment Factor (Unitless)
i= Rainfall Intensity (in/hr)
A= Area of Site (Acres)

ATTACHMENT 11

3.0 DESCRIPTION OF SITE DRAINAGE PATTERNS

Existing Conditions	
Basin	
A	Basin drains down 5th Ave. to E. Cliff Drive to surface flow west towards harbor. This basin drains offsite and will does not affect proposed improvements.
B	Basin drains primarily east to road side berm/channel where existing culvert structure passes drainage below existing park road and on to defined swale/creek.
C	Basin drains down 7th Ave. and east down E. Cliff Dr. to existing catch basin with 15" CMP outlet to beach.
D	Basin drains down 7th Avenue towards E. Cliff Dr. intersection and in to existing catch basin at return.

Proposed Conditions	
Basin	
B1	Area drains to parking bay with proposed infiltration and standard catch basin adjacent to roundabout and bluff improvements.
B2	Area drains to central proposed parking bay equipped with proposed infiltration and standard catch basins
B3	Area drains to parking bay with proposed infiltration catch basin and standard catch basin with outlet
B4	Area drains to proposed catch basin on north side of roundabout adjacent to parking bay
B5	Area drains to proposed catch basin at eastern corner of 6th Ave. and E. Cliff Dr. intersection
C	Area drains to existing catch basin with 15" CMP outlet to beach
D	Basin drains down 7th Avenue towards E. Cliff Dr. intersection and in to existing catch basin at return.

Refer to "Project Drainage Basin" Maps for delineated areas

ATTACHMENT 11

4.0 ANALYSIS & DISCUSSION

HYDROLOGY (OVERLAND FLOW):

Calculations for project post-development overland flows are shown in the "Hydrology Calculations" section of the report. Overland flows were calculated for all sub-basins individually for the 10 and 25 year storm events. These values are used for further analysis in subsequent of the report. A table summarizing these calculations is shown in Section 5.0

GUTTER CAPACITY CHECK

Calculations for gutter capacity check are located within the Hydraflow Storm Sewers analysis "Inlet Report" spreadsheet under the spread heading. Sub-basin B4 calculations show a large gutter spread width due to inadequate storm drain infrastructure upstream of the project area. The installation of additional inlets is recommended in the upper portions of Basin B to reduce drainage impacts and gutter spread within the proposed project area.

HYDRAULIC CAPACITY CHECK

Calculations for project post-development hydraulic capacity for existing and proposed storm drain infrastructure within the project area are shown on the Hydraflow Storm Sewers analysis spreadsheets. Hydraulic capacity was checked for 10 and 25-year storm events and proposed systems have been designed to adequately handle a 25-year storm event. Calculations show that all inlets and pipes will handle a 25-year storm event with additional freeboard in the system. It should be noted that existing storm drain pipes within the project boundary show evidence of reduced effectiveness due to lack of maintenance and clogging. All existing pipes should be maintained or replaced during project construction.

WATER QUALITY TREATMENT UNITS

A secondary storm drain system designed to capture first flush flows will be utilized alongside the standard storm drain system. The secondary system will capture the more heavily polluted dry weather and initial storm event runoff and route them to an infiltration system that will filter and cleanse the water. This system will utilize the sand and gravel within the structural caissons used for coastal armoring as the media for cleansing the water before it reaches the beach, and ultimately the coastal waters. An appropriate sand and gravel mixture will need to be determined that will be able to filter and cleanse the water at a rate able to handle the Standard California Water Quality

Treatment Intensity of 0.2 inches per hour. Storm water will simply back up out of the secondary catch basin and into the adjacent primary storm drain system once capacity of the secondary system occurs. Please refer to the details and product cut-sheets within this report for more information.

5.0 SUMMARY OF RESULTS

The table below summarizes all storm runoff data and water quality treatment flows.

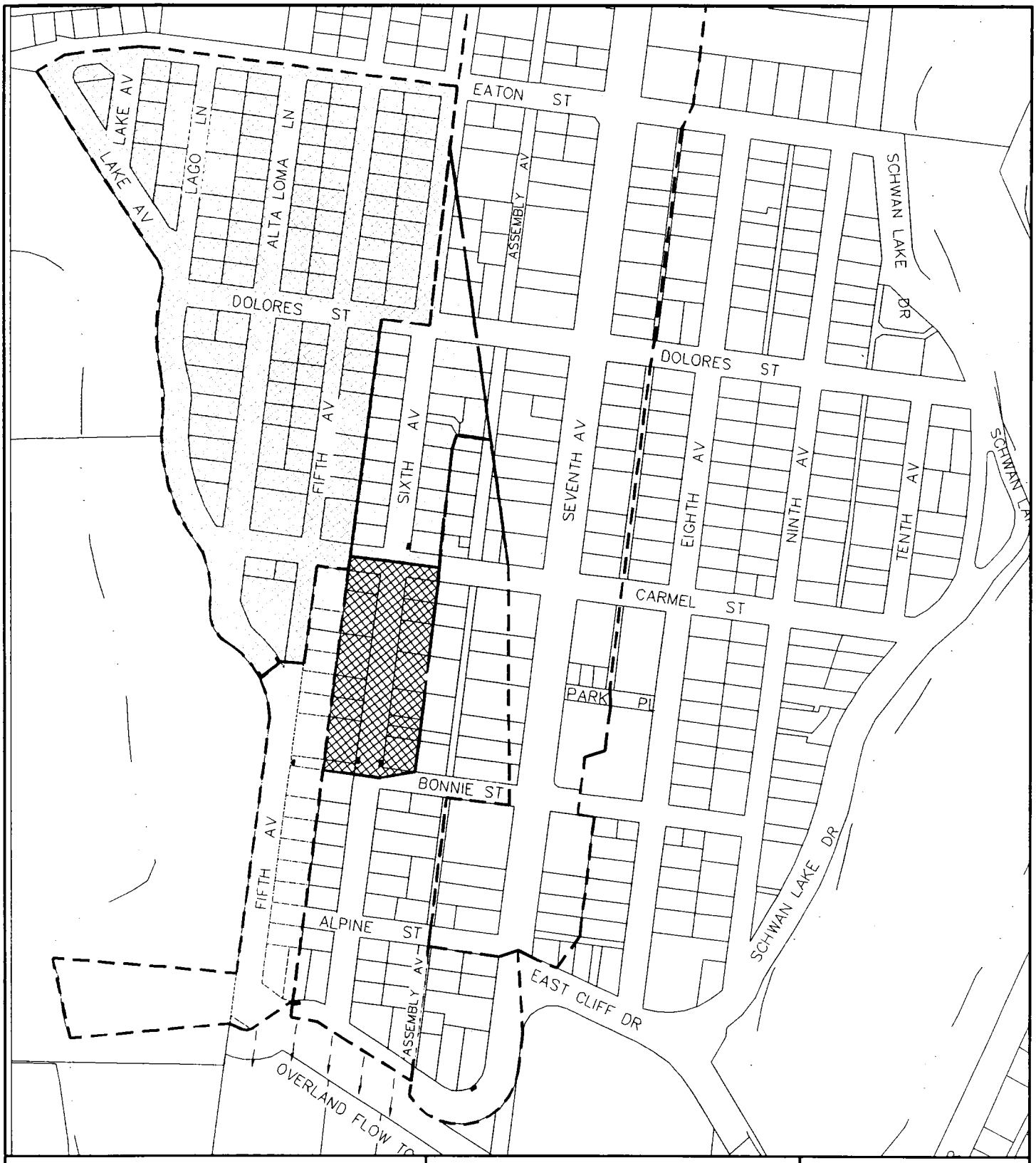
STORMWATER FLOW SUMMARY				
Sub-Basin	Area (ac)	Q10 (CFS)	Q25 (CFS)	Q_{WQ} (CFS)
A	2.90	4.72	6.23	0.51
B	4.75	7.71	10.18	0.84
B1	0.08	0.15	0.19	0.01
B2	0.09	0.16	0.22	0.02
B3	0.06	0.11	0.14	0.01
B4	4.48	8.18	9.6	0.72
B5	0.17	0.31	0.41	0.03
C	1.35	2.19	2.89	0.22
D	0.15	0.27	0.36	0.03

Q10 = Post Development flow for a 10-Year Storm Event
Q25= Post Development flow for a 25-Year Storm Event
Qwq = Required treatment flow based on California Water Quality Standards

6.0 CONCLUSIONS

Based on analysis shown in this report, all storm drain components have been checked to adequately handle a 25 year design storm event. In addition, the proposed storm drain infiltration system will effectively re-route and improve the water quality of a portion of these flows before they reach Twin Lakes Beach and adjacent coast waters.

Project Drainage Maps



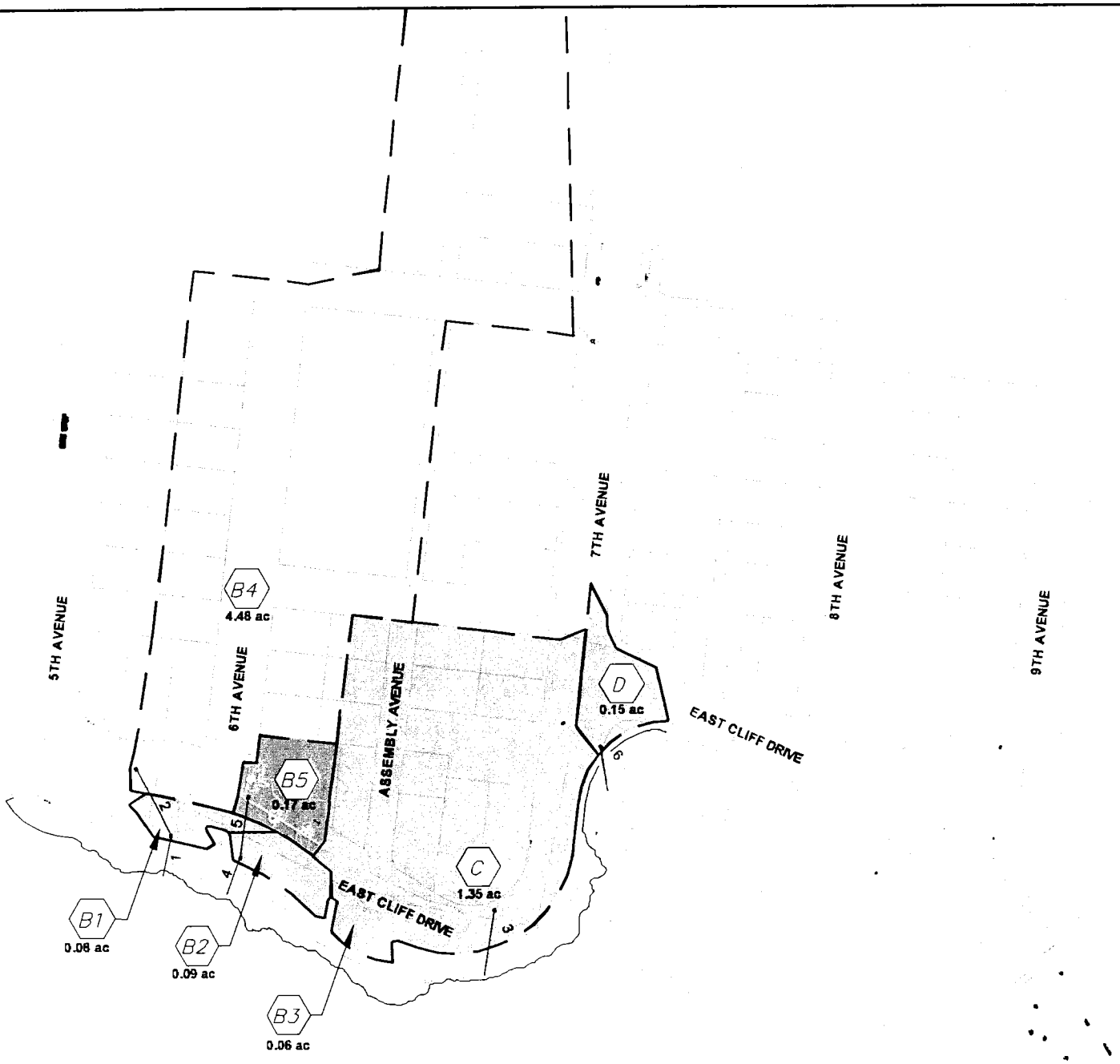
PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS
FOR EAST CLIFF DRIVE AT TWIN LAKES
BEACHFRONT

PRE-DEVELOPMENT DRAINAGE MAP

rrmdesigngroup
creating environments people enjoy®
3765 South Higuera St., Ste. 102, San Luis Obispo, CA 93401
P: (805) 543-1794 | F: (805) 543-4609 | www.rrmcesign.com

DRAWN BY:	SJB
CHECKED BY:	SJB
DATE:	7-19-11
JOB NO.:	1309513
SCALE:	N.T.S.
SHEET NO.:	--

ATTACHMENT 11



PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS
FOR EAST CLIFF DRIVE AT TWIN LAKES
BEACHFRONT

POST-DEVELOPMENT DRAINAGE MAP

rrmdesigngroup
creating environments people enjoy®
3765 South Higuera St., Ste. 102, San Luis Obispo, CA 93401
P: (805) 543-1794 | F: (805) 543-4609 | www.rrmcsign.com

DRAWN BY:	SJB
CHECKED BY:	SJB
DATE:	7-19-11
JOB NO.:	1309513
SCALE:	N.T.S.
SHEET NO.:	--

ATTACHMENT 1

Rational Method Calculations
10-Year Storm Event

DRAINAGE CALCULATIONS FOR:
PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS:
EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT - 5th Ave -7th Ave
July 19, 2011

Project Drainage Basins - Flow Rate Calculations for 10 Year Event

DRAINAGE AREAS AND RATIONAL COEFFICIENTS					
Sub-Basin	Total Area (SF)	Existing C	Added Impervious (SF)	Area (AC)	Avg C
A	126500	0.8	0	2.90	0.8
B	206850	0.8	0	4.75	0.8
C	58780	0.8	0	1.35	0.8
D	6642	0.9	0	0.15	0.9

Ia and Ca Modifcation Factors		
Return Period	I_a	C_a
2	0.64	1.00
5	0.85	1.00
10	1.00	1.00
15	1.09	1.00
25	1.20	1.10
50	1.35	1.20
100	1.50	1.25

Basis of Calculation

I = ((4.29112)*(1.1952P60)/tc^((0.60924)*(0.78522P60)) * Ia

Q=C*Ca*I*A

Intensity for Storm

Return Period=	10	Years
P60 Isopleth=	1.4	(Based on Location - See County P60 Isopleths Map)
Ia=	1	(Based on Return Period - See Above)
Ca=	1	(Based on Return Period - See Above)

RUNOFF FLOW CALCULATIONS					
Sub-Basin	Area (ac)	C	Tc (min)	I (in/hr)	Q (cfs)
A	2.90	0.8	10	2.03	4.72
B	4.75	0.8	10	2.03	7.71
B1	0.08	0.9	10	2.03	0.15
B2	0.09	0.9	10	2.03	0.16
B3	0.06	0.9	10	2.03	0.11
B4	4.48	0.9	10	2.03	8.18
B5	0.17	0.9	10	2.03	0.31
C	1.35	0.8	10	2.03	2.19
D	0.15	0.9	10	2.03	0.27

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.	Junction Type
1		7.42	24	Cir	38.836	11.70	12.50	2.060	12.76	13.46	n/a	13.46 j	End	Grate
2		7.28	24	Cir	69.704	12.60	14.00	2.008	13.46	14.96	0.38	14.96	1	Combination
3		2.35	15	Cir	63.117	14.50	17.00	3.961	15.17	17.61	n/a	17.61	End	Combination
4		0.44	15	Cir	36.774	15.00	15.77	2.094	15.29	16.04	n/a	16.04	End	Grate
5		0.27	15	Cir	56.638	15.87	17.00	1.995	16.04	17.21	n/a	17.21	4	Combination
6		0.28	15	Cir	21.090	15.00	20.00	23.708	16.12	20.21	n/a	20.21	End	Combination

Project File: 10 Year-7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

NOTES: Known Qs only ; j - Line contains hyd. jump.

ATTACHMENT 11

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	B1	0.14*	0.00	0.14	0.00	Grate	0.0	0.00	6.00	3.00	2.00	Sag	2.00	0.050	0.020	0.013	-0.07	-1.43	0.04	0.34	2.0	Off
2	B	7.28*	0.00	4.17	3.11	Comb	6.0	3.00	0.00	3.00	2.00	0.025	2.00	0.083	0.020	0.013	0.34	10.90	0.38	10.52	2.0	Off
3	C	2.35*	0.00	2.35	0.00	Comb	6.0	3.00	6.00	3.00	2.00	Sag	2.00	0.083	0.040	0.013	0.16	1.92	0.24	1.95	2.0	Off
4	B2	0.17*	0.00	0.17	0.00	Grate	0.0	0.00	6.00	3.00	2.00	Sag	2.00	0.050	0.020	0.013	0.02	0.34	0.04	0.65	1.0	Off
5	B5	0.27*	0.00	0.27	0.00	Comb	6.0	3.00	0.00	3.00	2.00	0.050	2.00	0.083	0.020	0.013	0.10	1.25	0.11	1.09	2.0	4
6	D	0.28*	0.00	0.28	0.00	Comb	8.0	3.00	6.00	3.00	2.00	Sag	2.00	0.083	0.050	0.013	-0.04	-0.49	0.06	0.45	2.0	Off

Project File: 10 Year-7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

NOTES: Inlet N-Values = 0.016 ; Known Qs only; * Indicates Known Q added. All curb inlets are Horiz throat.

ATTACHMENT 4

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
	(in)	(cfs)									(ft)											(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	7.42	11.70	12.76	1.06	1.69	4.39	0.30	13.06	0.354	38.836	12.50	13.46 j	0.96**	1.50	4.95	0.38	13.85	0.487	0.420	n/a	0.99	n/a
2	24	7.28	12.60	13.46	0.86	1.30	5.59	0.49	13.95	0.688	69.704	14.00	14.96	0.96**	1.48	4.91	0.38	15.33	0.484	0.586	n/a	1.00	0.38
3	15	2.35	14.50	15.17	0.00	0.00	0.00	0.00	15.17	0.000	63.117	17.00	17.61	0.00**	0.00	0.00	0.00	17.61	0.000	0.000	0.000	1.00	n/a
4	15	0.44	15.00	15.29	0.00	0.00	0.00	0.00	15.29	0.000	36.774	15.77	16.04	0.00**	0.00	0.00	0.00	16.04	0.000	0.000	0.000	0.50	n/a
5	15	0.27	15.87	16.04	0.00	0.00	0.00	0.00	16.04	0.000	56.638	17.00	17.21	0.00**	0.00	0.00	0.00	17.21	0.000	0.000	0.000	1.00	n/a
6	15	0.28	15.00	16.12	0.00	0.00	0.00	0.00	16.12	0.000	21.090	20.00	20.21	0.00**	0.00	0.00	0.00	20.21	0.000	0.000	0.000	1.00	n/a

Project File: 10 Year-7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

Notes: ; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

Hydraflow HGL Computation Procedure

General Procedure: Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

Rational Method Calculations
25-Year Storm Event

ATTACHMENT 1 1

DRAINAGE CALCULATIONS FOR:
PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS:
EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT - 5th Ave -7th Ave
July 19, 2011

Project Drainage Basins - Flow Rate Calculations for 25 Year Event

DRAINAGE AREAS AND RATIONAL COEFFICIENTS					
Sub-Basin	Total Area (SF)	Existing C	Added Impervious (SF)	Area (AC)	Avg C
A	126500	0.8	0	2.90	0.8
B	206850	0.8	0	4.75	0.8
C	58780	0.8	0	1.35	0.8
D	6642	0.9	0	0.15	1.8

Ia and Ca Modifcation Factors		
Return Period	Ia	Ca
2	0.64	1.00
5	0.85	1.00
10	1.00	1.00
15	1.09	1.00
25	1.20	1.10
50	1.35	1.20
100	1.50	1.25

Basis of Calculation

I = ((4.29112)*(1.1952P60)/tc^((0.60924)*(0.78522P60)) * Ia

Q=C*Ca*I*A

Intensity for Storm

Return Period=	25	Years
P60 Isopleth=	1.4	(Based on Location - See County P60 Isopleths Map)
Ia=	1.2	(Based on Return Period - See Above)
Ca=	1.1	(Based on Return Period - See Above)

RUNOFF FLOW CALCULATIONS						
Sub-Basin	Area (ac)	C	Tc (min)	I (in/hr)	Q (cfs)	
A	2.90	0.8	10	2.44	6.23	(Offsite)
B	4.75	0.8	10	2.44	10.18	
B1	0.08	0.9	10	2.44	0.19	
B2	0.09	0.9	10	2.44	0.22	
B3	0.06	0.9	10	2.44	0.14	
B4	4.48	0.8	10	2.44	9.60	
B5	0.17	0.9	10	2.44	0.41	
C	1.35	0.8	10	2.44	2.89	
D	0.15	0.9	10	2.44	0.36	

Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line slope (%)	HGL down (ft)	HGL up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns line No.	Junction Type
1		9.79	24	Cir	38.836	11.70	12.50	2.060	12.81	13.61	n/a	13.61 j	End	Grate
2		9.60	24	Cir	69.704	12.60	14.00	2.008	13.61	15.10	0.46	15.10	1	Combination
3		2.89	15	Cir	63.117	14.50	17.00	3.961	15.18	17.68	n/a	17.68	End	Combination
4		0.63	15	Cir	36.774	15.00	15.77	2.094	15.32	16.09	n/a	16.09	End	Grate
5		0.41	15	Cir	56.638	15.87	17.00	1.995	16.09	17.26	n/a	17.26	4	Combination
6		0.36	15	Cir	21.090	15.00	20.00	23.708	16.19	20.24	n/a	20.24	End	Combination

Project File: 25 Year 7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

NOTES: Known Qs only ; j - Line contains hyd. jump.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	B1	0.19*	0.00	0.19	0.00	Grate	0.0	0.00	6.00	3.00	2.00	Sag	2.00	0.050	0.020	0.013	-0.06	-1.27	0.04	0.42	2.0	Off
2	B	9.60*	0.00	4.97	4.63	Comb	6.0	3.00	0.00	3.00	2.00	0.025	2.00	0.083	0.020	0.013	0.37	12.30	0.41	11.97	2.0	Off
3	C	2.89*	0.00	2.89	0.00	Comb	6.0	3.00	6.00	3.00	2.00	Sag	2.00	0.083	0.040	0.013	0.19	2.58	0.27	2.58	2.0	Off
4	B2	0.22*	0.00	0.22	0.00	Grate	0.0	0.00	6.00	3.00	2.00	Sag	2.00	0.050	0.020	0.013	0.02	0.49	0.05	0.78	1.0	Off
5	B5	0.41*	0.00	0.41	0.00	Comb	6.0	3.00	0.00	3.00	2.00	0.050	2.00	0.083	0.020	0.013	0.12	1.46	0.13	1.28	2.0	4
6	D	0.36*	0.00	0.36	0.00	Comb	8.0	3.00	6.00	3.00	2.00	Sag	2.00	0.083	0.050	0.013	-0.03	-0.37	0.07	0.52	2.0	Off

Project File: 25 Year 7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

NOTES: Inlet N-Values = 0.016 ; Known Qs only; * Indicates Known Q added. All curb inlets are Horiz throat.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len	Upstream								Check		JL coeff	Minor loss
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
	(in)	(cfs)									(ft)											(K)	(ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	24	9.79	11.70	12.81	1.11	1.79	5.47	0.46	13.27	0.530	38.836	12.50	13.61 j	1.11**	1.79	5.48	0.47	14.07	0.533	0.532	n/a	0.99	n/a
2	24	9.60	12.60	13.61	1.01	1.59	6.05	0.57	14.18	0.701	69.704	14.00	15.10	1.10**	1.77	5.44	0.46	15.56	0.529	0.615	n/a	1.00	0.46
3	15	2.89	14.50	15.18	0.00	0.00	0.00	0.00	15.18	0.000	63.117	17.00	17.68	0.00**	0.00	0.00	0.00	17.68	0.000	0.000	0.000	1.00	n/a
4	15	0.63	15.00	15.32	0.00	0.00	0.00	0.00	15.32	0.000	36.774	15.77	16.09	0.00**	0.00	0.00	0.00	16.09	0.000	0.000	0.000	0.50	n/a
5	15	0.41	15.87	16.09	0.00	0.00	0.00	0.00	16.09	0.000	56.638	17.00	17.26	0.00**	0.00	0.00	0.00	17.26	0.000	0.000	0.000	1.00	n/a
6	15	0.36	15.00	16.19	0.00	0.00	0.00	0.00	16.19	0.000	21.090	20.00	20.24	0.00**	0.00	0.00	0.00	20.24	0.000	0.000	0.000	1.00	n/a

Project File: 25 Year 7-19-11.stm | Number of lines: 6 | Run Date: 08-01-2011

Notes: ; ** Critical depth.; j-Line contains hyd. jump. ; c = cir e = ellip b = box

ATTACHMENT 11

Hydraflow HGL Computation Procedure

General Procedure: Hydraflow computes the HGL using the Bernoulli energy equation. Manning's equation is used to determine energy losses due to pipe friction. In a standard step, iterative procedure, Hydraflow assumes upstream HGLs until the energy equation balances. If the energy equation cannot balance, supercritical flow exists and critical depth is temporarily assumed at the upstream end. A supercritical flow Profile is then computed using the same procedure in a downstream direction using momentum principles.

Col. 1 The line number being computed. Calculations begin at Line 1 and proceed upstream.

Col. 2 The line size. In the case of non-circular pipes, the line rise is printed above the span.

Col. 3 Total flow rate in the line.

Col. 4 The elevation of the downstream invert.

Col. 5 Elevation of the hydraulic grade line at the downstream end. This is computed as the upstream HGL + Minor loss of this line's downstream line.

Col. 6 The downstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 7 Cross-sectional area of the flow at the downstream end.

Col. 8 The velocity of the flow at the downstream end, (Col. 3 / Col. 7).

Col. 9 Velocity head (Velocity squared / 2g).

Col. 10 The elevation of the energy grade line at the downstream end, HGL + Velocity head, (Col. 5 + Col. 9).

Col. 11 The friction slope at the downstream end (the S or Slope term in Manning's equation).

Col. 12 The line length.

Col. 13 The elevation of the upstream invert.

Col. 14 Elevation of the hydraulic grade line at the upstream end.

Col. 15 The upstream depth of flow inside the pipe (HGL - Invert elevation) but not greater than the line size.

Col. 16 Cross-sectional area of the flow at the upstream end.

Col. 17 The velocity of the flow at the upstream end, (Col. 3 / Col. 16).

Col. 18 Velocity head (Velocity squared / 2g).

Col. 19 The elevation of the energy grade line at the upstream end, HGL + Velocity head, (Col. 14 + Col. 18) .

Col. 20 The friction slope at the upstream end (the S or Slope term in Manning's equation).

Col. 21 The average of the downstream and upstream friction slopes.

Col. 22 Energy loss. Average Sf/100 x Line Length (Col. 21/100 x Col. 12). Equals (EGL upstream - EGL downstream) +/- tolerance.

Col. 23 The junction loss coefficient (K).

Col. 24 Minor loss. (Col. 23 x Col. 18). Is added to upstream HGL and used as the starting HGL for the next upstream line(s).

ATTACHMENT 1

Water Quality Treatment Calculations and Details

DRAINAGE CALCULATIONS FOR:
PUBLIC RIGHT-OF-WAY/ROAD IMPROVEMENTS:
EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT - 5TH Ave -7TH Ave

Stormwater Infiltration/Treatment Calculations

DRAINAGE AREAS AND RATIONAL COEFFICIENTS					
Sub-Basin	Total Area (SF)	Existing C	Added Impervious (SF)	Area (AC)	Avg C
A	126500	0.8	0	2.90	0.8
B	206850	0.8	0	4.75	0.8
C	58780	0.8	0	1.35	0.8
D	6642	0.9	0	0.15	0.9

Basis of Calculation

$Q_{WQ}=C*I*A$

Q_{WQ}=Water Quality Treatment Flow Rate

C=Runoff Coefficient

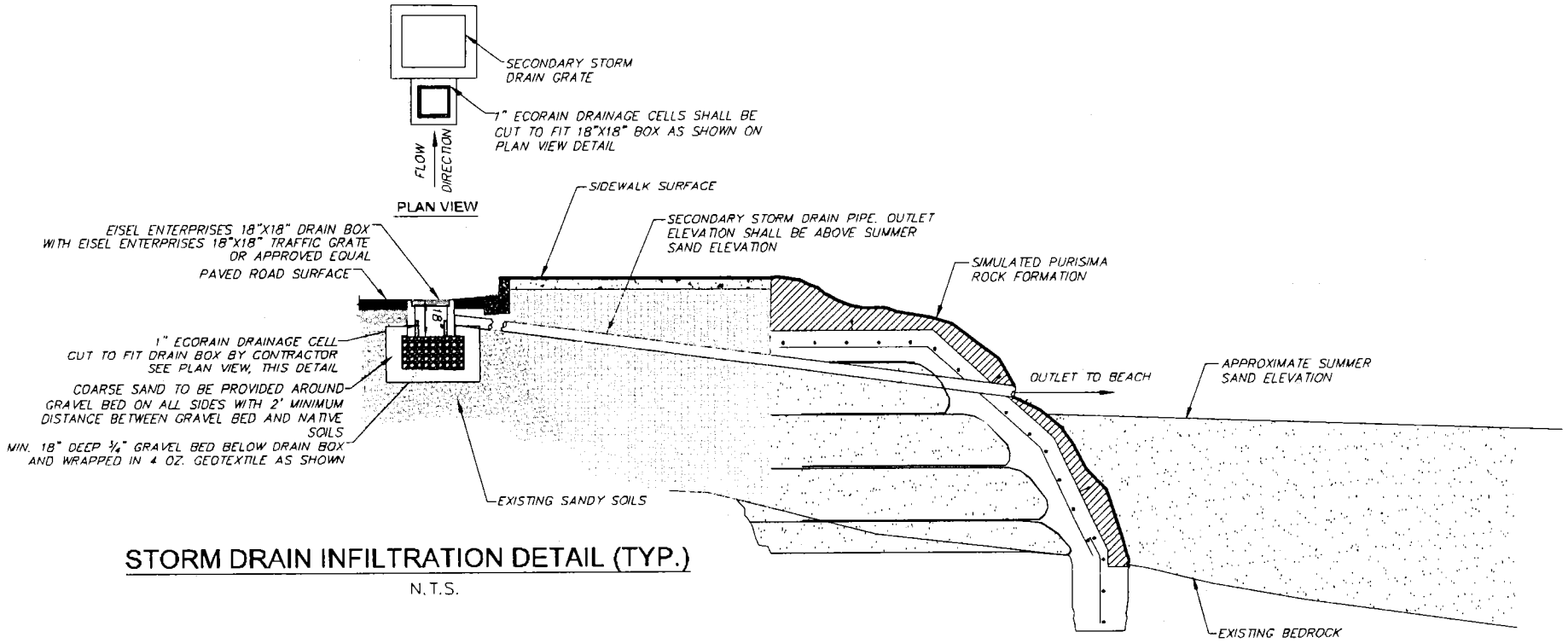
I=0.2 in/hr (Standard California Water Quality Treatment Intensity)

A=Tributary Drainage Area

RUNOFF FLOW CALCULATIONS					
Sub-Basin	Area (ac)	C	Tc (min)	I (in/hr)	Q_{WQ} (cfs)
A	2.90	0.8	10	0.20	0.51
B	4.75	0.8	10	0.20	0.84
B1	0.08	0.9	10	0.20	0.01
B2	0.09	0.9	10	0.20	0.02
B3	0.06	0.9	10	0.20	0.01
B4	4.48	0.8	10	0.20	0.72
B5	0.17	0.9	10	0.20	0.03
C	1.35	0.8	10	0.20	0.22
D	0.15	0.9	10	0.20	0.03

Notes: The calculations above assume that all water entering the project site will be treated.

ATTACHMENT 11



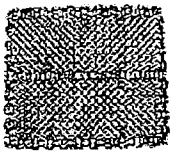
STORM DRAIN INFILTRATION DETAIL (TYP.)

N.T.S.

SIMPLE SOLUTIONS THAT REALLY WORK

City of Los Angeles Approved R & R number

EcoRain™
1"(25 mm)
DRAINAGE CELL



EcoRain Systems
QUALITY STORMWATER SYSTEMS

SPECIFICATION SHEET

Home
About
Articles
Frequently Asked Questions
Contact us
EcoRain Tank
EcoRain Tank Specs
EcoRain Drainage Cell
EcoRain Drainage Cell Specs
EcoRain Porous Pavers
EcoRain Porous Pavers Specs
Projects
Testimonials

	Standard Used	Metric	Imperial
Width		500 mm	1,64'
Length		600 mm	1,97'
Height		25 mm	1.0'
Surface Area		50 to 70% void	
Material		100% recycled polypropylene	
Biological & Chemical Resistance		Unaffected by moulds and algae, soil-bourne chemicals, bacteria and bitumen	
Service Temperature		5 -30°C to 120°C	-22°F to 248°F
Compressive Strength/ Ultimate Load	ASTM D1621	±151.28 t/m2	±306.80 psi
Flow Rate per unit width	ASTM D4716		>27.73 gals/min

NOTE: All EcoRain Products and Systems are WORLD wide PATENT PENDING & DESIGN REGISTEREDS
Disclaimer: All information provided in this publication is correct to the best knowledge of the company and is given out in good faith. This information is intended only as a general guide, no responsibility can be accepted for any errors, omissions or incorrect assumption. As each project is unique, and as EcoRain Systems, Inc and its distributors and agents world wide have no direct control over the methods employed by the user in specifying, installing or supervising of its products hence no responsibility is accepted by EcoRain Systems, Inc and its distributors and agents world wide. Users should satisfy themselves as to the suitability of the product for their purpose.

Spanish

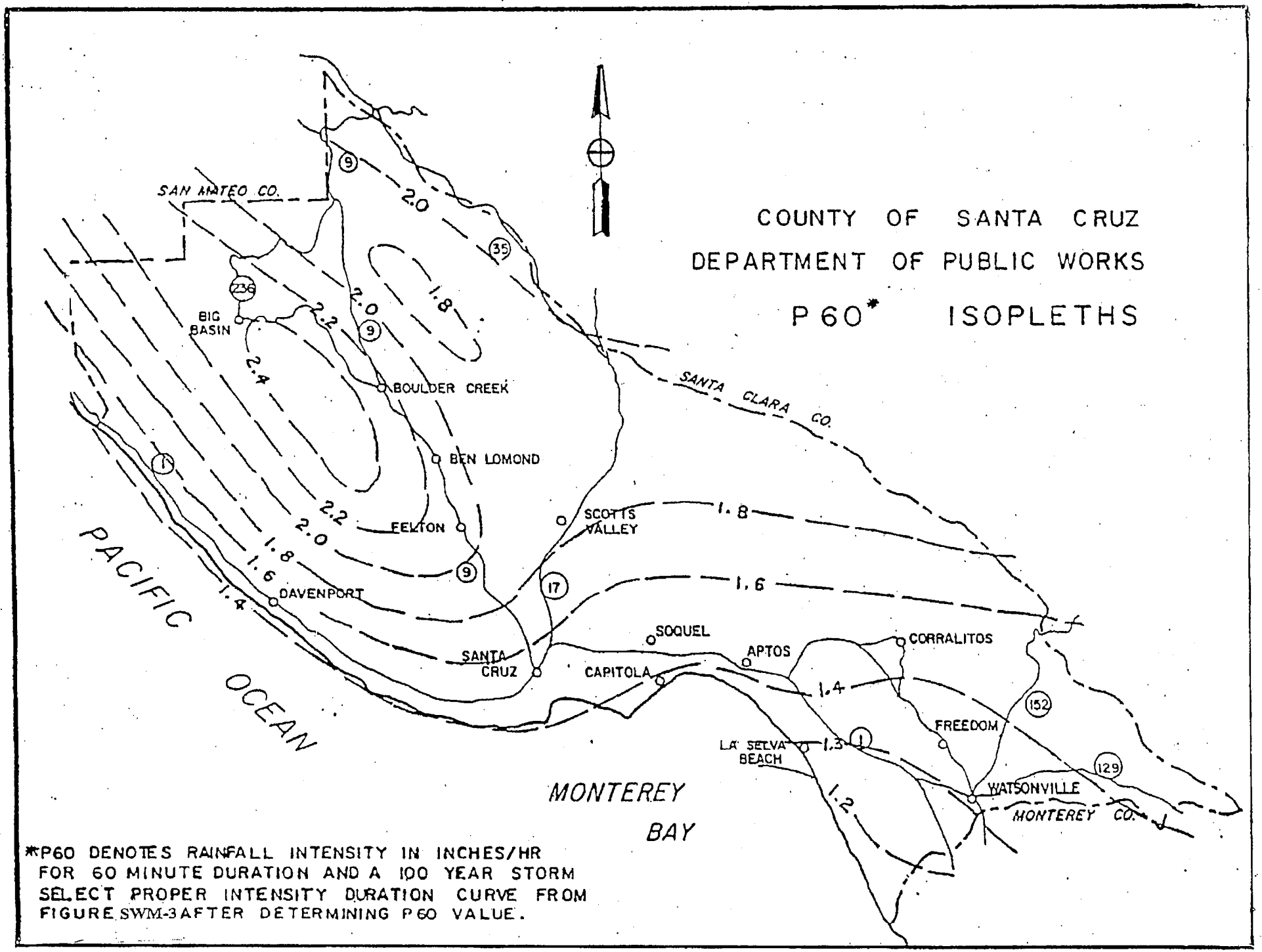
For USA and Canada
sales@EcoRain.com Telephone: 818 905 7145 Toll Free: 1 866 991 RAIN (7246)
www.EcoRain.com EcoRain Systems Inc. 14320 Ventura Blvd #402 Sherman Oaks, CA 91423

Design now arranged

ATTACHMENT 11

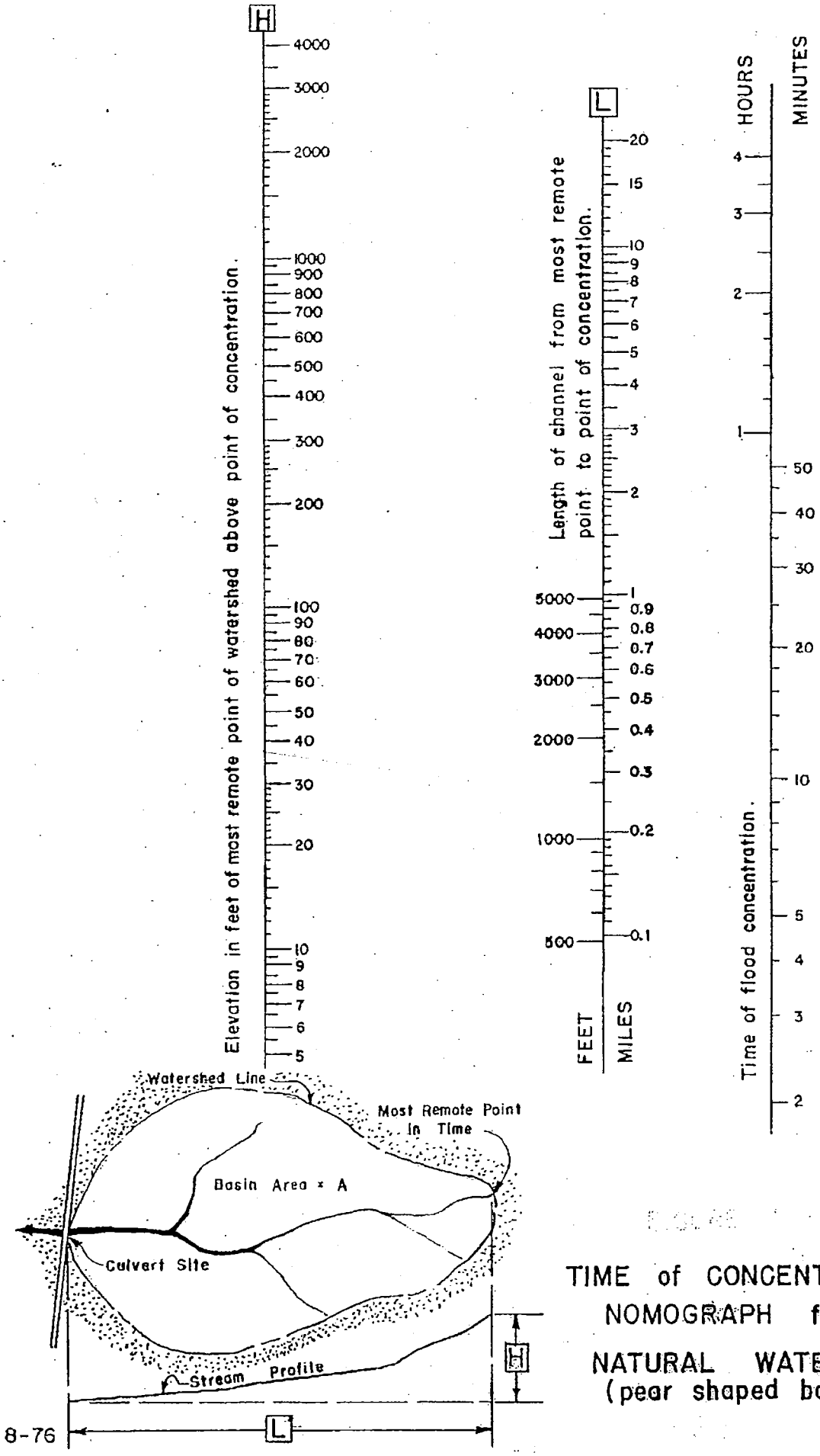
Santa Cruz County Design Calculation Appendices

ATTACHMENT 3



*P60 DENOTES RAINFALL INTENSITY IN INCHES/HR FOR 60 MINUTE DURATION AND A 100 YEAR STORM SELECT PROPER INTENSITY DURATION CURVE FROM FIGURE SWM-3 AFTER DETERMINING P60 VALUE.

FIG. SWM-2



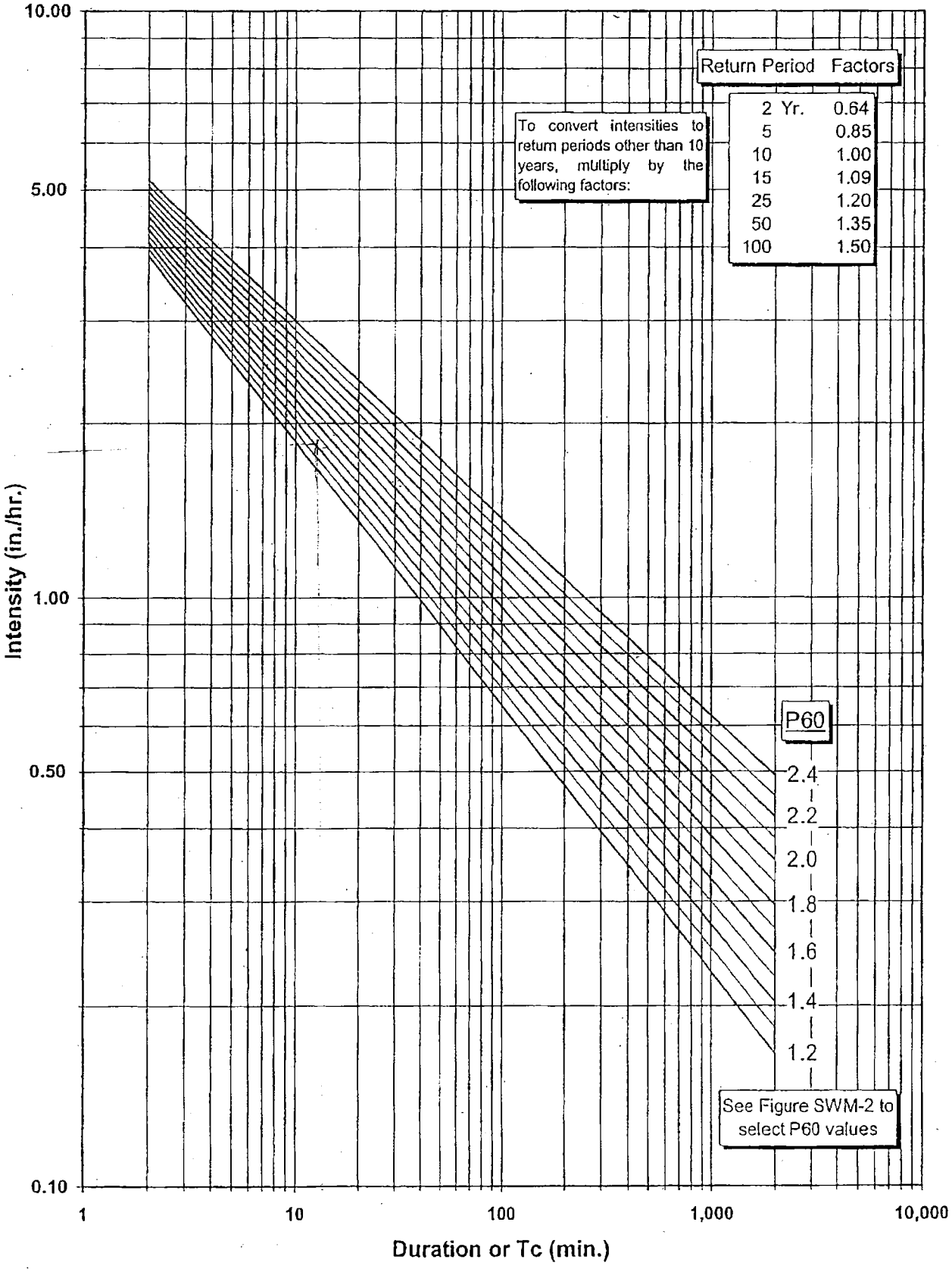
TIME of CONCENTRATION
NOMOGRAPH for
NATURAL WATERSHEDS
(pear shaped basins)

REV. 8-76

FIG. SWM-4

Rainfall Intensity - Duration Curves
10 Yr. Return Period

((4.29112)*(1.1952)^P60_VALUE)/(DURATION^((0.60924)*(0.78522)^P60_VALUE))



Rev. 11-05

FIG. SWM-3

ATTACHMENT 1 1

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW ~~OF PROPOSED PUBLIC IMPROVEMENTS~~ PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

REQUESTED BY:
SHERYL BAILEY
PROJECT MANAGER
THE COUNTY OF SANTA CRUZ
PARKS DIVISION OF THE DEPARTMENT OF PUBLIC WORKS
SIMPKINS SWIM CENTER
979 AVENUE
SANTA CRUZ, CA 95062

SITE INSPECTION ON JULY 30, 2012
BY NIGEL BELTON
ISA CERTIFIED ARBORIST WE410A

JOB: – TWIN LAKES BEACHFRONT PROJECT - 2012

ATTACHMENT 12

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 1.

Background and Assignment:

This report addendum has been provided at the request of Sheryl Bailey, Project Manager for the County of Santa Cruz Parks Division of the Department of Public Works. The addendum supersedes and supplements the original report prepared for Jim Davies, former Project Manager for the County of Santa Cruz Redevelopment Agency, dated March 24, 2011. The scope of the current project has been reduced in size and no longer includes the section of East Cliff Drive located between and Avenues. The current improvement area extends along the section of East Cliff Drive that is located between the intersections of Avenue and (Lake) Avenue. Note that this addendum deletes trees numbers 1. - 3. identified in the previous report and adds additional trees and shrubs as well. Subsequently, the tree and shrub numbers in this addendum do not relate to those numbers utilized in the previous report.

The previous report included a review of all the trees that were equal to or larger than 20 inches in diameter at 54 inches above grade (DBH) only. The County Planning Department has recently requested that this addendum include trees and other vegetation (including shrubs) greater than six inches DBH consistent with County Section – 13.20.130. This report also includes vegetation (trees and shrubs) smaller than six inches DBH. Note that two forms of measurement criteria have been utilized contingent on whether an accurate measurement of the tree diameter at 54 inches above grade can be made. Where trees or shrubs cannot be measured at 54 inches above grade due to their growth pattern (i.e. - multi stems or fronds emanating below that height) the alternative measurement criteria entails stem or trunk diameter(s) measured at six inches above grade.

Additionally, note that the Planning Department has provided the project design team the following criteria pertaining to the development of the tree replacement and /or relocation plan.
(1) – Relocate trees that are greater than six inches DBH but less than 21 inches DBH if the plans call for removal and the arborist determines the trees are suitable for relocation.
(2) – Replace those trees greater than 20 inch DBH if the plans call for removal and the arborist determines the trees are suitable for preservation.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 2.

Background and Assignment – Continued:

This report is intended to provide the necessary background information for the design team to prepare the replacement and relocation plans and to also inform the reader regarding other pertinent facts including the following details.
- Identification of tree or shrub species (including notes on whether native or non native species).
- The DBH or an alternative measurement regarding tree/shrubs size where a DBH measurement is not possible.
- The overall health, structure and appearance of individual trees/shrubs
- Suitability for retention, removal or relocation (note that in the case of the Banana trees, their suitability for preservation has been determined by the influence of the local climate on their potential to grow to maturity and whether the improvement plans call for their removal).

The initial site inspection pertaining to the most current design of this project was conducted with Sheryl Bailey. This inspection identified trees and shrubs that will be impacted by proposed improvements, including a number of trees that can be conserved and others that may have to be transplanted or removed to provide room for public improvements. The great majority of the trees and/or vegetation that will be potentially impacted by the proposed improvements are located within the County's public right of way.

Ms. Bailey provided me contemporary plans for the proposed improvements to use as a source of reference (Revised plan dated 8/23/12). Note that these plans are schematic. The final plans will need to be reviewed by an arborist to make any required recommendations pertaining to specific construction methodologies that may need to be utilized in order minimize impacts on desirable trees during and beyond the construction period.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 3.

Background and Assignment – Continued:

Note that there is a tree location map prepared by rrmdesigngroup and a tree matrix chart included to accompany this report.

Tree Survey – Observations and Recommendations:

1. Tasmanian Blue gum Eucalyptus (Eucalyptus globulus) – Non native species

Location: – State Park Property at the corner of Avenue.

Size: – 42 inch DBH – Approximately 55 feet tall

Condition and description: – Mature tree - Fair health and fair structure.

Suitability for preservation: – High due to size and condition - Plans call for retention

2. Tasmanian Blue Gum Eucalyptus – Non native species

Location: – State Park Property - East of East Cliff Drive.

Size: – 50 inch DBH – Approximately 55 feet tall.

Condition and description: – Mature Tree - Good health and structure.

Suitability for preservation: – High due to size and condition - Plans call for retention.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 4.

3. Tasmanian Blue Gum Eucalyptus – Non native species

Location: – State Park Property – East of East Cliff Drive near the public toilets.

Size: – 48 inch DBH – Approximately 55 feet tall.

Condition and description: – Mature Tree - Good health and a fair structure.

Suitability for preservation: – High due to size and condition - Plans call for retention.

4. Monterey Cypress (Cupressus macrocarpa) – California native

Location: – On the boundary of the County Right of Way and the Carroll property at 2691 East Cliff Drive (APN: 27-182-03).

Size: – 84 inch estimated DBH – Approximately 60 feet tall.

Condition and description: – Mature tree – Good health and a fair structure

Suitability for preservation: – High, due to size, condition and appearance. An attractive California native tree - Plans call for retention.

Additional notes: - Note the proximity of the existing retaining wall which is adjacent to the curb. Care will have to be taken to minimize root loss and damage in the design and construction phases of this project pertaining to any improvement work adjacent to this tree.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 5.

5. Myoporum Tree – Myoporum laetum – Non native species

Location: – On the Wrenn property at 2655 East Cliff Drive (APN: 27 -182-04).

Size: – Two trunks measured at 3.5 inches DBH respectively – Approximately 10 feet tall.

Condition: – Mature Tree - Poor health due to an insect infestation (Myoporum Thrip – Klambothrips myopori).

Suitability for preservation: – Low (unless treated with an appropriate insecticide to control the insect pest) - Note that the plan calls for retention as it is not in the way of the improvement work.

6. Banana (Musa sp.) – Non native species

Location – County Right of Way in front of the Murphy property at 2621 East Cliff Drive (APN; 027 – 181-04).

Size: – Four inch diameter at six inches above grade – Approximately six feet tall – Note that this tree branches into multiple fronds below 54 inches above grade.

Condition and description: – Young tree – Poor health.

Suitability for preservation or relocation: - Low, due to poor site suitability, condition and appearance – Note that the plan calls for retention because it is not in the way of the improvement work.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 6.

7. Yucca (Yucca sp.) – Non native species

Location: – County Right of Way in front of the boundary separating the Murphy and the Rivoir Properties at 2615 East Cliff Drive (APN:'s 027 – 181-04 and – 10 respectively).

Size: – 11 stems that emanate from a common trunk – Average stem diameter of 2.5 inches DBH – Approximately six feet tall.

Condition and description: – Young tree – Good health.

Suitability for preservation or re-location: - Low due to its appearance - Note the plan calls for removal because it is in the way of improvement work.

8. Through 10. - Three Windmill Palms (Trachycarpus fortunei) – Non native species

Location: – County Right of Way in front of the boundary separating the Murphy property and the Rivoir Property (2621 and 2615 East Cliff Drive, respectively).

Size: – Eight inch diameters measured at six inches above grade – Four feet tall.

Condition and description: – Young trees – Good health.

Suitability for preservation and relocation; – High suitability for preservation due to their good condition and appearance - Note that the plans call for removal because they are in the way of improvement work.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 7.

11. Hollywood Juniper (Juniperus chinensis Torulosa) – Non native species

Location – County Right of Way in front of the boundary separating the Murphy and Rivoir properties (2621 and 2615 respectively)

Size: – 14 inch diameter at six inches above grade – Approximately 12 feet tall. Note that this tree branches out into multiple limbs at below 54 inches above grade.

Condition and description: – Medium aged tree – Good health and a fair structure.

Suitability for preservation and relocation: – Low because of appearance and structure - Note that the plan calls for removal

12. Banana – Non native species

Location: - County Right of Way in front of the Rivoir property located at 2615 East Cliff Drive (APN; 027-181-10).

Size: – Four inch diameter at six inches above grade – 2.5 feet tall.

Condition and description: – Young tree – Fair health and structure.

Suitability for preservation and relocation: – Low because of its condition and poor suitability to the local climate range. – Note that the plan calls for removal.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 8.

13. Yucca – Non native species

Location: - County Right of Way in front of the Rivoir property located at 2615 East Cliff Drive (APN; 027-181-10).

Size: – Eight stems – 2.5 inch average DBH – Seven feet tall.

Condition and description: – Young tree – Good health and fair structure.

Suitability for preservation and relocation: – Fair suitability for preservation due to appearance. It could be relocated. Note that the plan calls for removal.

14. Mexican Fan Palm (Washingtonia robusta) – Non native species

Location: – County Right of Way in front of the Rivoir property.

Size: – 26 inch DBH – Approximately 40 feet tall.

Condition and description: – Mature tree – Good health and structure.

Suitability for preservation and relocation: – High suitability for preservation due to its condition, size and appearance - Note that the plan calls for removal and replacement.

15. Monterey Cypress - California native tree

Location: – County Right of Way in front of the Wessbecher property at 2601 East Cliff Drive (APN; 027-181-09).

Size: – 24 inch DBH – 45 feet tall.

Condition and description: – Mature tree – Good health and structure.

Suitability for preservation and relocation: – High suitability for preservation due to its condition, appearance and size - Note that the plan calls for removal and replacement.

16. Mexican Fan Palm - Non native species

Location: – County Right of Way in front of the Wessbecher property.

Size: – Two Stems being 16 inches and 17 inches DBH each – 12 feet tall.

Condition and description: – Young to Medium aged tree(s) (note that it is most likely that the two co-joined stems are actually two individual palms planted together) – Good health and structure.

Suitability for preservation and relocation: – High suitability for preservation due to condition and appearance – Note that the plan calls for removal and relocation within the County ROW or other suitable location.

17. Cordyline (Cordyline australis) – Non native species

Location: – County Right of Way in front of the Wessbecher property.

Size: – Six stems that average nine inches DBH – Seven feet tall – Note – Multiple tops at various heights preclude measurements at 54 inches above grade.

Condition and description: – Mature shrub– Good health and fair/poor structure.

Suitability for preservation and relocation: – Low suitability due to condition and appearance – Note that the plan calls for removal.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 10.

18. Windmill Palm – Non native species

Location: – County Right of Way in front of the Wessbecher property.

Size: – Nine inch DBH – 10 feet tall.

Condition and description: – Young tree – Poor health and good structure.

Suitability for preservation and relocation: – Low suitability due to poor health – Note that the plan calls for removal.

19. Mexican Fan Palm – Non native species

Location: – South west of the Wessbecher property in the County Right of Way.

Size: – 24 inch DBH – 12 feet tall.

Condition and description: – Medium aged tree - Good health and structure.

Suitability for preservation and relocation: – High suitability due to condition and appearance - Note that the plan calls for removal and replacement.

20. Mexican Fan Palm – Non native species

Location: – West of the Wessbecher property in the County Right of Way.

Size: – 20 inch DBH – 11 feet tall.

Condition and description: – Medium aged tree – Good health and structure.

Suitability for preservation and relocation: – High suitability for preservation due condition and appearance - Note that plans call for retention and protection in place.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 11.

21. Monterey Cypress – California native tree

Location: – West of the Wessbecher property in the County Right of Way.

Size – 48 inch DBH: – Approximately 48 feet tall.

Condition and description: – Mature tree - Poor health and structure.

Suitability for preservation: – Low suitability for preservation due to poor condition and structure – Note that the plans call for retention and protection in place.

Additional notes: - This tree is in very poor and declining health due as evidenced by significant die back and a high dead wood ratio in the canopy. The improvement work in close proximity to the tree will entail significant root loss which will likely exacerbate the further decline of this tree. Roots over two inches in diameter that encroach into the proposed improvement area will have to be cut cleanly by hand to avoid tearing damage.

22. Banana – Non native species

Location: - County Right of Way in front of the Wessbecher property.

Size: – Five inches at six inches above grade – Seven feet tall – Note that this tree has multiple fronds that emanate below 54 inches above grade.

Condition and description: – Young tree - Good health and structure.

Suitability for preservation and relocation: – Medium suitability for preservation – Note that the plan calls for removal because it is in the way of improvement work.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 12.

23. Yucca – Non native species

Location: – South west of the Wessbecher property in the County Right of Way.

Size: – Three inch DBH – Four feet tall.

Condition and description: – Young tree – Good health and structure.

Suitability for preservation or relocation: – Low suitability due to its size and appearance – Note that the plan calls for retention and preservation in place.

24. Windmill Palm – Non native species

Location: – County Right of Way in front of the Flamen property at 2521 East Cliff Drive (APN; 027-162-09).

Size: – 13.5 inch DBH – Nine feet tall.

Condition and description: – Medium aged tree – Good health and structure.

Suitability for preservation and relocation: – High suitability due to condition and appearance - Note that the plan calls for relocation to within the County ROW or another suitable location.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 13.

25. Queen Palm (Arecastrum romanzoffianum) – Non native species

Location: – Located on the Flamen property about two feet from the County Right of Way.

Size: – 13 inch DBH – 15 feet tall.

Condition and description: – Mature tree – Good health and structure.

Suitability for preservation: – High due to condition and appearance. Note that Palm trees are generally very tolerant of root cutting in close proximity to the trunk – Note that plans call for the retention and protection of this tree on site.

26. Three California Lilac (Ceonothus sp.) – California native species

Location: – County Right of Way in front of the Reath property at 2511 East Cliff Drive (APN; 027-162-10).

Size: – Averaging about four inches diameter at six inches above grade – Four feet tall.

Condition and description: – Mature shrubs – Variable conditions ranging from poor to good health.

Suitability for preservation and relocation: – Low suitability for preservation due to conditions and appearance – Note that the plan calls for removal.

Sincerely yours

Nigel Belton
- Attachments: - 1. Tree location map
  - 2. Tree matrix chart
  - 3. Eight photographs of the subject trees and shrubs

ATTACHMENT 12

PUBLIC RIGHT-OF-WAY AND ROAD IMPROVEMENTS FOR EAST CLIFF DRIVE AT TWIN LAKES BEACHFRONT

EXISTING CONDITIONS

rrmdesigngroup

creating environments people enjoy

Santa Cruz County
Department of Public Works
701 Ocean St., Room 410,
Santa Cruz, CA 95060

1309513

2.1

EXISTING CONDITIONS

TWIN LAKES STATE BEACH

SURVEY PROVIDED BY SANTA CRUZ COUNTY

DESIGN DEVELOPMENT DRAWINGS - NOT FOR CONSTRUCTION

ATTACHMENT 12

Twin Lakes Beachfront
Improvement Project
Tree or Shrub Arborist Report Matrix
8/23/12

#	Species	Property Address Adjacent to ROW	Tree	Shrub	DBH	Other Diam.	Ht.	Project Removes	Arborist Recommends Removal
1	Euc	State Park Property	Y	N	42	N/A	55'	N	N
2	Euc	State Park Property	Y	N	50	N/A	55'	N	N
3	Euc	State Park Property	Y	N	48	N/A	55'	N	N
4	Monterey Cypress	2691 East Cliff Drive	Y	N	84	N/A	60'	N	N
5	Myoporum Tree	2655 East Cliff Drive	Y	N	3.5 & 3.5	N/A	10'	N	N
6	Banana	2621 East Cliff Drive	Y	N	N/A at 54" in height -tree is multi-frond	4" @ 6 " above grade	6'	N	Y
7	Yucca	2621 and 2615 East Cliff Drive	Y	N	2.5	N/A	6'	Y	Y
8	Windmill Palm	2621 and 2615 East Cliff Drive	Y	N	N/A	8" @ 6" above grade	4'	Y	N
9	Windmill Palm	2621 and 2615 East Cliff Drive	Y	N	N/A	8"@ 6" above grade	4'	Y	N
10	Windmill Palm	2621 and 2615 East Cliff Drive	Y	N	N/A	8"@ 6" above grade	4'	Y	N
11	Hollywood Juniper	2621 and 2615 East Cliff Drive	Y	N	N/A @ 54" height tree is multi-limbed	14" @6" above grade	12'	Y	Y

#	Species	Property Address Adjacent to ROW	Tree	Shrub	DBH	Other Diam.	Ht.	Project Removes	Arborist Recommends Removal
12	Banana	2615 East Cliff Drive	Y	N	N/A at 54" in height tree is multi-frond	5"@ 6" above grade	2.5'	Y	Y
13	Yucca	2615 East Cliff Drive	Y	N	2.5"	N/A	7'	Y	N
14	Mexican Fan Palm	2615 East Cliff Drive	Y	N	26"	N/A	40'	Y *	N
15	Monterey Cypress	2601 East Cliff Drive	Y	N	24"	N/A	45'	Y *	N
16	Mexican Fan Palm	2601 East Cliff Drive	Y	N	16" & 17"	N/A	12'	Y **	N
17	Cordyline	2601 East Cliff Drive	N	Y	N/A	6 trunks @9" @ 6" above grade	7'	Y	Y
18	Windmill Palm	2601 East Cliff Drive	Y	N	9"	N/A	10'	Y	Y
19	Mexican Fan Palm	2601 East Cliff Drive	Y	N	24"	N/A	12'	Y *	N
20	Mexican Fan Palm	2601 East Cliff Drive	Y	N	20"	N/A	11'	N	N
21	Monterey Cypress	2601 East Cliff Drive	Y	N	48"	N/A	48'	N	Y
22	Banana	2601 East Cliff Drive	Y	N	N/A at 54" in height tree is multi-frond	5"@ 6" above grade	7'	Y	N
23	Yucca	2601 East Cliff Drive	Y	N	N/A	3" at 6" above grade	4"	N	Y
24	Windmill Palm	2521 East Cliff Drive	Y	N	13.5"	N/A	9'	Y **	N
25	Queen Palm	2521 East Cliff Drive	Y	N	13"	N/A	15'	N	N

#	Species	Property Address Adjacent to ROW	Tree	Shrub	DBH	Other Diam.	Ht.	Project Removes	Arborist Recommends Removal
26	CA Lilac (3)	2511 East Cliff Drive	N	Y	N/A	4" @ 6"	4'	Y	Y

* - Note- That the applicants plans propose to remove/Replace Tree #'s 14, 15, & 19 utilizing a 3:1 replacement ratio

** - Note that the applicants propose to relocate Trees #'s 16 & 24

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

The view of trees and shrubs in the County Right of Way in front of the Murphy and Rivoir properties:

Note – Trees and shrubs - number's 7 through number 11.

ATTACHMENT 12

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

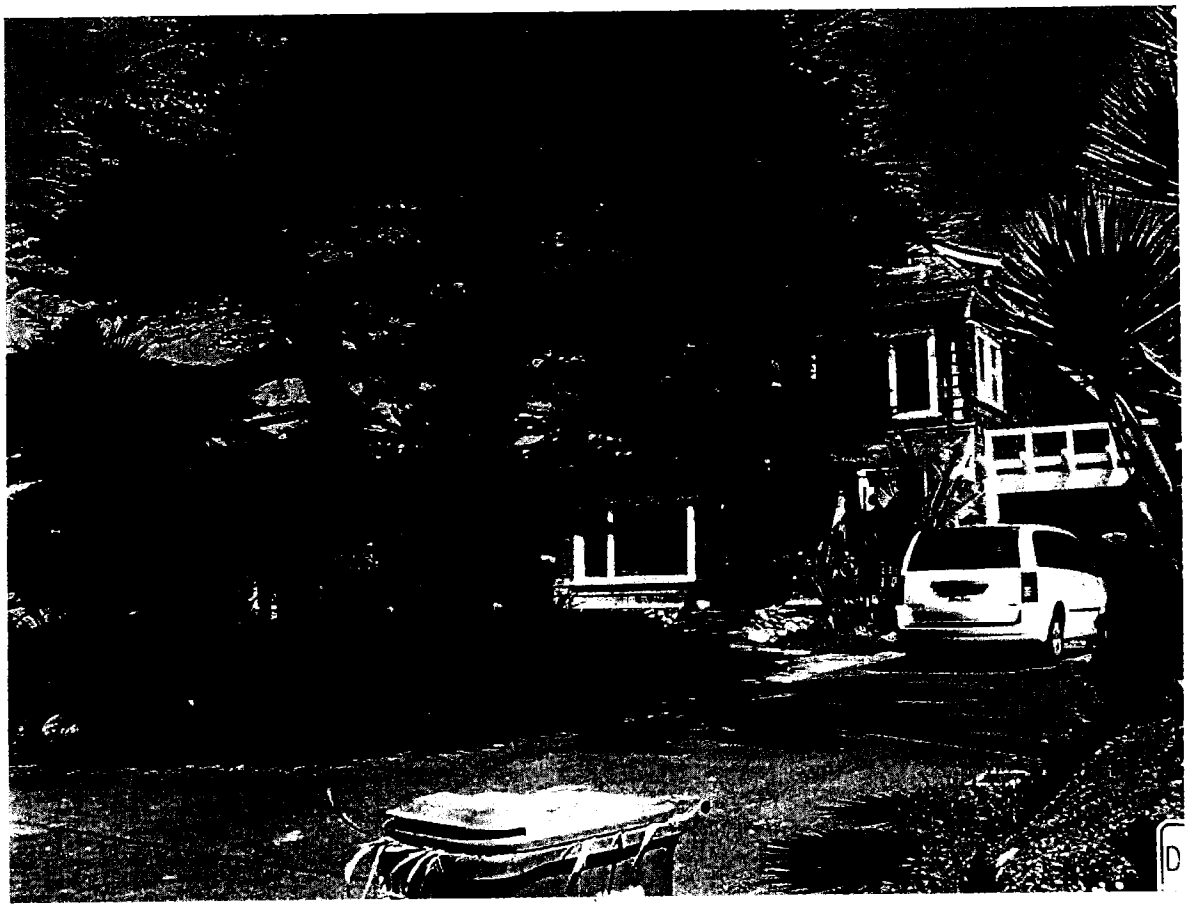
The view of the trees and shrubs in the County Right of Way in front of the Rivoir Property:

Note – Trees and shrubs - number's 12 through 14.

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

The view of the Monterey Cypress Tree located in the County Right of Way in front of the Wessbecher property;

Note – Tree number 15 in the report.



ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

The view looking north east of the trees and shrubs in the County Right of Way adjacent to the Wessbecher property:

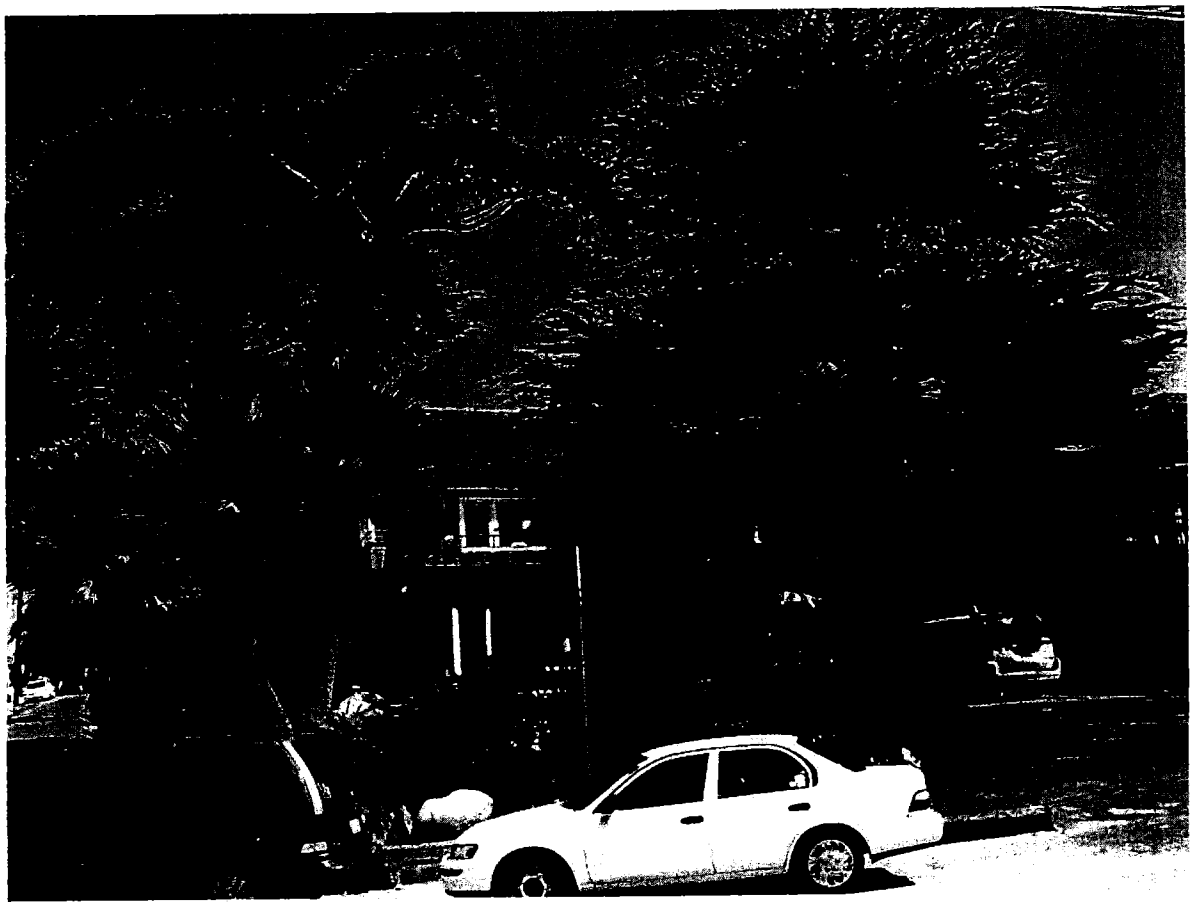
Note – Trees and shrubs – including number's 16 through 19.

ATTACHMENT 12

ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

The view of the trees and shrubs looking north, that are in the County Right of Way adjacent to the Wessbecher property:

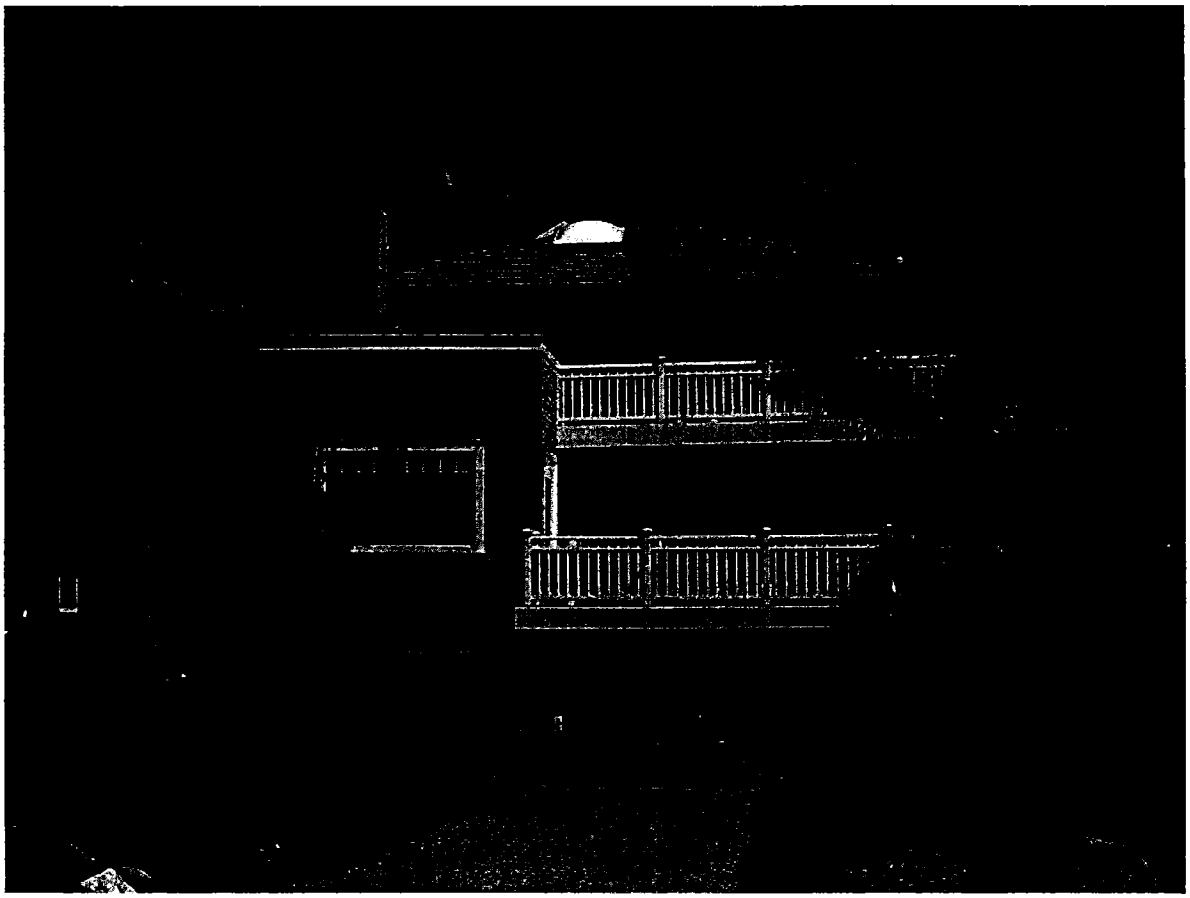
Note the two Monterey Cypress Trees - numbers' 15 and 21.
Note the poor condition of Tree number 21 located near the west side of the residence.



ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

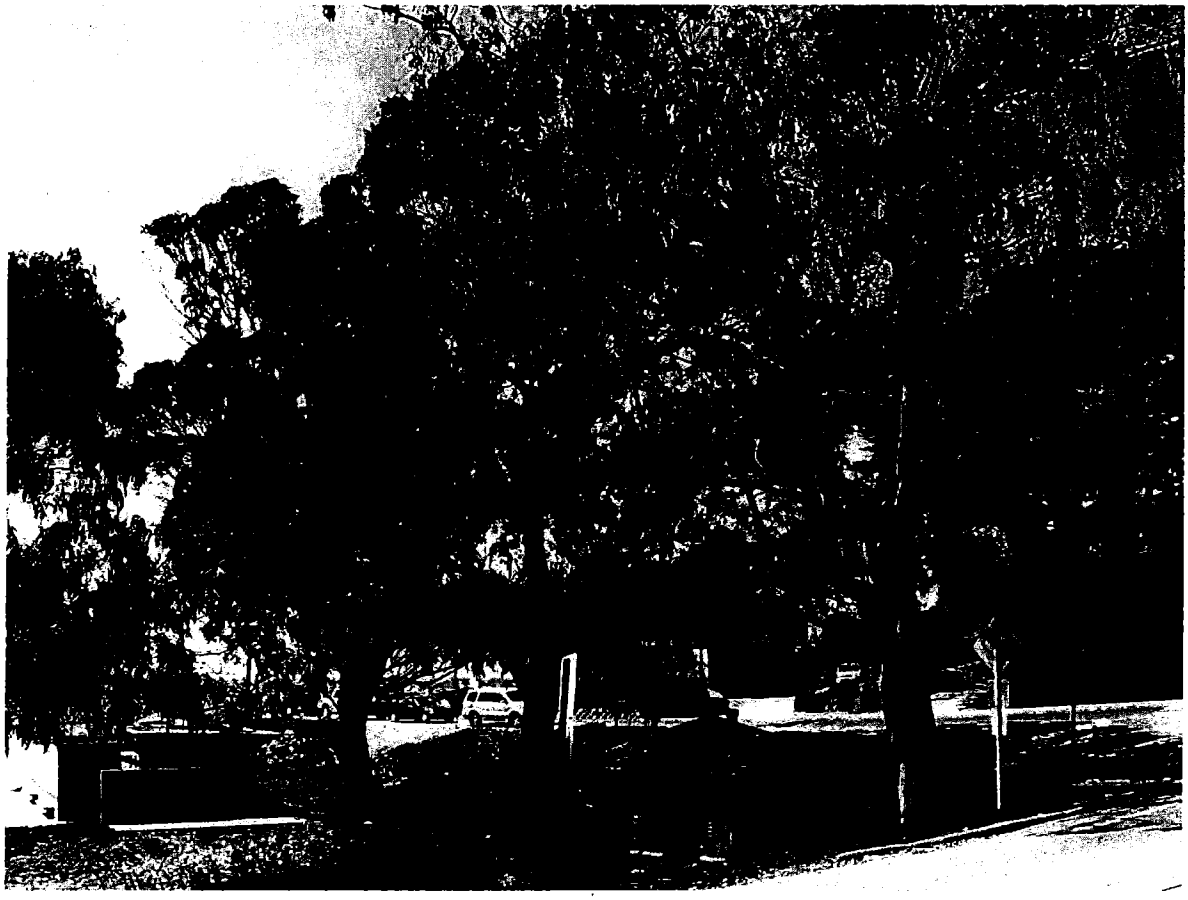
The view of the palms located in the County Right of Way in front of the Flamen property - tree number's 24 and 25:

- Note that the Queen Palm located behind the Windmill Palm (Tree number 24) on the right side of the driveway is not included in this report as it is set back beyond the County Right of Way.



ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

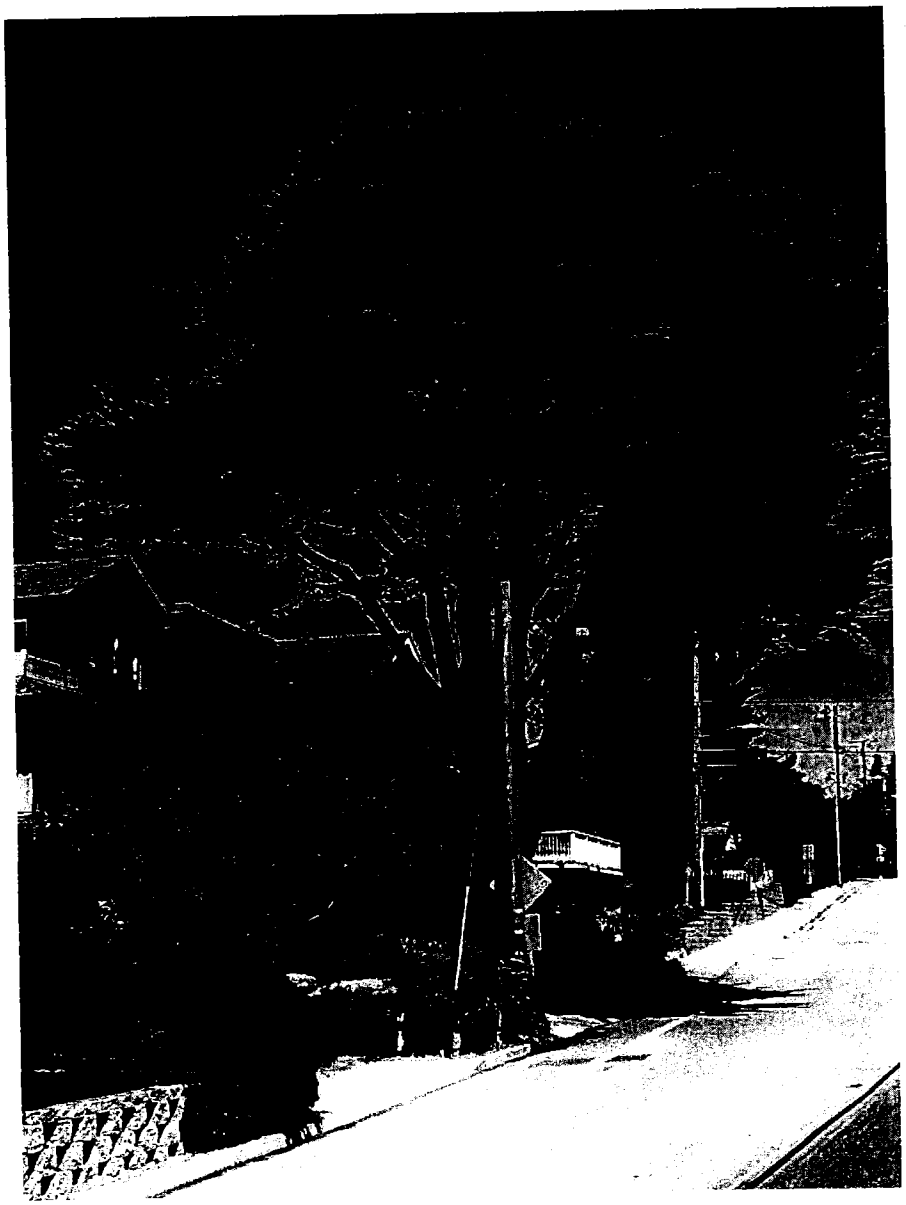
The view of the three Blue Gum Eucalyptus trees located on State Park Property looking west from the near the corner of Avenue and East Cliff Drive – trees' number 1 through 3:



ARBORIST REPORT ADDENDUM - THE REVISED OVERVIEW OF PROPOSED PUBLIC IMPROVEMENTS PERTAINING TO THE EXISTING TREES AND SHRUBS LOCATED WITHIN THE TWIN LAKES BEACHFRONT PROJECT

The view of the Monterey Cypress and the Myoporum Tree looking north - Located at the Carroll and Wrenn properties respectively – trees number 4 and 5:

- Note the location of the Monterey Cypress (tree number 4) and the retaining wall adjacent to curb.
- Note the poor condition of the Myoporum (tree number 5) in the foreground.



AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

REQUESTED BY:
JAMES DAVIES
PROJECT MANAGER
SANTA CRUZ COUNTY REDEVELOPMENT AGENCY
701 OCEAN STREET, ROOM 510
SANTA CRUZ, CA 95060

SITE INSPECTION ON AUGUST 4, 2009
REPORT UPDATED - MARCH 24, 2010
BY NIGEL BELTON
ISA CERTIFIED ARBORIST WE410A

JOB: RDA – TWIN LAKES BEACHFRONT PROJECT

AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 1.

Background and Assignment:

This report has been provided at the request of James Davies, Project Manager for the Santa Cruz County Redevelopment Agency.

The report pertains to street and sidewalk improvements proposed for the Twin Lakes Beach Front improvement project. The improvement area extends from the turning circle at the end of 5Th Avenue along East Cliff Drive to end at the intersection of 9th Avenue adjacent to Schwan Lake.

The initial site inspection was conducted with James Davies. The inspection identified the significant trees that will be impacted by proposed improvements, including a number of trees that will have to be removed. Mr. Davies provided me the current concept plan to use as a source of reference.

- This report will identify all the trees that will be potentially impacted by the design and construction process.
- The report will discuss the condition of trees that are in or encroach over the public right of way.
- It will identify trees that will have to be removed in the public right of way.
- The report will make design and construction period recommendations compatible with preservation of the majority of these trees.

AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

Tree Survey and Recommendations:

1. Blue Gum Eucalyptus (Eucalyptus globulus)

Location – This tree is located at the Eastern end of the project area opposite 9th Avenue. The Eucalyptus is situated on State Parks property being located in the beach adjacent to the base of the low bank that parallels to East Cliff Drive. Note that this tree and the five other Blue Gum Eucalyptus Trees discussed in this report are not located within the County Right of Way. These trees are located on State Park Property.

DBH (trunk diameter measured at 54 inches above grade) – 67 inches

Condition – Good health and vitality
- Fair structure

Observations:
This large tree has three main stems that emanate from a common trunk at between four and five feet above grade. The narrow attachments between the stems appear to be structurally sound. The tree exhibits a strong lean and weight bias to the north east. The development of the structures of this tree and the five adjacent Blue gum Eucalyptus trees along the beach front have been influenced by their coastal exposure to prevailing onshore winds and salt spray.

The tree is located near the edge of the bank below the street. An asphalt service road currently extends down to the beach from East Cliff Drive in relatively close proximity to the west side of the root collar.

AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 3.

Recommendations:
The concept plan shows that the service drive way will be relocated to the east side of this tree.

It is important that the existing driveway is removed with care to minimize potential damage to the roots of this tree. The surface and base material should be progressively removed by an excavator located on the existing driveway surface, beach or top of the bank in order to avoid damage or loss of significant roots and the compaction of the soil below (significant roots are one inch diameter and larger within 36 inches of the tree root collar and two inches and larger in diameter beyond that distance). The grades in the area of the existing driveway should not be lowered significantly (six inches or more) without first determining the actual depth and location of significant roots in this area. This determination will require an excavation (by hand) along the edge of the driveway nearest to the tree.

The concept plan shows that the proposed driveway will be located within approximately 15 feet of the east side of the root collar (the base of the trunk at and below existing grade) and as close as 10 feet away on the southern side. Care must be taken to protect significant roots during the construction process. Additional recommendations regarding root protection and construction mitigation work, the location of tree protection zones and the installation of tree protection fencing shall be provided when detailed construction and grading plans are available. This consideration will ensure that the arborist have the opportunity to review construction drawings and have the opportunity to provide appropriate recommendations regarding tree preservation concerns and requirements. It should also be noted that the consulting arborist must be present on site during all phases of construction procedures that will potentially affect these trees in order to minimize any potential for damage and optimize their protection.

The concept plan shows that the grade will be changed in the area around the trunk and the proposed service road location. It shows that an area of gently sloped fill material will be extended out from the existing toe of the bank adjacent to the north side of this tree. The fill will extend approximately 35 feet south of the trunk of this tree. The tree is currently situated in beach sand. This work will have to be done carefully to ensure the protection of the root structure of this tree.

AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

The concept plan also shows that low retaining walls will be installed around each of the first three Blue Gum Eucalyptus trees identified in this survey. The walls will be located in close proximity to the root collars of these trees (the current plan shows that these walls will be within four feet of the trunks at grade).

These walls shall be designed in such a way as to minimize the potential for root loss during construction work. The walls shall be installed on a grade beams and piers or an appropriate alternative support system as opposed to relying on a deep foundation style for structural integrity. The minimum set backs between the trunks and the walls can be increased to six feet. Set back distances that encroach into the adjacent slope more than six feet from the trunk risk damaging roots that may be just below its surface (note that significant roots over two inches in diameter are often located in the upper 30 inches of the soil horizon). Hand excavate the foot prints of the three proposed retaining walls before making the final determination of the set back distances.

A pre-construction root examination procedure shall be helpful in preserving large roots (over 2 inch diameter). This procedure should entail the hand excavation of the pier sites. Pier locations may have to be re-located when larger roots are observed in order to avoid excessive root loss.

2. Blue Gum Eucalyptus

Location – This tree is located approximately 145 feet west of Tree #1 and is situated at the base of the bank below East Cliff Drive. It is located on State Parks property.

DBH – 40 inches

Condition – Good health and vitality
- Fair structure

Observations:
This tree exhibits a strong weight bias and lean to the north east and encroaches over East Cliff Drive.

Recommendations:

Care should be taken regarding the design and construction of the low retaining wall in close proximity to the root collar. See the notes for trees #1.

3. Blue Gum Eucalyptus

Location – This tree is located approximately 25 feet west of tree #2 and is situated at the base of the bank below East Cliff Drive. The tree is situated on State Park property.

DBH – 43 inches

Condition - Good health and vitality
- Fair structure

Observations:
This tree has a more evenly distributed canopy than the two preceding trees, however the scaffold limb structure is heavy and may be vulnerable to failure.

Recommendations:
The recommendations made for the two previous trees regarding the design of the proposed retaining wall also pertain to this tree.

4. Blue Gum Eucalyptus

Location – This tree is located at the corner of East Cliff Drive and 7th Avenue. It is located on the bank below East Cliff Drive and is growing on State Park property.

DBH – 41 inches

Condition – Fair health and vitality
- Fair structure

Observations:
This tree exhibits a thin foliar canopy, having a higher dead wood to green foliage ratio when compared with the adjacent healthy trees.

Recommendations:
The conceptual design shows that the proposed path and stair way will be in close proximity to this tree (within five feet of the south side of this tree). The design of this structure will have to be compatible with the conservation of the majority of the root structure in close proximity to the tree. The critical area concerning the conservation of significant roots (the critical root zone) during the design and construction process regarding the stairs and walkways should be considered as being the area of soil that extends 17 feet out from the north, west and south sides of the root collar of this tree.

5. Blue Gum Eucalyptus

Location – This tree is located in the sand about 30 feet south of the pump house on State Park property.

DBH – 48 inches

Condition – Good health and vitality
- Fair structure

Observations:
This tree has a broad spreading canopy that exhibits a weight bias to the east and north quadrants.

Recommendations;
This tree will not be adversely affected by the proposed redevelopment work.

AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

6. Blue Gum Eucalyptus

Location – This tree is located on State Park property. It is situated approximately 30 feet south of the pump house and is 20 feet west of the existing rest room.

DBH – 45 inches

Condition – Good health and vitality
- Fair structure

Observations: This tree does not appear to encroach over the right of way and improvement project area.

Recommendations:

This tree will not be adversely affected by the proposed improvement work.

7. Mexican Fan Palm (Washingtonian Robusta)

Location – This palm is located in the County Right Of Way in front of the residence at 2616 East Cliff Drive.

DBH – Estimated to be about 35 inches

Condition - Good health, vitality and structure.

Observation and Recommendations:
This palm is situated in an established landscaped strip between two driveways.

The palm can be successfully relocated into the adjacent private property or to another site. Otherwise it will need to be removed. The optimal time for transplanting palms is during the summer months when new root regeneration is more successful than in the winter.

AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 8.

8. Canary Island Date Palm (Phoenix canariensis)

Location – This palm is located in the County Right Of Way and area of proposed improvements. It is adjacent to the Mexican Fan Palm (Tree #6), being closer to the street.

DBH – Estimated to be about 24 inches

Condition - Good health, vitality and structure.

Observations and Recommendations:
This young palm is also located in the area that will be affected by the proposed right of way improvements. It should be transplanted to another location or removed entirely.

9. Monterey Cypress (Cupressus macrocarpa)

Location – This tree is located in the County Right Of Way and area of proposed improvements. It is in front of the private residence at the corner of 6th Avenue and East Cliff Drive.

DBH – Estimated to be between 20 and 24 inches.

Condition – Good health, vitality and structure.

Observations and Recommendations:
This tree is located in the established landscape in front of 2610 East Cliff Drive.

Unfortunately this tree will have to be removed as it is within the County Right Of Way and improvement area. The tree is too large to successfully transplant to another location. The process of relocation would entail the loss of an excessive proportion of the root structure. This species does not transplant easily.

AN OVERVIEW REGARDING THE IMPACT
AN OVERVIEW OF THE PROPOSED STREET IMPROVEMENTS
ON SIGNIFICANT TREES
WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 9.

10. Monterey Cypress

Location – This large tree is located within the County Right Of Way at the corner of 6th Avenue and East Cliff Drive.

DBH – Estimated to be in Excess of 36 inches

Condition – Poor health, vitality and structure

Observations:
This tree is located in the established landscape next to the private residence. The tree is declining in health as evidenced by the large dead south facing scaffold limb and the poor condition of the upper canopy. Evidence of decline in the upper canopy includes thinning foliage, a high ratio of dead wood and poor foliage color. The decline is particularly evident in the south side of the upper canopy.

Recommendations:
This tree should be removed. It is in the right of way and even if it could be retained, would be significantly impacted by the proposed roadway improvement work which would further exacerbate its decline. The tree will continue to decline in health. The process of decline is irreversible due to the age of this tree and its current poor condition.

The large dead south facing scaffold limb is vulnerable to falling and represents a hazard. It should be removed as soon as possible.

AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 10.

Summary:

Care must be taken in close proximity to the three Blue Gum Eucalyptus Trees located on the State Beach and one Eucalyptus Tree located on the bank below the county right of way. (Trees #1 though #4) regarding any construction activities that could be injurious to their roots. Design considerations and construction methodologies must be compatible with the goal of reducing damage to the roots of these trees.

Recommendations:

The utilization of pier and grade beam foundations (or appropriate alternative designs) for the proposed retaining walls adjacent to the Eucalyptus trees will most likely be required to ensure root protection. Hand excavation of the proposed wall foot print profiles and pier locations in the adjacent slopes will be needed to determine if excessive root damage will occur during construction work. The design of the stair way in close proximity to Tree #4.will require care to minimize grade changes and the potential for root loss.

Note that this report is a preliminary overview of concerns regarding the impact of the proposed improvements. I will need to review the detailed design plans concerning the welfare of these trees before the final construction plans are approved.

The conceptual plan identifies the following activities that have potential to damage the roots of these trees:

- The installation of retaining walls in close proximity to the tree root collars.
- The removal of the existing access roadway near tree #1.
- The raising of grades under the canopy drip line of tree #1.
- The construction of a new access roadway in close proximity to tree #1.
- The construction of a pedestrian walkway and stairs in close proximity to tree #4.

I recommend that State Parks be approached regarding pruning trees #1.through #4.to reduce potential hazards from limb failures over the roadway, parking areas, walkways and the beach area before improvements are installed.

The two other Blue Gum Eucalyptus trees (tree numbers 5. and 6.) are not likely to be significantly impacted by the improvement project.

AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

PAGE 11.

Recommendations - Continued

The two Palms that are located in the right of way in front of 2616 East Cliff Drive (trees number 7. and 8.) are within the improvement area and must be transplanted at another location or removed.

The two Monterey Cypress Trees located in the right of way adjacent to 2610 East Cliff Drive (tree numbers 9. and 10.) will have to be removed because they are in the improvement area. Tree number 10. is declining in health. The large dead scaffold limb on the south side of this tree is a hazard and should be removed as soon as possible.

Please contact me if you have any questions.

Sincerely yours

Nigel Belton

Two Attachments – A photograph of the Monterey Cypress on the corner of 6th Avenue
- A tree inventory map of the project

ATTACHMENT 12

AN OVERVIEW REGARDING THE IMPACT OF THE PROPOSED STREET IMPROVEMENTS ON SIGNIFICANT TREES WITHIN THE TWIN LAKES BEACHFRONT PROJECT

View of Tree Number 10. looking east from the corner of 6th Avenue and East Cliff Drive

ATTACHMENT 19

ATTACHMENT 19

Twin Lakes Beach Project

Considerations for relocating a 24 inch diameter Monterey cypress located in the public right-of-way south of the residence located at 2601 E. Cliff Drive, Santa Cruz CA 95062.

Prepared for:

Vanir Construction Management, Inc
and
Santa Cruz County
Parks Division of the Department of Public Works

August 31, 2012

Prepared By:

Richard Gessner
Registered Consulting Arborist ® #496
Board Certified Master Arborist WE-4341B
Certified Tree Risk Assessor #904
California Qualified Applicators License QL-104230

Monarch Consulting Arborists LLC
P.O. Box 1010
Felton, CA 95018
831. 331. 8982

ATTACHMENT 13

Table of Contents

Summary 1

Introduction 1

Background 1

Assignment 1

Limits of the assignment 2

Purpose and use of the report 2

Observations 2

Analysis 3

Discussion 4

Monterey Cypress Species Profile 4

Health Assessment 5

Structural Evaluation 6

Condition Rating 7

Suitability for Transplantation 8

Long and Short Term Viability of Preservation 9

Root Pruning 9

Watering 9

Fertilizing 9

Mulching 10

Pest Management 10

Tree Pruning 10

Timing 10

Tree Protection and Minimum Encroachment 11

Richard Gessner - Monarch Consulting Arborists LLC - (831) 331-8982 - rick@monarcharborist.com
P.O. Box 1010 Felton, CA 95018

Critical Root Zone *12*

Transplanting Locations Within the Right-of-Way *13*

Feasibility of Alternatives *14*

Conclusion **15**

Recommendations **15**

Option 1 ..... *15*

Option 2 ..... *15*

Bibliography **16**

Glossary of Terms **17**

Appendix A: Tree Assessment Tables **21**

A1: Site Characteristics *21*

A2: Tree Characteristics *22*

A3: Tree Characteristics Continued *23*

Appendix B: Additional Photographs **24**

B1: Site from the west *24*

B2: Retaining wall on the south side *25*

B3: Cypress to evaluate *26*

B4: Structural root growing west *27*

Appendix C: Tree Protection Guidelines **28**

Pre-Construction Meeting with the Project Arborist *28*

Tree Protection Zones and Fencing *28*

Monitoring *28*

Restrictions Within the Tree Protection Zone *28*

Root Pruning *28*

Boring or Tunneling *29*

Timing *29*

Tree Pruning and Removal Operations *29*

Tree Protection Signs *29*

Appendix D: Tree Protection Signs **30**

D1: English *30*

D2: Spanish *31*

Appendix E: Tree Well and Tree Island Illustrations **32**

Qualifications, Assumptions, and Limiting Conditions **33**

Certification of Performance **34**

Summary

The Monterey cypress *Cupressus macrocarpa* located within the County of Santa Cruz's public right-of-way in front of 2601 E. Cliff Drive has no significant structural or health issues and is suitable for transplanting. There is adequate soil volume and enough space to the northwest to relocate the tree if the other cypress is removed. A proper aftercare program and irrigation system are critical to the tree's survival after transplantation. Although it is possible for the tree to remain in place and be protected in a tree island, the island would extend midway into the new road alignment and fragment the proposed bike lane.

Introduction

Background

I was contracted by Vanir Construction Management, Inc. to provide an assessment of the Monterey cypress for the Twin Lakes Beach Project. The Parks Division of the Department of Public Works of Santa Cruz County is exploring the possibility of transplanting the cypress tree to another location to make room for a new road alignment, bike lane, and designated parking area along the beach front.

Assignment

- Provide an arborist's assessment of the tree's current health and structure, surrounding conditions, and likelihood of surviving transplantation to determine whether it is a good candidate for relocation.

- Outline transplanting procedures and an aftercare plan to help the tree survive during and after relocation, including protection guidelines to help prevent the planned construction activity from adversely affecting the tree's health. Specific information regarding minimum encroachment distances into the the **critical root zone** of the tree will be provided.

- Identify possible replanting locations within the County's right-of-way on the north side of the roadway.

- Provide feasible alternatives to relocating the tree.

Limits of the assignment

- The information in this report is limited to the condition of the tree during my inspection on August 9, 2012.
- No **aerial inspections**, trenching or **resistance drilling** was performed, only a visual inspection from the ground.
- No **tree risk assessments** were performed.

Purpose and use of the report

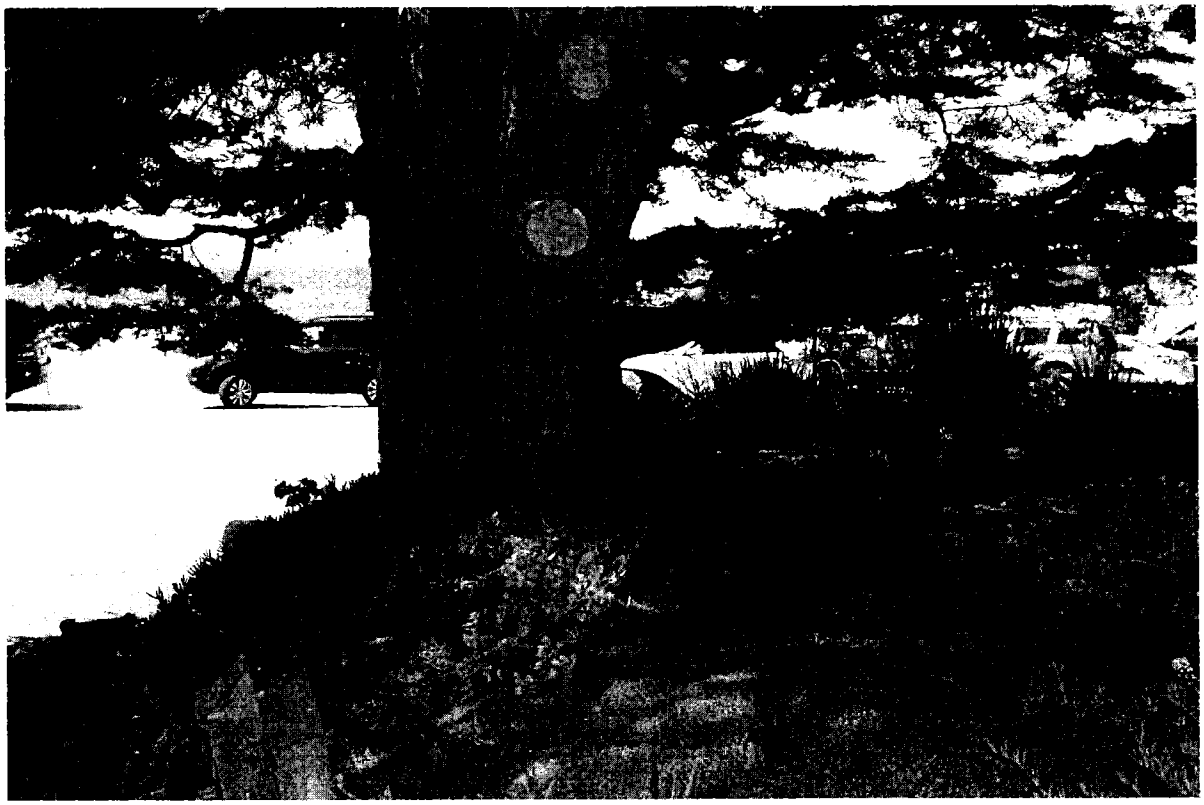
The report is to help inform Vanir Construction Management, Inc. and the Santa Cruz County Parks Division of the Department of Public Works about the cypress tree's suitability for relocation, condition, and which alternatives to relocating the tree may be feasible.

Observations

The public right-of-way is located in front of 2601 E. Cliff Drive across the street from Twin Lakes State Beach and on the corner of Sixth Avenue. On June 20, 1988 a temporary and revocable public right-of-way encroachment permit (#88-142) was issued for the planting of the Monterey cypress *Cupressus macrocarpa,* which included the tree, soil, and the retaining wall. The cypress proposed for preservation or transplantation is in front of the residence to the west of the driveway. The cypress is situated on top of a raised planting bed about three feet above the driveway and road in a raised planting area. There are several palm trees and one other larger cypress in the public right-of way to the west and northwest near Sixth Avenue. The cypress is surrounded by a rock wall thirteen feet from the **main stem** to the south and three feet to the east. There is an irrigated turf and planting area underneath the tree to the west and a path to the front door on the north side. Along the roadway to the south is a walking path and off street parking. The parent soil type in the area is sand and the prevailing winds typically come from the northwest.

The photo above is of the cypress tree taken from the southwest side.

The Monterey cypress tree has a trunk diameter of 24 inches (75 inch circumference) at 4.5 feet above grade and is approximately 44 feet tall (Appendix B). The **canopy** radius is 17 feet wide and the foliar color, size, and density are normal for the species. There are no insect pests or diseases present and the current growth on the lower branch tips is about ten inches. One low limb is growing toward the northeast and has an acute angle attachment. Otherwise the tree has one central leader and moderate-sized **scaffold branches**. The cypress has been pruned about two thirds of the way up presumably to clear a view of the ocean. The **live crown ratio** is about 90 percent with branching starting just above grade near the base of the tree. There are visible **root flares** with at least three larger flares growing north, south, and west with the **structural roots** on the east side growing straight down near the rock wall.



The photo above is of the cypress tree taken from the north side.

Analysis

No offsite technical analysis or testing was performed for this assignment.

The trunk diameter was measured with a Pro Tape™ Diameter Tape, made by Spencer Products Company, USA at 4.5 feet above grade and the height was measured using a Nikon® Forestry 550 laser range finder. Canopy radius was measured with a standard tape measure from the base of the tree to the outer most leaf area.

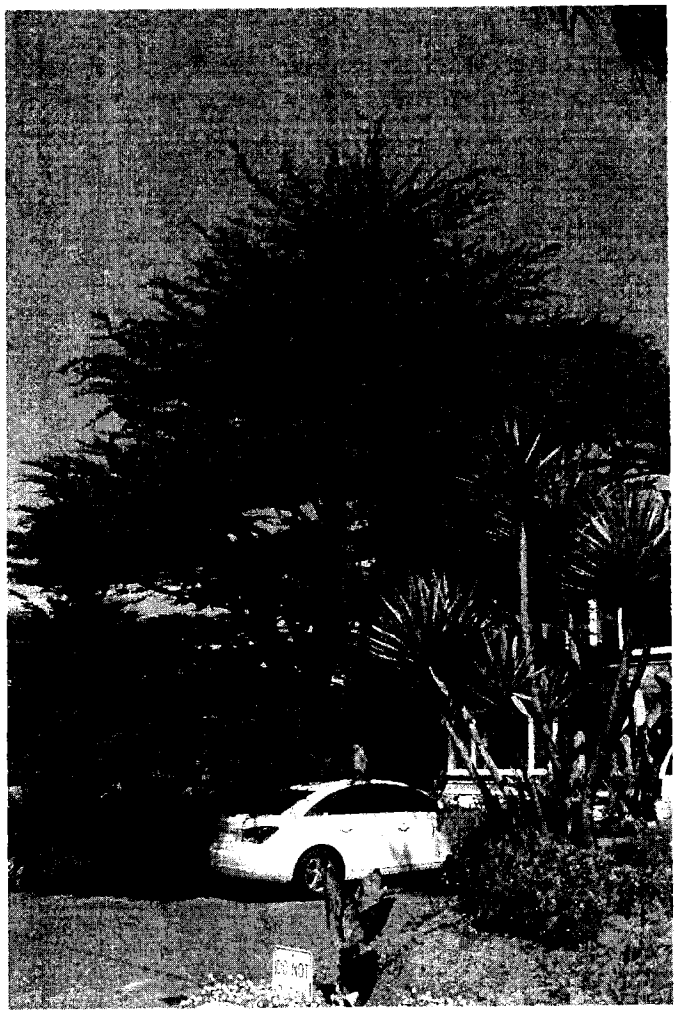
Discussion

Monterey Cypress Species Profile

Monterey cypress *Cupressus macrocarpa* grows naturally in only two groves along the Monterey Peninsula at Cypress Point and Point Lobos in Carmel. All specimens of this tree around the world have descended from these two groves (Peattie, 1991). The trees are grown in Europe, Australia, New Zealand, South America, many parts of California, and are easily cultivated from seed. Monterey cypress typically grow from 40 to 70 feet tall with a canopy spreading 30 to 40 feet wide with bright green foliage. The trees are susceptible to coryneum canker *Seridium sp.* which causes the foliage to turn yellow then brown. Monterey cypress are also susceptible to insect pests such as *Phloeosinus sp.* bark beetles, Monterey cypress scale *Xylococculus macrocarpae*, and cypress bark mealybug *Ehrhornia cupressi.*

Codominant branches are known to fail, however entire tree failure from the base is rare among Monterey cypress (Clark and Matheny, 1994).

Monterey cypress is known to be intolerant of site disturbances during construction (Matheny and Clark, 1998).



The photo above is of the Monterey cypress taken from the east side.

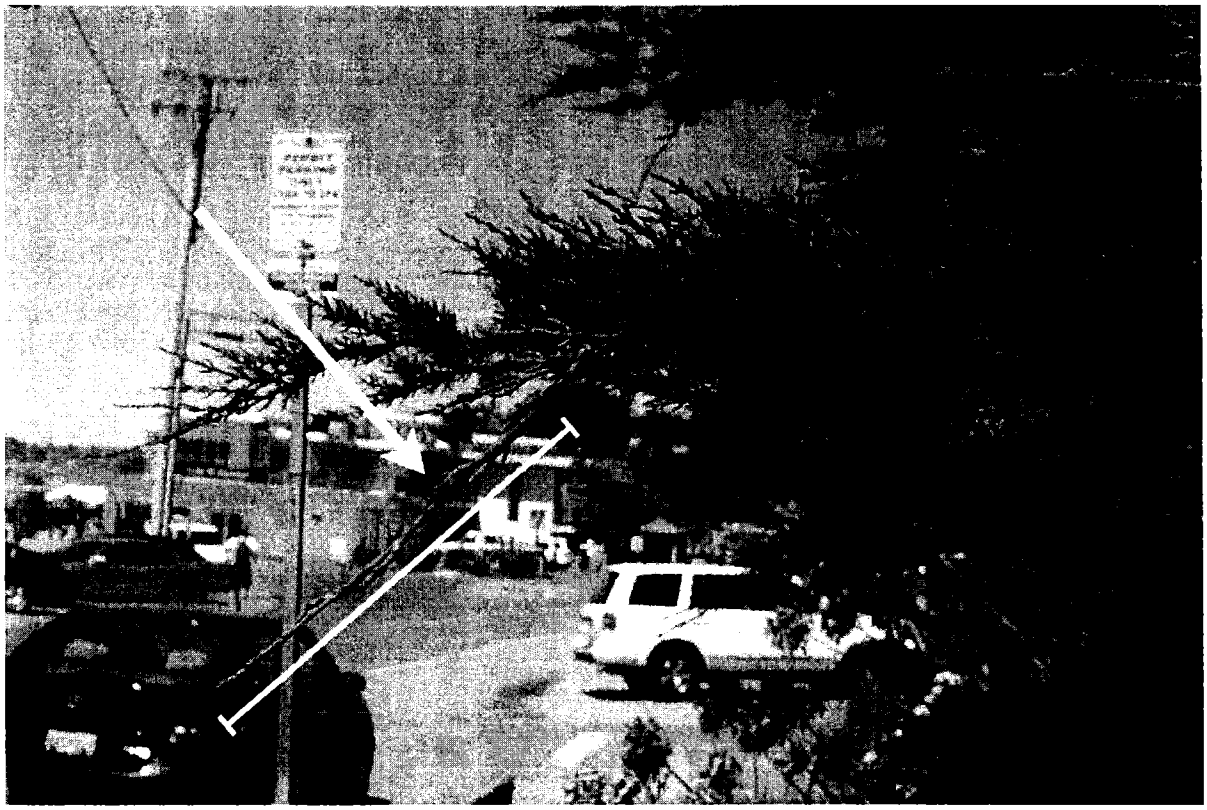
Health Assessment

The tree health assessment focuses on the following observations:

- Overall appearance
- Foliar health
- Twig growth
- Environment (**abiotic disorders**)
- Presence of insects and disease (**biotic disorders**)

The overall health rating is either good, fair, or poor. The system is based on the overall appearance of the tree, its leaf and twig growth, and the presence and severity of insects or disease (Appendix A).

The tree is in good health with no signs or symptoms of decline or any insects or diseases were observed. New growth is about ten inches long and the foliage is dark green and normal for the species.



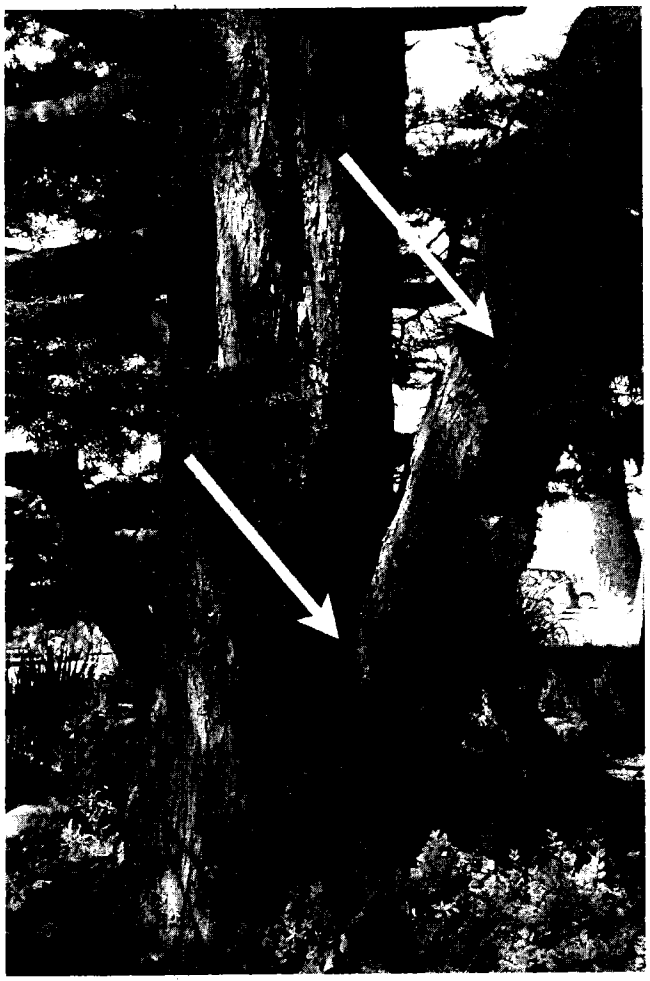
The photo above is of the new twig growth and healthy foliage.

Structural Evaluation

The structural evaluation is based on the following components (Adapted from Smiley, Fraedrich and Hendrickson, 2007)(Appendix A):

- Canopy
- Main stem
- **Root collar**
- Soil environment

The tree canopy was inspected for the following structural defects that may contribute to failure: dead branches, previous failures, **topping** or head cuts, broken branches, codominant stems, **weak sprouts**, **unbalanced crown**, and live crown ratio. The stem inspection focused on the lower four to six feet where the most pressure would be if the stem were to bend during storms or high winds (Smiley, Fraedrich and Hendrickson, 2007). I looked for symptoms of decay such as **wounds**, **cavities**, cracks, **fungal conks**, bleeding, bulging, and loose bark on both the stem and the root collar, which indicate structural defects. Within the soil environment, water-logged soil from irrigation or heavy rain combined with high wind can contribute to failure. I looked for potential conditions leading to root or **soil failure**; **girdling roots**, lean, and limited soil environment from driveways, sidewalks and buildings and a buried root collar.



The photo above shows the acute angle branch originating near the base of the tree.

The only structural concerns for the tree are the limited soil space to the east where the retaining wall is located and the acute angle branch located on the lower stem. If the tree were to be transplanted the lower lateral limb may need to be removed or significantly reduced. The tree has good trunk **taper**, high live crown ratio, no codominant stems or other common structural conditions that could lead to branch or stem failure.

Condition Rating

Tree condition is based on a scale of good, fair, and poor and is calculated using the analysis of condition factors provided in the *Guide for Plant Appraisal, 9th Edition, 2000.*

A tree's condition percentage is a determination of its overall health and structure based on five aspects: Roots, trunk, scaffold branches, twigs, and foliage. Each aspect is rated using the following point scale:

- 4= No apparent problems
- 3= Minor problems
- 2= Major problems
- 1= Extreme problems

Tree roots, trunk, and scaffold branches are rated on both health and structure where as twigs and foliage are based solely on health (ISA, 2000). The points are totaled for each tree and converted to a percentage.

Monterey cypress condition percentage calculation

	Roots	Scaffold	Trunk	Small Branches	Foliage/ Twigs
Health	4	4	4	4	4
Structure	3	3	4		

30/32 = .9375 x 100 = **93.75%**

The following scale defines the condition rating from the "condition" percentages:

- Good = 90%-100%
- Fair = 89%-75%
- Poor = > 74%

By this formula and evaluation, the tree is considered to be in good overall condition with no major apparent problems. The reasoning behind giving the scaffold structure only three points instead of four is because there is one low lateral limb that has a poor attachment and the upper canopy has a window cut through it for a view of the ocean. The root system is asymmetrical and the limited space to the east was also considered a minor problem with the root structure.

Suitability for Transplantation

A tree's suitability for transplantation is determined based on its health, structure, age, species characteristics, longevity, current and new growing environments. Prior to transplanting it is important to assess these characteristics. The tree's general health, foliar color and density, and signs of insects or disease are assessed. The structural condition of the tree including the roots, overall shape and symmetry of the crown, current growing environment, and past and future pruning needs all need to be accounted for and be acceptable. Species data and transplantation history and any other conditions that could limit the survival of the plant are also assessed.

The transplant site including any above ground or underground utilities, access, soil conditions, slope, grade, and orientation, is also assessed during the evaluation for suitability.

ANSI A300 (Part 6) 2005 Transplanting Tree, Shrub, and other Woody Plant Maintenance - Standard Practices suggests that trees greater than 8 inches in diameter should have a minimum **rootball** diameter of 12 inches for every inch of trunk diameter. Because the Monterey cypress is 24 inches in trunk diameter this would require a rootball radius of 12 feet around the main stem. It may not be necessary or possible to obtain 12 feet on the east side of the tree because the retaining wall is currently 3 feet from the main stem. By excavating underneath the current pathway with an **Air Spade®** or similar pneumatic device or using **ground penetrating radar** it may be possible to determine if roots exist in this area. Other than the east side there is adequate soil volume on the other three sides to successfully transplant the tree.

Because the tree is situated in a raised planting area and the prevailing winds are from the northwest it is likely that the tree's root system is asymmetrical and concentrated to the north, south, and west. There is limited space to the east because of the rock wall. The larger visible **root flares** extend to the south, west, and north, and the tree's **response growth** to wind forces would place most of the roots on the windward side for stability.

The cypress has good suitability for transplantation with the exception of the limited soil area on the east side. Fill soil may need to be placed to the east of the tree depending on the landscape design plan. Allowing more space for root growth on the east side may actually help with the stability of the tree in the future if new roots are generated and grow into this space.

Monterey cypress have been successfully transplanted for several years along the Central Coast, including a very large and well-publicized tree at the Pebble Beach Golf Links.

Long and Short Term Viability of Preservation

Trees are complex living organisms and it is not possible to quantify the long term health or condition of any living entity, including trees. Abiotic and biotic factors influence trees over time and that influence cannot be predicted. There are some cultural practices that can be employed to help the Monterey cypress survive after root loss associated with transplantation.

Keeping the current conditions inside the remaining root zone and proper watering will be the most important factors in the tree's survival after transplantation.

Roundball tree transplantation method would be used to encapsulate as much of the rootball as possible. The ball size, diameter, and depth, should encompass as much of the root system as necessary to successfully transplant the tree. A minimum rootball diameter of 12 inches for every inch of trunk diameter or greater would be best for transplanting the tree. Because the tree is 24 inches in diameter this would require a 12 foot radius of rootball.

Root Pruning

Root loss will inevitably be incurred and roots will need to be pruned prior to transplanting. When roots over two inches in diameter are encountered they should be pruned by hand with loppers, handsaw, reciprocating saw, or chain saw rather than left crushed or torn. Roots should be cut beyond **sinker roots** or outside root branch junctions and be supervised by the project arborist. When completed, exposed roots should be kept moist with burlap or **backfilled** within one hour.

Watering

Watering is the most critical aftercare aspect that cannot be overlooked. Irrigation frequency depends on **evapotranspiration** and the amount of water available in the soil. Controllers that use climate conditions to calibrate watering times and use are called ***ET*** controllers or ***Smart*** controllers and help to apply the right amount of water. Equipment such as moisture meters or **tensiometers** can be used to monitor soil moisture on site. The schedule needs to be tailored to this individual tree in its new location. Watering frequency and amounts should be established prior to transplanting and a **percolation test** can be performed at the time of transplantation. Too much water and not enough water can both have adverse effects on the tree limiting its survivability.

Fertilizing

No fertilizing should be performed without a **soil analysis**. Manage the soil according to recommendations from a qualified testing laboratory or have a qualified professional analyze the results and make the future recommendations for management of the tree.

Mulching

Mulch should be applied to the rootball after transplantation. Organic mulching requires putting compost, bark, wood chips or other plant material over the top soil to help improve soil conditions. Organic mulches help keep soil moisture and temperature more constant and provide some level of nutrient recycling as they break down. Mulch will help mimic the forest environment, can be attractive to landscapes, and helps to keep weeds down. Over time, mulch will also help reduce compaction in the soil and improve overall root growth, improving plant health. Mulch should be incorporated as part of a general **plant health care** plan for the site.

Pest Management

Treat the lower stem every 90 days with **Bifenthrin** (Onyx®) or **Pyrethrin** (Astro®) to help prevent bark beetle attacks during the spring and summer months after transplantation. BEcause of the root loss and stress incurred the tree will be more susceptible to secondary pests like bark beetles.

Tree Pruning

Tree pruning should only be performed before the tree is transplanted and well before that time when possible. Pruning should consist of the removal of dead, dying, broken branches and anything that is required for the transplanting operation to take place. For example, the lower limbs may need to be removed or reduced in length to accommodated equipment durning transplantation. It is not recommended to reduce the crown to balance it with the subsequent root loss. 90 percent of the live branches should be retained during and after transplantation.

Timing

Most **conifers** should be transplanted during the fall months. Because the tree is located along the coast the timing is not quite as critical. Coastal temperatures do not get too extreme which can help with establishment. Avoid transplanting during heat waves or times when frost or extreme low temperatures are expected.

Tree Protection and Minimum Encroachment

Tree protection focuses on protecting trees from damage to the roots, stem, or scaffold branches from heavy equipment. Two zones of protection need to be determined to protect a tree's health and structure, which are the **Tree Protection Zone (TPZ)** and the Critical Root Zone (CRZ).

The Tree Protection Zone (TPZ) is the defined area in which certain activities are prohibited to minimize potential injury to the tree. The TPZ can be determined by a formula based on species tolerance, tree age, and **diameter at breast height (DBH)** (Matheny and Clark, 1998). The species tolerance is defined as good, moderate, or poor, and the age is identified as young, mature, or over-mature. Once these parameters are determined, the radial distances from the trunk that should be protected is calculated using the established table.

The table below is the matrix for determining the tree protection zone base on the age and species tolerance.

Species Tolerance to Construction Damage	Relative Tree Age	Distance from Trunk in feet per inch of Trunk Diameter
Good	Young (<20% life expectancy) Mature (20-80% life expectancy) Over-mature (>80% life expectancy)	0.5 feet 0.75 feet 1 foot
Moderate	Young Mature Over-mature	0.75 feet 1 foot 1.25 feet
Poor	Young Mature Over-mature	1 foot 1.25 feet 1.5 feet

(Table: Matheny and Clark, 1998)

Because the species tolerance is poor and the age is young it would be best to allow at least 24 feet of tree protection zone where applicable, if the tree is to remain it in its current location. This is an ideal tree protection radius and there are site constraints like the rock retaining wall that would not allow 24 feet radially around the tree.

Another way to help determine what will be adequate tree protection is to use the **drip line** distance, in this case a 17 foot radius from the main stem.

No method of protection takes into account asymmetrical root systems.

The diagram below is an illustration of the drip line protection area and the interior critical root zone.

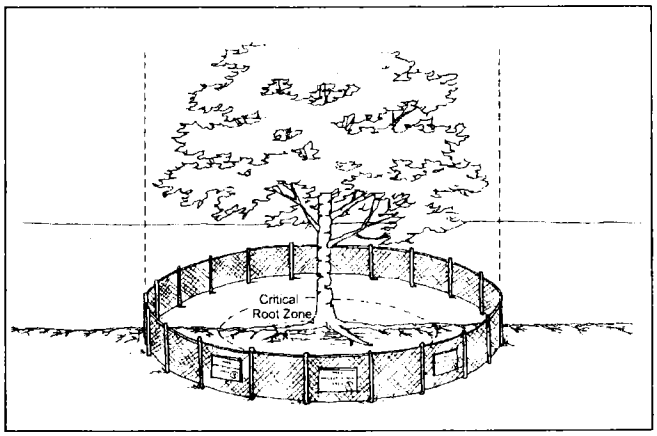


Diagram courtesy of ISA Best Management Practices Managing: Trees During Construction, 2008.

Critical Root Zone

The critical root zone (CRZ) is the area of soil around the trunk of a tree where roots are located that provide stability and uptake of water and nutrients required for the tree's survival. The CRZ is the minimum distance from the trunk that trenching or root cutting can occur and will be defined by the trunk diameter at a distance of three times the diameter in feet, and preferably, five times (Smiley, Fraedrich and Hendrickson, 2007) . For example if the tree is two feet in diameter, the minimum CRZ distance would be six to ten feet from the stem on one side of the tree.

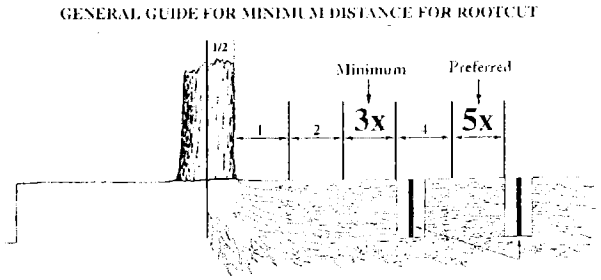
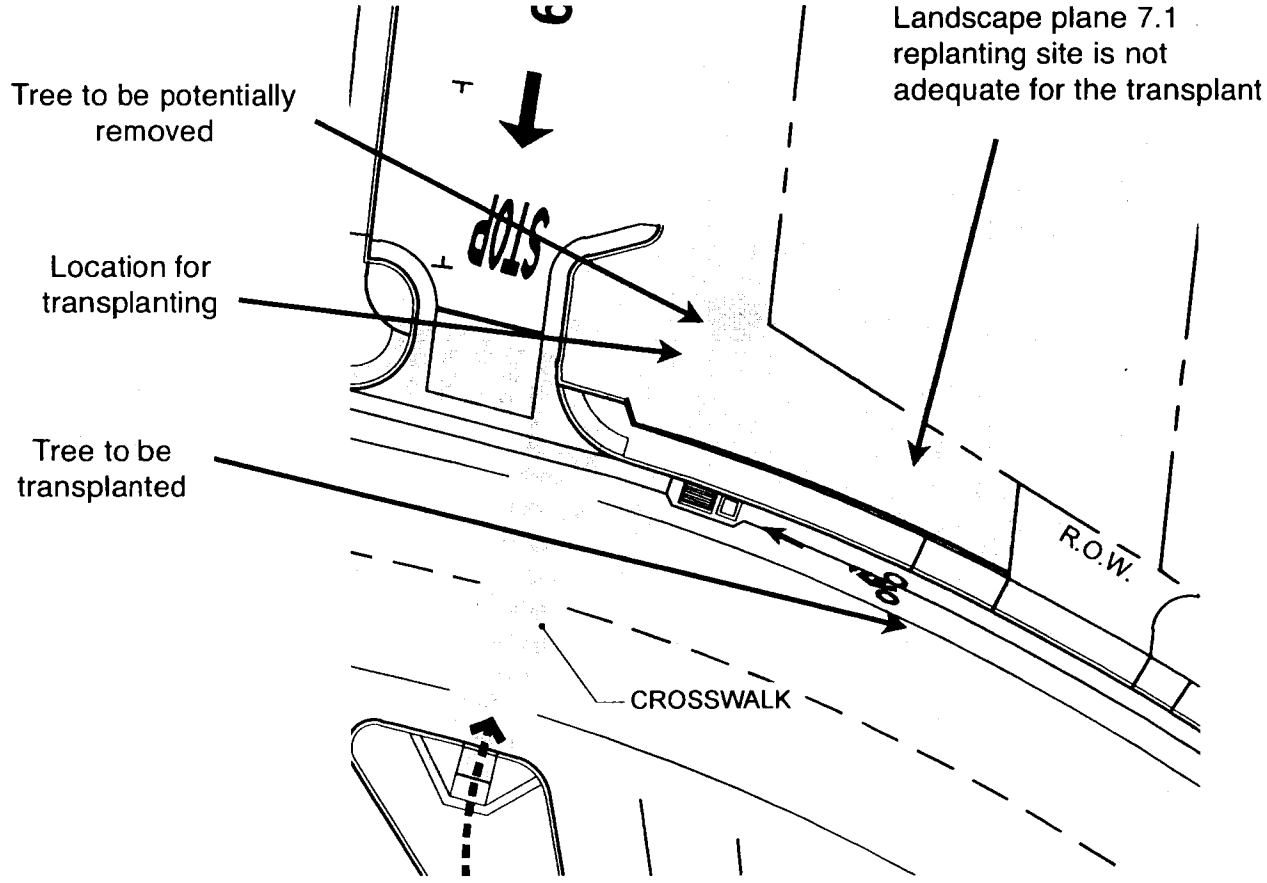


Diagram above is courtesy of Bartlett Tree Research Laboratories: Tree Risk Management, 2007

Encroachment into the critical root zone of any tree may compromise its structural integrity and those trees should be evaluated for removal.

Transplanting Locations Within the Right-of-Way

The most feasible location to transplant the Monterey cypress to is approximately 35 to 40 feet to the northwest. However, there is currently another Monterey cypress tree near that location. The other cypress tree appears to be in decline with one large dead stem, sparse foliage, low live crown ratio, and pockets of **decay** near the base. I did not perform a formal structure, health, or condition assessment on the tree but my general observations indicate that this tree is not suitable for preservation if development is to occur nearby. If this tree were removed it would create space for the smaller, younger tree with a longer **safe useful life expectancy**. There is enough room in this location to account for the rootball allowing about 20 feet of planting area in all directions. The spot directly to the north of the cypress is too small for the tree to transplanted into. Landscape plan 7.1 shows a new tree in this location, which is fine, but this tree cannot be transplanted to that spot because there is not enough room.



The image above is taken from sheet 4.1 RRM Design Group August 23, 2012. Image not to scale.

Feasibility of Alternatives

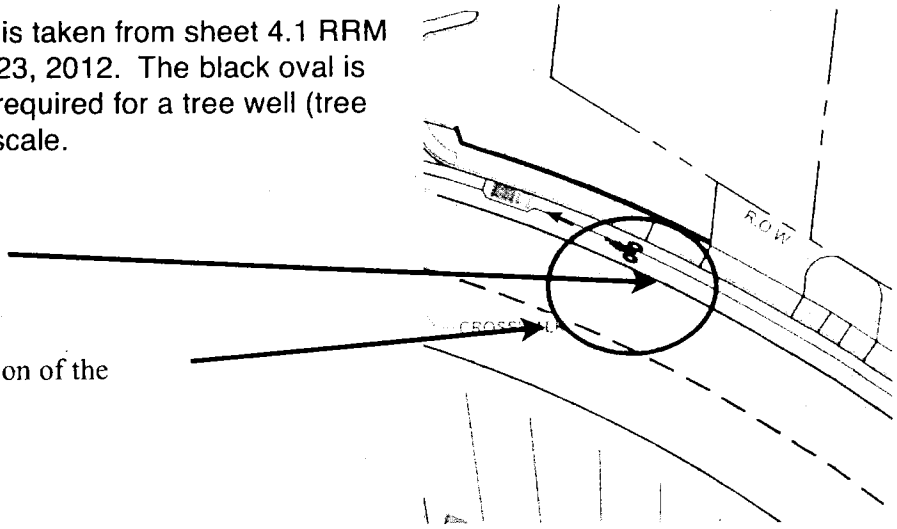
Tree **wells** and **islands** are sometimes used to protect and preserve trees when infrastructure is to be built around them (Appendix E). To clarify terms, tree wells are used when trees are at or below grade and tree islands are used when trees are already growing above grade. A tree island is basically a containerized tree which is what would be required in this instance.

I do not believe a tree island would work under the current design plan because it interferes with the road alignment. Because the tree is above grade the island would be very large and extend into the roadway and bike lane with the only alternative being realignment of the road.

A tree island for the Monterey cypress would need to be a minimum radius of approximately 24 feet where possible, which is the tree protection zone distance. However the current retaining wall is only 13 feet to the southwest of the tree and 3 feet to the east with a turf area extending beyond the 17 foot drip line to the north and west. The appropriate distances to encompass enough root area would place the tree island into the center of the proposed road to the south, and totally encompass the bicycle lane to the north based on the RRM Design Group sheet 4.1 renderings.

The minimum dimensions of the tree island would be 13 feet to the south, 10 feet to the east, and 24 feet to the north and west. Usually tree wells can encroach closer to the main stem because the trees are at grade level which is then raised around the tree. This is accomplished by placing **drain tile** radially over the root area and course gravel at grade over the existing root system preserving roots underneath the new road or sidewalk. The problem with this Monterey cypress is that it is growing three feet above grade and not below or at road grade level. Creating a smaller tree island requires root cutting and destruction with no new space for roots to grow into, as there would be if it were transplanted in the open. The tree would be containerized and the island would need to be large enough to ensure survival.

The image to the right is taken from sheet 4.1 RRM Design Group August 23, 2012. The black oval is the approximate area required for a tree well (tree island). Image not to scale.



ATTACHMENT 13

Conclusion

The Monterey cypress's age, structure, health, overall condition, and current growing environment are adequate for transplantation and the tree is suitable for transplantation. There is adequate soil volume for encapsulating the rootball and enough space to the northwest to relocate the tree if the other cypress is removed. A proper aftercare program and watering scheme are critical to the survival of the tree once transplanted. Although a tree island is possible, it will take up a significant amount of space extending midway through the new road alignment and encompassing the entire bike lane. It would require some technical specifications and engineering to allow proper drainage and irrigation inside the tree island.

Recommendations

Option 1

Have the larger cypress tree to the northwest evaluated for its suitability for preservation, condition, and safe useful life expectancy.

Perform all necessary exploration such as underground utility locations and root zone excavations to confirm or deny the presence of roots, especially where the current driveway is located. Use air excavation or ground penetrating radar to locate and possibly map the root system.

Transplant the Monterey cypress to a new location that has enough space for the rootball and allows for roots to grow back into new a surrounding landscape

Replant smaller, more suitable trees in the location to the north of the existing tree to help replace the contributions the old tree provided, this is shown on sheet 7.1.

Option 2

Realign the road and bike path to accommodate the tree in its current location. Use the current retaining wall as the south and east boundaries. Incorporate the tree into the design in its existing location.

Bibliography

American National Standards Institute and the Tree Care Industry Association, Inc. *ANSI A300 (Part 6) 2005 Transplanting Tree, Shrub, and other Woody Plant Maintenance - Standard Practices.* Manchester, NH, 2005, Print

Clark, James R., and Nelda P. Matheny. *A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas.* Bedminster, PA: International Society of Arboriculture, 1994. Print.

Fite, Kelby, and Edgar Thomas Smiley. *Managing trees during construction.* Champaign, IL: International Society of Arboriculture, 2008. Print.

ISA. *Guide For Plant Appraisal.* Savoy, IL: International Society Of Arboriculture, 2000. Print.

ISA. *Glossary of Arboricultural Terms.* Champaign: International Society of Arboriculture, 2006. Print.

Matheny, Nelda P. *Trees and development: A technical guide to preservation of trees during land development.* Bedminster, PA: International Society of Arboriculture, 1998. Print.

Peattie, Donald Culross. *A Natural History of Western Trees.* Boston: Houghton Mifflin, 1991. Print.

RRM Design Group Public Right-Of Way and Road Improvement for East Cliff Drive at Twin Lakes Beachfront, August 23, 2012. Design Plans.

Smiley, E. Thomas, Fraedrich, Bruce R., and Hendrickson, Neil. *Tree Risk Management.* 2nd ed. Charlotte, NC: Bartlett Tree Research Laboratories, 2007

Glossary of Terms

Abiotic disorders: Plant malady caused by non-living, environmental, or man-made agents.

Aerial inspections: Assessment of the crown of a tree by climbing within the crown or by the use of an elevating work platform, often to examine a particular defect, e.g. cavity or hollow.

Air Spade®: Device that directs a jet of highly compressed air to excavate soil. Used within the root zone of trees to avoid or minimize damage to the roots, or near underground structures such as pipes and wires to avoid or minimize damage to them.

Backfilled: Soil or amended soil used to fill the hole when planting a tree. Soil common fill, aggregates, or contaminants in various combinations put back into an excavation. May not be hospitable for root growth and function.

Bifenthrin: A pyrethroid insecticide that affects the nervous system of insects.

Biotic disorders: Disorder caused by an infectious living agent.

Canopy: Collective branches and foliage of a tree or group of trees' crowns. Aggregate or collective tree crowns.

Cavities: open or closed hollow within the tree stem, usually associated with decay.

Codominant branches: Forked branches nearly the same size in diameter, arising from a common junction and lacking a normal branch union.

Conifers: Cone bearing tree or other plant that has its seeds in a structure called a cone.

Critical root zone (CRZ): Area of soil around a tree where the majority of roots are located and that provide stability as well as uptake water and minerals. CRZ determination is sometimes based on the drip line or multiple of DBH, but because root growth is often asymmetric due to site conditions, on-site investigation is preferred.

Decay: An area of wood that is undergoing decomposition. Decomposition of organic tissues by fungi or bacteria.

Diameter at breast height (DBH): Measures at 1.4 meters (4.5 feet) above ground in the United States, Australia (arboriculture), New Zealand, and when using the *Guide for Plant Appraisal*, 9th edition; at 1.3 meters (4.3 feet) above ground in Australia (forestry), Canada, the European Union, and in UK forestry; and at 1.5 meters (5 feet) above ground in UK arboriculture.

Drip Line: Imaginary line defined by the branch spread or a single plant or group of plants.

Drain tile: A cylindrical tile with holes in the walls used at the base of a building foundation to carry away groundwater.

ET controllers: Irrigation controllers that operate based on the principle of scheduling irrigation, based on evapotranspiration (ET), which is a function of weather conditions and plant type.

Evapotranspiration: Loss of water by evaporation from the soil surface and transpiration by plants.

Fungal conks: Fruiting body or non fruiting body (sterile) of a fungus. Often associated with decay.

Girdling roots: Root that encircles all or part of the trunk of a tree or other roots and constricts the vascular tissue and inhibits secondary growth and the movement of water and photosynthates.

Ground penetrating radar: a geophysical method that uses radar pulses to image the subsurface. This nondestructive method uses electromagnetic radiation in the microwave band (UHF/VHF frequencies) of the radio spectrum, and detects the reflected signals from subsurface structures. GPR can be used in a variety of media, including rock, soil, ice, fresh water, pavements and structures. It can detect objects, changes in material, and voids and cracks.

Live crown ratio: Ratio of the height of the crown containing live foliage to the overall height of the tree.

Main Stem: Woody structure bearing foliage and buds that give rise to other branches or stems.

Mulch: Material that is spread or sometimes sprayed on the soil surface to reduce weed growth, To retain soil moisture and moderate temperature extremes, to reduce compaction from pedestrian or vehicle traffic or to prevent damage from lawn maintenance equipment, to reduce erosion or soil splattering onto adjacent surfaces, to improve soil quality through its eventual decomposition, and/or to improve aesthetic appearance of the landscape. Mulch can be composed of chipped, ground, or shredded organic material such as bark, wood, or recycled paper; unmodified organic material such as seed hulls; organic fiber blankets or mats; or inorganic material such as plastic sheeting.

Percolation test: Observing how quickly a known volume of water dissipates into the subsoil of a drilled hole of known surface area.

Plant health care: Comprehensive program to manage the health, structure, and appearance of plants in the landscape.

Pyrethrin: Any of a group of insecticidal compounds present in pyrethrum flowers.

Resistance drilling: Drilling into the tree with either a conventional cordless drill or a Resistograph® to help determine the thickness of sound wood.

Response growth: New wood produced in response to loads to compensate for higher strain in marginal fibers; includes reaction wood (compression or tension) and wound wood. A stress response where a tree puts on just enough wood to compensate for stress conditions.

Root Collar: Flared area at the tree trunk base where roots and trunk come together. root flares

Root flares: Transition zone from trunk to roots where the trunk expands into the buttress or structural roots.

Rootball: Soil containing all or a portion of the roots that are moved with a plant when it is planted or transplanted.

Roundball tree transplantation: a process used fro encapsulating the rootball, without boxing, used for large tree transplantation. Similar to balled and bur lapped trees.

Safe useful life expectancy: The safe useful life expectancy rating is a number assigned to the trees that was derived from the visual inspection during the inventory. The rating gives an estimate of the remaining life of the trees and accounts for age, life span of the species, environmental conditions, location, and safety.

Scaffold branches: Permanent or structural branches that for the scaffold architecture or structure of a tree.

Sinker roots: Downward growing roots that provide anchorage and take up water and minerals. Especially useful during periods of drought.

Smart controllers: Irrigation controllers that operate based on the principle of scheduling irrigation, based on evapotranspiration (ET), which is a function of weather conditions and plant type.

Soil analysis: Analysis of the soil to determine pH mineral composition, structure, salinity, and other characteristics.

Soil failure: Soil does not have the strength to keep the root system firmly anchored.

Structural Roots: Large, woody, tree roots that anchor and support the trunk and crown. Roots characterized by secondary thickening and relatively large diameter, giving form to the root system and functioning in anchor and support.

Taper: Change in diameter over the length of trunks, branches, and roots. topping

Tensiometers: An instrument used to measure soil moisture.

Topping: Inappropriate pruning technique to reduce tree size. Cutting back a tree to a predetermined crown limit, often at internodes.

Tree islands: Enclosed planting bed surrounding a tree, often within a paved area or adjacent to a street.

Tree Protection Zone (TPZ): Defined area within which certain activities are prohibited or restricted to prevent or minimize potential injury to designated trees, especially during construction or development.

Tree Risk Assessment: Process of evaluating what unexpected things could happen, how likely it is, and what the likely outcomes are. In tree management, the systematic process to determine the level of risk posed by a tree, tree part, or group of trees.

Tree wells: A wall constructed around a tree to protect the trunk by maintaining the original grade between the trunk and the wall when the grade is raised by filling outside and behind the wall.

Unbalanced crown: Bowed or curved trunks, asymmetric canopy that may or may not be able to support extra weight of snow ice or rain.

Weak sprouts: Upright, epicormic shoot arising from the trunk or branches or a plant above the root graft or soil line. Shoot arising from a latent or adventitious bud (growth point).

Wounds: A type of injury to the tree form mechanical or biological damage.

This Glossary of terms was adapted from the *Glossary of Arboricultural Terms* (ISA, 2011)

Appendix A: Tree Assessment Tables

A1: Site Characteristics

Site Characteristics						
History of Failure	Trunk		Branch		Root/Soil	
Notes	None					
Wind Exposure	Single		Protected			
Wind Direction	Northwest	Precipitation				
Disturbance	Yes		No			
	Clearing		Trenching		Piling	
	Drainage		Groundwater raising		Groundwater lower	
	Infrastructure repair		Construction		Cut	
Notes	3 feet above grade. 3 feet to retaining wall south. Planted in 1989? 13 feet to west retaining wall.					
Restrictions	Roads		Buildings		Impermeable surfaces	
	Curbing	✓	Sidewalk		Container	
Soil	Compacted		Saturated		Eroded	
Soil Type	Clay		Loam		Sand	✓
	Silt		Rock			
Irrigation:	Yes		No			
Water Type:	Potable	✓	Reclaimed		Grey	
Site Character:	Residence	✓	Commercial		Industrial	
	Park		Open Space		Natural	
	Forest/ Woodland		Slope/Hillside			
Landscape Type:	Street	✓	Parkway		Median	
	Turf	✓	Bed/Boarder		Raised Bed	✓
Obstructions:	Lights		Signs		Line-of-sight	
	View		Traffic		Sidewalk	
	Utility		Vegetation		Building	
Area Use:	Lawn		Recreation	✓	Parking	✓
	Traffic	✓	Pedestrian	✓	Building	
Past Treatment:	Pruning	✓	Fertilizing		Spraying	
	Cabling		Other			
Notes	Window cut into crown.					

Checked boxes are observed characteristics and unchecked were not observed.

ATTACHMENT 13

A2: Tree Characteristics

Tree Assessment Field Form

Root Problems				
	Decayed or missing roots		Fungal fruiting structures	Dead or detached bark
	Abnormal root flares or fused buttress roots		Buried root collar	Basal decay
	Stem girdling roots		Wounded roots	Oozing
	Adventitious roots			
Notes	None observed			
Possible indicators of root problems	Crown dieback, thinning, or decline		Soil or root disturbances (trenching, grading, compaction)	Soil mounding or cracking
	Restricted soil space	✓	excessive soil moisture	Soil Erosion
Notes				
Major Defects and Conditions				
	Dead parts			
	Broken or hanging branches			
	Cracks		Shear plane	Inrolled
		Banana		Compression
	Weakly attached branches/ Codominant stems		U Shape	V Shape
		Included bark		Decay
Notes	None observed			
Missing or decayed wood indicators				
Potential indicators of decay				
	Old wounds and stubs			
	Response growth		Swelling	Bulges
		Ridges		
	Cracks and seams			
	Oozing through the bark			
	Dead or loosely attached bark		Abnormal bark pattern	Abnormal bark color
Notes	None observed			

Checked boxes are observed characteristics and unchecked were not observed.

A3: Tree Characteristics Continued

Positive indicators of decay

	Cavity opening	Width	Length
Location:		Depth	
	Nesting holes	Other voids	
	Fungal fruiting structures	Mushrooms	Conks
Fungal identification:			
	Carpenter ants	Termite emergence	

Sapwood decay or damage

	Cankers	Percent of circumference	
	Mechanical injury		
	Animal feeding		
	Sapwood decay	Sum scale	Other

Notes:

Other conditions

	Seams	Ribs	
	Adventitious branches	Water sprouts	Epicormic sprouts
	Multiple branches originating from one point		
	History of branch failure		

Notes:

Unusual Tree Architecture

	Lean	Recent lean	Corrected lean
	Bow	Bow with a crack	Measured Lean Angle
	Unbalanced crown		Direction of Lean
	Live crown ratio:	80.00%	
	Poor taper	Poor taper in branches	Poor stem taper
	Overextended branches	Abrupt bend in branch or stem	

Notes:

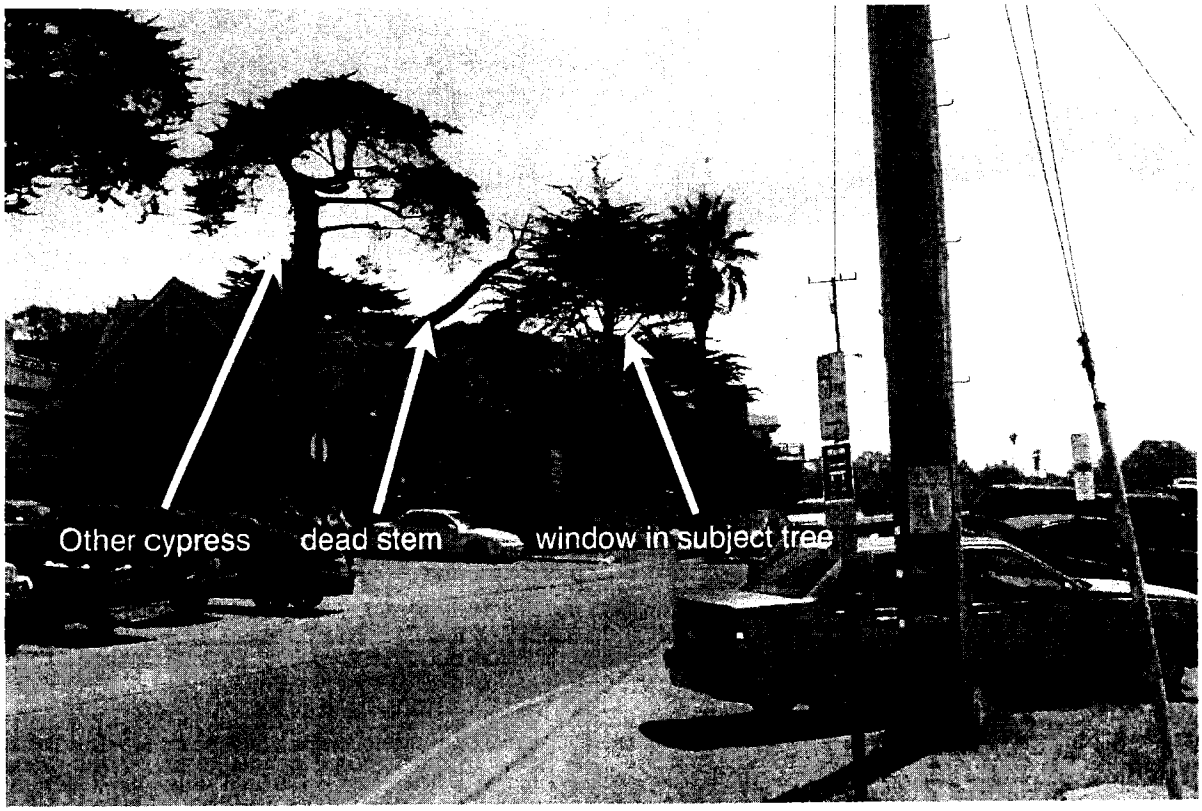
Foliar Health:					
Color	Normal	✓	Chlorotic		Necrotic
Size:	Normal	✓	Small		
Density:	Dense		Normal	✓	Sparse
Insects or Disease Present	Yes		No	✓	
Insect or disease I.D.					
Symptom:	Leaf Spot		Wilting		Yellowing
	Galls		Root Rot		Marginal burns
	Leaf/needle drop		Stunting		Plant dieback
	Leaf mottle		Dead leaf area		Dead plant
Plant Part Affected:	Whole plant		Leaves/needles		Stem
	Roots		Flowers		Fruit
	Bark		Other		
Distribution:	High areas		Low areas		Spread
	Uniform		one side		
Notes:	18 inches of new gro				

Checked boxes are observed characteristics and unchecked were not observed.

ATTACHMENT 13

Appendix B: Additional Photographs

B1: Site from the west



The tree in the foreground is the western most cypress and the tree in the back is the cypress that may be transplanted. Notice the window cut through the upper canopy.

ATTACHMENT 13

B2: Retaining wall on the south side

The photo above is of the driveway and rock retaining wall surrounding the tree. The tree island could use this boundary.

B3: Cypress to evaluate

The photo above is of the tree that should be evaluated for its suitability for retention.

B4: Structural root growing west

The photo above is of the root collar area and the arrow indicates the structural root flare on the west side.

Appendix C: Tree Protection Guidelines

Tree protection locations should be marked before any fencing contractor arrives.

Pre-Construction Meeting with the Project Arborist

Prior to beginning work, all contractors involved with the project should attend a pre construction meeting with the project arborist to review the tree protection guidelines. Access routes, storage areas, and work procedures will be discussed.

Tree Protection Zones and Fencing

Tree protection fencing should be established prior to the arrival of construction equipment or materials on site. Fencing should be comprised of six-foot high chain link fencing mounted on eight-foot tall, 1 7/8-inch diameter galvanized posts, driven 24 inches into the ground and spaced no more than 10 feet apart. Once established, the fencing must remain undisturbed and be maintained throughout the construction process until final inspection.

Monitoring

Any trenching, construction or demolition that is expected to damage or encounter tree roots should be monitored by the project arborist or a qualified ISA Certified Arborist and should be documented.

The site should be evaluated by the project arborist or a qualified ISA Certified Arborist after construction is complete, and any necessary remedial work that needs to be performed should be noted.

Restrictions Within the Tree Protection Zone

No storage of construction materials, debris, or excess soil will be allowed within the Tree Protection Zone. Spoils from the trenching shall not be placed within the tree protection zone either temporarily or permanently. Construction personnel and equipment shall be routed outside the tree protection zones.

Root Pruning

When roots over two inches in diameter are encountered they should be pruned by hand with loppers, handsaw, reciprocating saw, or chain saw rather than left crushed or torn. Roots should be cut beyond sinker roots or outside root branch junctions and be supervised by the project arborist. When completed, exposed roots should be kept moist with burlap or backfilled within one hour.

ATTACHMENT 18
pln056

Boring or Tunneling

Boring machines should be set up outside the drip line or established Tree Protection Zone. Boring may also be performed by digging a trench on both sides of the tree until roots one inch in diameter are encountered and then hand dug or excavated with an Air Spade® or similar air or water excavation tool. Bore holes should be adjacent to the trunk and never go directly under the main stem to avoid oblique (heart) roots. Bore holes should be a minimum of three feet deep.

Timing

If the construction is to occur during the summer months supplemental watering and bark beetle treatments should be applied to help ensure survival during and after construction.

Tree Pruning and Removal Operations

All tree pruning or removals should be performed by a qualified arborist with a C-61/D-49 or C-27 California Contractors License. Tree pruning should be according to ANSI A-300A pruning standards and adhere to ANSI Z133.1 safety standards. Trees that need to be removed or pruned should be identified in the pre-construction walk through.

Tree Protection Signs

All sections of fencing should be clearly marked with signs stating that all areas within the fencing are Tree Protection Zones and that disturbance is prohibited. Text on the signs should be in both English and Spanish (Appendix D).

Appendix D: Tree Protection Signs

D1: English

WARNING

Tree Protection Zone

This Fence Shall not be moved without approval. Only authorized personnel may enter this area!

Project Arborist

ATTACHMENT 18 pln056

D2: Spanish

CUIDADO
Zona De Arbol Pretejido

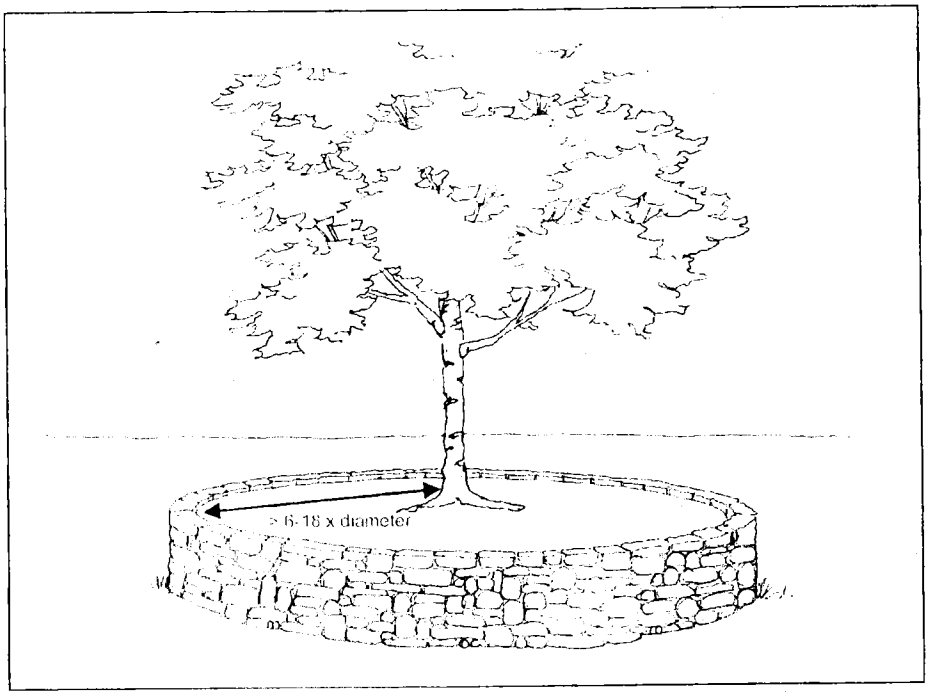
Esta cerca no sera removida sin aprobacion. Solo personal autorizado entrara en esta area!

Project Arborist

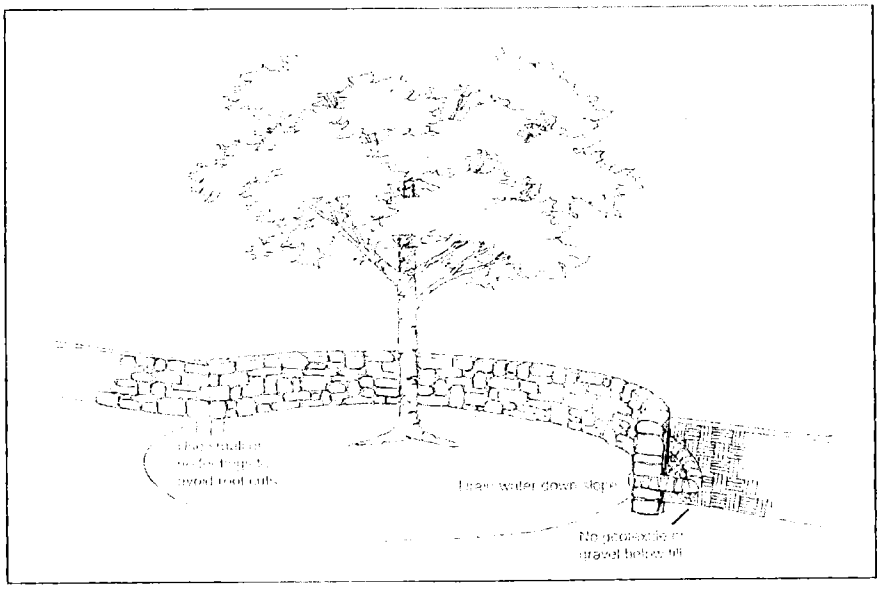
ATTACHMENT

Appendix E: Tree Well and Tree Island Illustrations

Below is an illustration of what a tree island would look like



Below is an illustration of what a tree well would look like



Diagrams courtesy of ISA Best Management Practices: Managing Trees During Construction, 2008.

ATTACHMENT 18 pln056

Qualifications, Assumptions, and Limiting Conditions

Any legal description provided to the consultant is assumed to be correct. Any titles or ownership of properties are assumed to be good and marketable. All property is appraised or evaluated as though free and clear, under responsible ownership and competent management.

All property is presumed to be in conformance with applicable codes, ordinances, statutes, or other regulations.

Care has been taken to obtain information from reliable sources. However, the consultant cannot be responsible for the accuracy of information provided by others.

The consultant shall not be required to give testimony or attend meetings, hearings, conferences, mediations, arbitration, or trials by reason of this report unless subsequent contractual arrangements are made, including payment of an additional fee for such services.

This report and any appraisal value expressed herein represent the opinion of the consultant, and the consultant's fee is not contingent upon the reporting of a specified appraisal value, a stipulated result, or the occurrence of a subsequent event.

Sketches, drawings, and photographs in this report are intended for use as visual aids, are not necessarily to scale, and should not be construed as engineering or architectural reports or surveys. The reproduction of information generated by architects, engineers, or other consultants on any sketches, drawings, or photographs is only for coordination and ease of reference. Inclusion of said information with any drawings or other documents does not constitute a representation as to the sufficiency or accuracy of said information.

Unless otherwise expressed: a) this report covers only examined items and their condition at the time of inspection; and b) the inspection is limited to visual examination of accessible items without dissection, excavation, probing, or coring. There is no warranty or guarantee, expressed or implied, that structural problems or deficiencies of plants or property may not arise in the future.

ATTACHMENT 1

Certification of Performance

I Richard Gessner, Certify:

That I have personally inspected the tree(s) and/or the property referred to in this report, and have stated my findings accurately. The extent of the evaluation and/or appraisal is stated in the attached report and Terms of Assignment;

That I have no current or prospective interest in the vegetation or the property that is the subject of this report, and I have no personal interest or bias with respect to the parties involved;

That the analysis, opinions and conclusions stated herein are my own;

That my analysis, opinions, and conclusions were developed and this report has been prepared according to commonly accepted Arboricultural practices;

That no one provided significant professional assistance to the consultant, except as indicated within the report.

That my compensation is not contingent upon the reporting of a predetermined conclusion that favors the cause of the client or any other party, nor upon the results of the assessment, the attainment of stipulated results, or the occurrence of any other subsequent events;

I further certify that I am a Registered Consulting Arborist® with the American Society of Consulting Arborists, and that I acknowledge, accept and adhere to the ASCA Standards of Professional Practice. I am an International Society of Arboriculture Board Certified Master Arborist® and a Certified Tree Risk Assessor. I have been involved with the practice of Arboriculture and the care and study of trees since 1998.

Richard J. Gessner

ASCA Registered Consulting Arborist® #496
ISA Board Certified Master Arborist® WE-4341B
ISA - PNW Certified Tree Risk Assessor #904

Copyright

© Copyright 2012, Monarch Consulting Arborists LLC. Other than specific exception granted for copies made by the client for the express uses stated in this report, no parts of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, recording, or otherwise without the express, written permission of the author.

Environmental Design, Inc. – The Tree Transplant Experts

SENT BY E-MAIL

Sheryl Bailey, Project Manager □*Parks Division of the Department of Public Works* □*Simpkins Swim Center* □*979 17th Ave.* □*Santa Cruz, CA 95062* □*831-454-7963* □*prc027@co.santa-cruz.ca.us*

Vanir Construction Management, Inc. (Domenic Zigant) 2033 Gateway Place, #500 San Jose, CA 95110

Dear Sirs and Madames,

Environmental Design appreciates the opportunity to provide Santa Cruz County and its Construction Management team with a proposal for tree transplanting at the proposed project. At Environmental Design, we are proud to offer what we feel is the most comprehensive tree solutions service offering available in the green industry today. We have participated in the development of some of the world's most distinctive landscapes through the transplanting and supply of specimen trees. Environmental Design was founded in 1977 and has

become the premier large tree company in the world. The company has led the drive to apply technology to tree transplanting through a stunning list of achievements:

Designed and patented the world's largest on-site hydraulic tree spade

Designed and patented the world's largest highway legal tree spade

Developed and perfected the round ball tree transplanting technique used for giant tree transplanting

Developed and perfected the Gantry Lift System for giant tree transplanting Transplanted the largest tree ever moved

Our unique, comprehensive solutions portfolio consists of:

Environmental Design, Inc. – The Tree Transplant Experts

☐ **Tree Preservation**

☐ **Large to Giant Tree Transplant**

☐ **Procurement & Delivery Management**

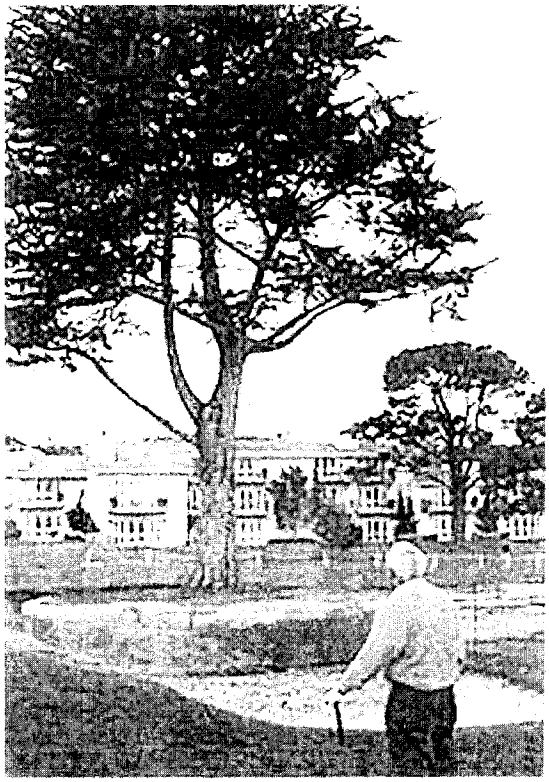
☐ **Custom Growing & Maintenance**

- **Native Tree Procurement & Collection**
- **International Specimen Tree Supply**
- **Installation & Maintenance Services**
- **Custom Tree Farm Design & Implementation**
- **Consulting Services** (The intent of the proposed and recommended service offering is to assume all Quality Control responsibilities related to having the highest quality transplanting service available your project. This often involves tailoring a solution specific to a given project situation and conditions. Our commitment to the client is to provide the transplanting service as specified by the project's design team. We have years of quality experience in providing this type of service. I have listed a few of our most recent projects involving this service offering below with direct references available upon request:

- (**9/11 Memorial**, New York, NY**City**
- **Garden**, St. Louis, MO
- **AT&T Performing Arts Center**, Dallas, TX
- **Flight 93 Memorial**, Shanksville, PA
- **Downtown Jebel Ali**, Dubai, UAE
- **Stanford University,** Palo Alto, CA (Specific to this project I have listed a sampling of over hundreds of projects completed that involved the transplanting of Monterey cypress trees.
- **Peeble Beach Company**
- **Cypress Point Golf Club** (

- **Monterey Peninsula Golf Club**
- **Tehama**
- **Carmel Development Company**
- **Presidio, GSA**

Monterey Cypress being planted at Peeble Beech Country Club's 18th green in 2002



Environmental Design, Inc. – The Tree Transplant Experts

132" Box Tree

Project Scope: Provide Transplanting Service to move one 24" Monterey Cypress on site

☐Supply labor, materials and equipment to transplant candidate tree utilizing the highest arboricultural standards and techniques.

☐Provide and install an automatic irrigation/drainage system specific to candidate tree.

☐Install mulch, site inspection tubes and tree rings for supplemental hydration.

☐Install stabilization cables during root establishment.

☐Supply written specifications for monitoring and maintenance procedures. (

Project Cost- 98,104.00 Lump Sum

☐All pricing is based on assumptions outlined below.

□Pricing includes mobilization and crane sets.

□Pricing is based upon labor rate to include Union participation, Davis-Bacon prevailing (wage requirements or other mandated Federal, State, County, or City requirement is included in base rate. (

□**Notes**

□ **Estimated 660 labor hours and 80 supervisory hours**

□**Crane labor and trucking will be sub-contracted to a union shop**

1. Price does not include aftercare or maintenance. This can be provided, under a separate proposal.
2. Price assumes EDI will provide a 200-ton crane or equivalent, for lifting and setting of □the proposed tree.
3. Price assumes planting location will be on a congruent site.
4. Price assumes this project is **not** a prevailing wage or union mandated project.
5. Price assumes EDI's work will not be interrupted or discontinued by litigation, protest, □or injunction.
6. Sales tax if applicable is additional.

Sincerely,

David B. Cox Vice President Environmental Design, Inc.
davidcox@treemover.com

281-376-4260 Phone 281-850-7365 cell 281-376-8953 Fax

_____ Approved

_____ Date

Environmental Design, Inc. – The Tree Transplant Experts

Please let me know if you have any questions and/or concerns. If the above is acceptable please sign below and return.

Environmental Design, Inc. – The Tree Transplant Experts

SENT BY E-MAIL

Sheryl Bailey, Project Manager □*Parks Division of the Department of Public Works* □*Simpkins Swim Center* □*979 17th Ave.* □*Santa Cruz, CA 95062* □*831-454-7963* □*prc027@co.santa-cruz.ca.us*

Vanir Construction Management, Inc. (Domenic Zigant) 2033 Gateway Place, #500 San Jose, CA 95110

Dear Sirs and Madames,

Environmental Design appreciates the opportunity to provide Santa Cruz County and its Construction Management team with a proposal for tree supply and planting at the proposed project. Below is a pricing structure for your discernment should the County elect to purchase Monterey cypress trees from an off site souce. All pricing includes delivery and installation with a one year warranty on the plant material.

48" Boxed Monterey Cypress 16-18' height 8' spread 9600.00

ATTACHMENT 14

60" Boxed Monterey Cypress 22-24' height 10-12' spread 14,400.00

84" Boxed Monterey Cypress 28-32' height 14-16' spread 27,500.00

96" Boxed Monterey Cypress 34-36' height 18-20' spread 36,000.00

Sincerely,

David B. Cox

Vice President Environmental Design, Inc.

davidcox@treemover.com

281-376-4260 Phone 281-850-7365 cell 281-376-8953 Fax

_____ Approved

_____ Date

Environmental Design, Inc. – The Tree Transplant Experts

Please let me know if you have any questions and/or concerns. If the above is acceptable please sign below and return.

COUNTY OF SANTA CRUZ

PLANNING DEPARTMENT

701 OCEAN STREET, 4TH FLOOR, SANTA CRUZ, CA 95060
(831) 454-2580 FAX: (831) 454-2131 TDD: (831) 454-2123
KATHLEEN MOLLOY PREVISICH, PLANNING DIRECTOR

Sheryl Bailey
701 Ocean Street, 4th Floor
Santa Cruz, CA 95060

September 16, 2011

Re: Application: REV111053

Dear Ms. Bailey:

The review of your biotic assessment, authored by Johns Gilchrist and Brian Mori, dated January 29, 2010, has been completed and the report has been accepted.

The proposal is for beachfront improvements to East Cliff Drive, between 5th and 9th Avenues, to provide an adequate bikeway and safe pedestrian path, with formalized parking and landscaping.

The biotic assessment identifies potential impacts to nesting birds, and recommends preconstruction surveys and buffer zones should active nest be present in the work area.

If the development proceeds as proposed and the recommendations put forth in the above-cited report, as described below, are implemented, we find this project will have no significant biological impacts.

Conditions for nesting birds:

Construction shall be timed, as much as feasible, to avoid the bird nesting season (March 1 to September 1). If construction must take place during the nesting season, pre-construction surveys shall be conducted for nesting birds at least two weeks before but not more than four weeks before construction begins. The survey area shall include the disturbance area plus up to 250 feet where nesting habitat for cormorants or raptors is present.

If active nests or nesting behavior is observed, a 60-foot buffer around songbird nests and a minimum 250-foot buffer around cormorant or raptor nests shall be established. No construction shall take place within a buffer until such time as the nests are no longer active. During construction activities a biological monitor shall record the behavior of nesting birds and shall have the authority to increase the buffer as needed.

Please call me if you have any questions about this letter. A copy will also be sent to the project

planner so that the conditions can be properly incorporated into any future permit.

Sincerely,

Matthew Johnston
Environmental Coordinator

CC: Antonella Gentile, Resource Planner
Sheila McDaniel, Project Planner

ATTACHMENT 15

BIOTIC ASSESSMENT

TWIN LAKES BEACHFRONT PROJECT
EAST CLIFF DRIVE, 5TH TO 9TH AVENUES
SANTA CRUZ COUNTY, CALIFORNIA

Prepared for:

James Davies
County of Santa Cruz
Redevelopment Agency

Prepared by:

John Gilchrist and Bryan Mori
John Gilchrist & Associates

January 29, 2010

ATTACHMENT 16

BIOTIC ASSESSMENT
TWIN LAKES BEACHFRONT PROJECT

TABLE OF CONTENTS

SUMMARY 1

INTRODUCTION & PROJECT PURPOSE 2
STUDY OBJECTIVE 2
SCOPE OF WORK 2

PROJECT DESCRIPTION 2
BACKGROUND 2
PROJECT IMPROVEMENTS 4
Bicycle and Pedestrian Improvements 4
Parking and Circulation 4
Coastal Protection 4
Landscaping 6
Site Preparation 6
Project Construction 6
Revegetation and Erosion Control 6
BMP's for Spills and Protection of Existing Vegetation 6

METHODS 7
VEGETATION 7
WILDLIFE 8
Nesting Birds Survey 8

EXISTING CONDITIONS 8
ENVIRONMENTAL SETTING 8
VEGETATION COMMUNITIES 9
Ruderal 9
Eucalyptus 9
Annual Grassland 9
PLANT SPECIES 11
SENSITIVE PLANT HABITAT AND SPECIES 11
WILDLIFE HABITATS 13
Beach 13
Eucalyptus 14
Ice Plant and Non-Native Grassland 14
SPECIAL STATUS WILDLIFE SPECIES 14
BIRD SPECIES PRTECTED BY THE BIRD TREATY ACT (MBTA) 16
Double-crested Cormorant 16

ATTACHMENT 1 (

pln05(

Other Nesting Birds 16

IMPACTS and MITIGATION 17
VEGETATION 17
WILDLIFE 17

REFERENCES 19

FIGURES

Figure 1. Topographic Location Map
Figure 2. Project Site Plan
Figure 3. Vegetation Map

TABLES

Table 1. Special Status Plants with Potential to Occur at Study Site
Table 2. Special Status Wildlife Known or Potentially Occurring in the Project Vicinity

APPENDICIES

Appendix A. Plant Species List – Twin Lakes Beachfront Project
Appendix B. Wildlife Species List

BIOTIC ASSESSMENT
TWIN LAKES BEACHFRONT PROJECT

SUMMARY

The County of Santa Cruz Redevelopment Agency is planning a series of beachfront improvements along East Cliff Drive. The proposed project extends from the intersection of East Cliff Drive and Fifth Avenue to the Schwan Lake outlet to near Ninth Avenue. East Cliff Drive is a heavily used corridor with narrow or no bike lanes and without a safe pedestrian walkway through most of its length in this area. Beach parking is informal and somewhat haphazard exposing bicyclists, pedestrians and motorists to hazards. The purpose of the proposed project is to provide an adequate bikeway and safe pedestrian path, with designated parking and landscaping. The path will also serve to provide an essential link in the continuation of the California Coastal Trail system and a local segment of the Monterey Bay National Marine Sanctuary Trail.

The project will remove existing ruderal vegetation adjacent to the roadway which is not considered a significant biologic impact. Elimination of invasive exotic plants is seen as a benefit from the project. Although bird nesting was not noted in the larger eucalyptus trees, nesting is prevalent around nearby Schwan Lake and could occur in the project area. Therefore construction could adversely affect nesting of native upland bird species. Mitigation has been proposed to minimize this impact. If construction cannot be done outside the nesting season, pre-construction surveys and buffer zones around nest sites are recommended until nesting has terminated. No sensitive plant or animal species will be affected by the project. With mitigation, all potentially significant biologic impacts can be reduced to insignificant levels.

ATTACHMENT 16
p1n056

INTRODUCTION and PROJECT PURPOSE

The County of Santa Cruz Redevelopment Agency (RDA) is proposing to construct beach access and roadway improvements on East Cliff Drive, from 5th Avenue to 9th Avenue in unincorporated Live Oak (See Project Location, Figure 1). This is Phase 3 of a series of projects between Eaton and Lake Aves. and 12th Avenue east of Schwan Lake. The Phase 1 improvements to Lake and 5th Avenues between Eaton and East Cliff have been constructed. A second Phase 2 RDA project (Schwan Lake, 9th to 12 Avenue) will connect this proposed 5th to 9th Avenue segment, around Schwan Lake, to Live Oak neighborhoods to the east. The proposed Twin Lakes Beachfront Improvement Project will involve reconstruction of East Cliff Dr. with related transportation, parking and access improvements on both sides of East Cliff Dr. East Cliff Drive is a scenic east-west alternative to Brommer Street and Capitola Road, and is heavily used by vehicles, bicyclists, and pedestrians. In the project area it provides access to the Santa Cruz Yacht Harbor and harbor businesses. Informal parking on the road also provides public access to Twin Lakes State Beach. The main purpose of the project is to provide a safe and continuous pedestrian pathway and bicycle lanes separated from vehicles that will connect residents living in the adjacent neighborhoods to the beach and harbor areas. It will also serve to provide better public access to a heavily used state beach, and become an essential link in the continuation of the California Coastal Trail system and a local segment of the Monterey Bay National Marine Sanctuary Trail.

SCOPE OF WORK

The scope of work for the present study includes an assessment of existing vegetation and wildlife resources and a determination of target sensitive species and natural communities. The work scope included a review of the botanical and wildlife literature and databases, and field surveys of existing conditions on the study site. An assessment of potential impacts was made from review of biologic resources, and available project construction and operation information. Recommendations to minimize adverse impacts are also included in this report.

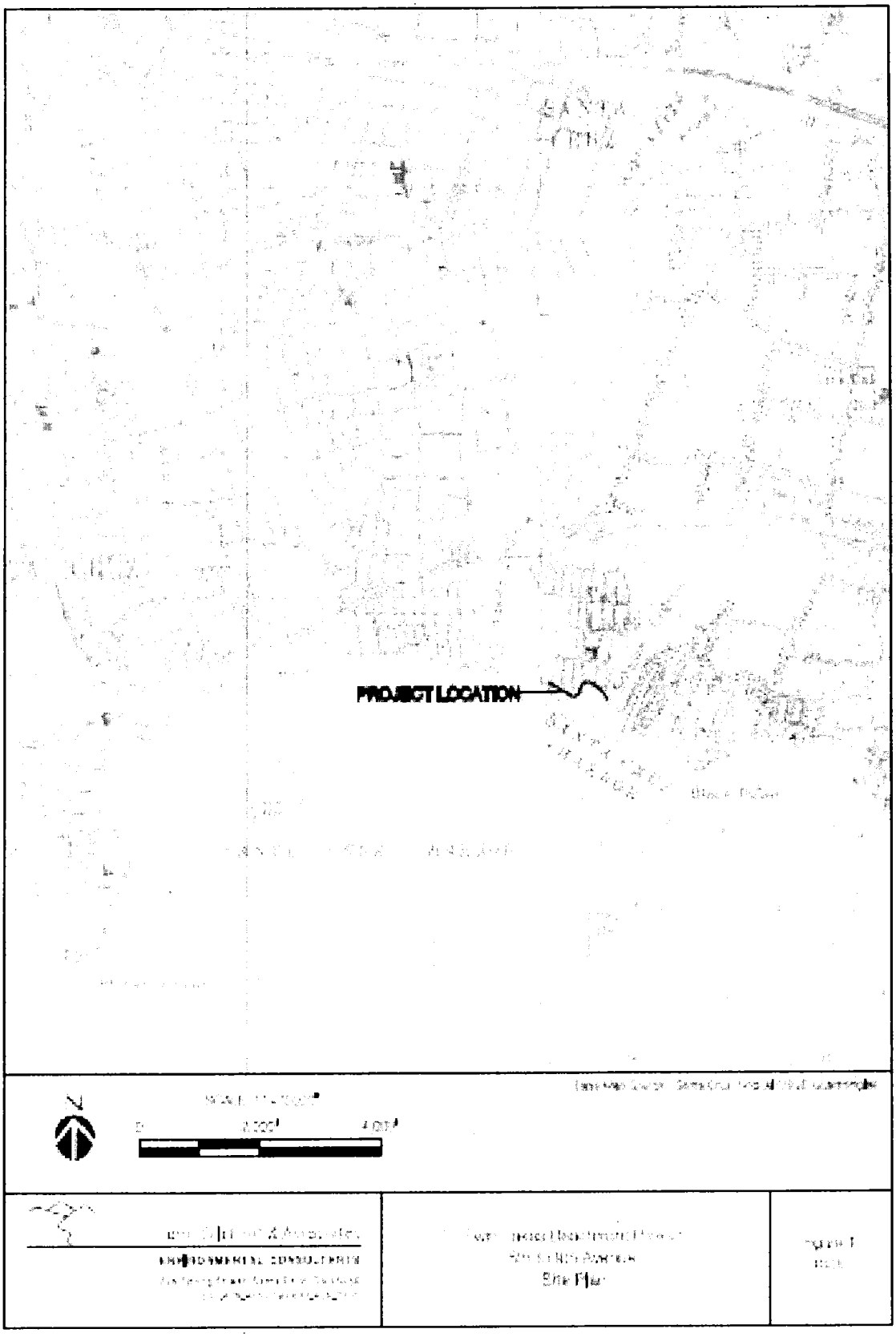
PROJECT DESCRIPTION

BACKGROUND

East Cliff Drive between 5th and 9th Avenues provides access to the Santa Cruz Yacht Harbor, nearby residential properties, and is an east-west thoroughfare to Live Oak. The street also provides informal parking to Twin Lakes State Beach and is extensively used by pedestrians and bicyclists, but currently lacks parking, pedestrian and bicycle lane improvements. These conditions result in a variety of pedestrian, bicycle and vehicle issues and conflicts. These conditions also interfere with the public's aesthetic enjoyment of scenic qualities of the beach, harbor and Monterey Bay.

PROJECT IMPROVEMENTS

The project design (RDA 2008) for the East Cliff Drive, 5th to 9th Avenue Improvements, provide for continuous pedestrian access separated from bicycle lanes and vehicles. Beach parking and landscape improvements are also part of the proposed project. The proposed project footprint lies entirely within the County's East Cliff Drive right-of-way or State Parks' Twin Lakes Beach property.



pln056

Bicycle and Pedestrian Improvements

The proposed project includes construction of a new, continuous 6 to 10 foot wide pedestrian pathway along the south (beach) side of East Cliff Dr. from 5th Avenue to the Schwan outflow weir east of 9th Avenue (See Figure 2). In addition, a new infill sidewalk will be constructed on the inland side between 7th and 8th Avenues, and an informal path will connect 6th to Assembly Ave on the inland side. Crosswalks on E. Cliff Dr. will be added or upgraded at strategic locations for pedestrian safety. The beach side pathway will be constructed with resin stabilized decomposed granite, similar to the existing path on Lake and 5th Avenues, and the proposed path around Schwan Lake.

The concept plan also provides for continuous 5 foot wide bike lane on both sides of East Cliff Drive. The inland bike path will connect with the proposed Schwan Lake bike-pedestrian path to provide a continuous east-west corridor. Accessible access ramps and stairways will be constructed in key locations to provide access from East Cliff Dr. to the beach.

Parking and Circulation

The concept plan proposes diagonal parking spaces between 5th and 6th Avenues on the inland side, and between 5th and Assembly and 8th and 9th Avenues on the beach side (Figure 2). Parallel parking would be allowed around a modified 9th Avenue circle, and motorcycle parking provided near Assembly. Approximately 60 parking spaces are proposed in a clustered arrangement to facilitate views to the beach and Bay. Vehicle circulation, especially for large vehicles, will be improved by enlarging the diameter of the traffic circle at the end of 5th Avenue, changing the 7th Avenue curve radius to the west (towards the beach), and realigning East Cliff north of its existing location to facilitate beach parking. Passenger pullout areas will also be provided on East Cliff at 5th and 8th Avenues to facilitate safe loading and unloading.

Coastal Protection

Significant winter storm events cause erosion of the coastal bluff along East Cliff and could damage existing and future public improvements. Conceptual recommendations for coastal protection include (Figure 2):

- A simulated rock concrete retaining wall between 5th Avenue and the curve leading to 7th Avenue. This wall would extend down to Purisima bedrock and be backfilled with sand from Harbor dredging. If would not be visible most of the year.

- Between the 7th Ave. curve to the State Park restroom, a stepped concrete retaining wall will fill in the ~10 grade change and protect the bluff slope. The wall will be partially backfilled with sand and revegetated with native plants.

- Short retaining walls with drilled piers supporting pedestrian improvements are planned between the 7th Ave. intersection and Schwan Lake culvert outlet. Existing rip-rap would be retained.

The planned retaining wall improvements will undergo further study and technical analysis and therefore may be modified somewhat as the design process moves forward. Water quality and storm drainage enhancements, and overhead utility undergrounding are also contemplated as part of the project, and will also receive further study.

ATTACHMENT I C

pln056

Landscaping

Landscaping improvements are planned at various locations on the inland and beach side of East Cliff Drive (Figure 2). Existing large (specimen) eucalyptus and cypress trees will be protected and incorporated into the final landscape plan.

Site Preparation

Some clearing and grubbing will be required for understory vegetation along the project alignment. Care will be taken to protect large cypress and eucalyptus trees. There will also be some disturbance to ornamental vegetation within the right-of-way on the inland side of East Cliff Drive. The East Cliff Drive roadway will be prepared by cutting and demolishing portions that will not be part of the future roadway. Bluff areas that receive shoreline protection will be recontoured as needed.

Project Construction

Standard equipment would be used during construction, and would likely include an excavator, small bulldozer and material supply trucks. Portions of East Cliff Drive may have traffic restrictions during construction, and at times, East Cliff between 5th and 7th Avenues may be converted to a one-way street.). A traffic plan will be developed by the contractor or Project Engineer and be approved by the Department of Public of Public Works Traffic Engineer.

Construction staging would occur on the state-owned Twin Lakes Beach between the restrooms and East Cliff Dr. and/or on a privately-owned vacant lot near E. Cliff Dr. and Ninth Ave. (with property-owner permission).

The project is estimated to require about 9 months to complete and is planned to begin in 2012 and be completed during 2013. Project construction will occur during typical weekday hours (8AM to 5:00 PM

Revegetation and Erosion Control

At completion of construction, disturbed soil areas shall be cleared of any construction materials or debris, restored to final grades, and non-beach areas replanted with native or appropriate landscape vegetation. A detailed landscape plan will be prepared indicating species, planting locations and installation techniques. Revegetation will be conducted according to approved project landscape plans. In areas subject to erosion specific erosion control measures will be included as part of those plans.

BMP's for Spills and Protection of Existing Vegetation

Trees which are adjacent to the construction area will need to be protected with flagging and fencing prior to the start of construction. A certified Arborist should develop appropriate tree protection measures and be present on the site at critical times during the construction to ensure compliance with any required measures.

All appropriate measures shall be taken to avoid spillage of excavated or construction material into the beach and into the beach lagoon. A water pollution control plan will be required in the

construction contract specifications for the project. Such measures may include but not be limited to:

- Develop spill contingency plans.
- Have the Environmental Section of the County Planning Department review and approve all spill contingency plans.
- Document that all construction employees have undergone appropriate spill contingency training.
- DPW Project Engineer will confirm that all appropriate spill and safety materials and equipment such as containment devices, absorbent pads, vacuums etc. are stockpiled by the Contractor and are immediately accessible for the construction site.

METHODS

VEGETATION

John Gilchrist conducted the vegetation assessment. Vegetation study methods included a review of available botanical literature and databases, followed by two field surveys of existing conditions at the project site. The initial step was to identify species and/or natural communities of concern that might be present on the study site. Sensitive elements were identified from the California Department of Fish and Game's (CDFG's) California Natural Diversity Data Base (CNDDB) records (CNDDB 2009a), the California Native Plant Society's (CNPS's) Inventory of Rare and Endangered Vascular Plants of California (Tibor 2001), and An Annotated Checklist of the Vascular Plants of Santa Cruz County, California (Morgan, Broadman, Hillman, Holloran, Hyland, and Neubauer 2005). Species of concern include those listed as rare, threatened, or endangered by the CDFG or the USFWS and those included on CNPS List 1A (Plants Presumed Extinct in California), List 1B (Plants Rare, Threatened, or Endangered in California and Elsewhere), List 2 (Plants Rare, Threatened, or Endangered in California But More Common Elsewhere), List 3 (Plants About Which We Need More Information – A Review List), and List 4 (Plants of Limited Distribution – A Watch List). Plants on Lists 3 and 4 are of lower sensitivity and may not warrant full consideration as protected species depending on their particular population condition. Sensitive species also include locally rare species that may qualify for CEQA consideration on a local level (Morgan *et al.* 2005). Special-status natural communities are those that are identified as sensitive habitats by Santa Cruz County or determined to be rare and worthy of consideration by the CNDDB (2003, 2006a). Coastal strand and wetlands as well as habitats for rare and endangered species are among those included.

The list of sensitive species and communities with the potential to occur on the study site is shown on Table 1. The individual species have low potential of occurrence, primarily due to the highly disturbed nature of the study site, and predominant presence of non-native species.

The study area was visited twice in 2009. 2009 surveys were conducted on June 23 and August 26. Although the surveys did not encompass the entire (spring) flowering season, the timing was appropriate to identify target species and communities with potential to occur in the study area.

The full length of the proposed beach improvements was traversed on foot. All plant species encountered were identified to the lowest taxonomic level possible and at minimum to the lowest taxonomic level required to assess sensitive status. Taxonomy followed *The Jepson Manual,*

ATTACHMENT 6
p1n056

Higher Plants of California (Hickman 1993) and *An Annotated Checklist of the Vascular Plants of Santa Cruz County. California* (Morgan *et al.* 2005). Vegetation types were described and classified according to the conventions of the CNDDB (2003) and Sawyer and Keeler-Wolf (1995).

WILDLIFE

Bryan Mori, wildlife biologist, conducted the wildlife investigation. Reconnaissance-level surveys of the project alignment were conducted on June 18 and July 21, 2009. The alignment was walked, using the Redevelopment Agency Twin Lakes Beachfront site map, dated 7/28/08 as a reference. General habitat conditions and wildlife species observed were recorded in a field notebook. A list of all observed wildlife species in the project vicinity is presented in Appendix B.

In addition to the field survey, the California Department of Fish & Game's (CDFG) Natural Diversity Data Base Rare Find 3 (CNDDB) was accessed for recorded occurrences of special-status wildlife species in the project area (CDFG 2009). The USGS 7.5 minute Santa Cruz quadrangle was reviewed for the CNDDB search. Also, relevant reports were reviewed and local biologists consulted for information on special-status species occurrences in the project area.

Nesting Birds Survey

Because bird nesting was identified as a key issue on the Schwan Lake segment of the project (Phase 2 project), focused bird nesting surveys were conducted on June 18 and July 21, 2009 for the beachfront improvement project. The survey start times ranged from early to mid-morning, with surveys generally lasting for one hour. The project alignment was slowly walked, large trees on the alignment surveyed, and all birds seen and heard were recorded onto the site map. A 10 x 40 power pair of binoculars was used to aid in species identification.

EXISTING CONDITIONS

ENVIRONMENTAL SETTING

The project alignment follows East Cliff Drive and the margin of Twin Lakes State Beach between 5th Avenue to 9th Avenue. 5th Avenue is the entrance to lower east side of the Santa Cruz Yacht Harbor, and 9th Avenue is adjacent to the southwestern margin of Schwan Lagoon (known locally as Schwan Lake) (Figures 1& 2). The project site is within either the East Cliff Drive right-of-way or the Twin Lake Beach State Parks property. High density residential development borders the northern margin of the project site and is found in the Twin Lakes neighborhood further north. Other land uses in the project vicinity include the Santa Cruz Yacht Harbor, lower yacht harbor commercial enterprises, and commercial/retail outlets on Lake Street and 7thAvenue.

The site vicinity supports a mosaic of plant communities within the urban matrix, including patches of annual grassland, eucalyptus and cypress trees, iceplant, and urban landscaping. A willow riparian community is present east of 9th Ave. along the southeast edge of Schwan Lake. East Cliff Drive is a 2-lane thoroughfare which supports significant traffic, especially east of 7th Avenue.

VEGETATION COMMUNITIES

Several plant communities were identified in the study area (Figure 3). Most areas contained non-native vegetation which included isolated patches of annual grassland, a ruderal iceplant community, and eucalyptus forest near the restrooms. Ornamental landscaping is found in the East Cliff right-of-way adjacent to residences north and west of East Cliff Dr. Most of the plant species in the beachside plant communities are tolerant of human trampling and seasonal disturbance from ocean wave run up and salt spray. Plant species are largely absent on the beach between 5th and Assembly Aves. due to the eroding bluff line, more intense human use, winter storm surf and movement of beach sands during Harbor dredging.

Ruderal

The disturbed areas immediately adjacent to the roadway support ruderal, weedy vegetation. Ruderal vegetation occurs as a result of ground disturbance, or in some areas intentional planting of a non-native species, and is characterized by a dense cover of invasive annual grasses and herbs. Some native species occasionally manage to survive but exotic species dominate. The dominant species in the ruderal community within the study areas is iceplant (*Carpobrotus edulis*). Iceplant covers the upper beach bankslope between Assembly Avenue to the bankslope east of 7th Avenue, including an area around the existing restrooms. Included within the iceplant is naked lady (*Amaryllis belladonna*), slender wild oat (*Avena barbata*), bull mallow (*Malva nicaeensis)* and wild radish (*Raphanus sativus*). At Ninth Avenue near Schwan Lake, the native coastal coyote brush shrub (*Baccharis pilularis*) grows among the weeds. Several arroyo willows (*Salix lasiolepis)* are also found in this area close to the lake, but outside the project area.

Eucalyptus Forest

A narrow forest of non-native blue-gum eucalyptus (*Eucalyptus globulus*) extends from an area just west of the restrooms to 9th Avenue. This community consists of six mature eucalyptus trees on the beachside of East Cliff Drive. The eucalyptus forest is not continuous, and the community does not appear to be spreading in this area as very few seedlings or eucalyptus sprouts were noted. As is typical for eucalyptus forests, understory shrubs and groundcover are sparse, with iceplant, non-native annual grasses and poison oak (*Toxidendron diversilobum*) comprising most of the understory in the study area. This vegetation type corresponds to the Eucalyptus Series of Sawyer and Keeler-Wolf (1995); Holland (CNDDB 2006b) does not describe this community.

Annual Grassland

The areas mapped as annual grassland are classified within the California annual grassland series (Sawyer and Keeler-Wolf 1995). This community is largely non-native and is not a sensitive vegetation type. While some of the species are also found in the ruderal areas, the community has a preponderance of non-native grasses and to a lesser extent, native taxa. In the project area isolated grassland is surrounded by large expanses of open ground (sand and coastal bluff). Dominant taxa include exotic annual grasses such as ripgut (*Bromus diandrus*), Bermuda grass (*Cynodon dactylon*), slender wild oat, farmer's foxtail (*Hordeum murinum* ssp. *leporinum*). Beach bursage or beach bur (*Ambrosia chamissonis*), poison oak, wild radish, mallow and Italian thistle (*Carduus* sp.) are also found in this community. Only poison oak is native.

LEGEND
Twin Lakes Beachfront Project - 5th to 9th Avenue
Vegetation Map
John Gallegos & Associates
ENVIRONMENTAL CONSULTANTS

PLANT SPECIES

As expected for this heavily used roadside environment, vegetation near the beach is comprised primarily of non-native ruderal and non-native forest components. Areas fronting the road adjacent the residences have non-native landscape species including several cypress trees (*Cupressus macrocarpa*) and a fan palm.

The field surveys yielded a total of 32 taxa, representing 17 plant families (Appendix A). The majority of the taxa are non-native, with some considered to be invasive and only 6 taxa are native to Santa Cruz County. The non-natives are primarily weedy, opportunistic species commonly found in disturbed coastal habitats. Native taxa included common coastal upland species such as coyote brush and poison oak.

A few garden escapes grow along the proposed project area. Naked ladies (*Amaryllis belladonna*) grow in and around the iceplant (*Carpobrotus edulis*), and the iceplant itself may have been a garden escape or intentionally planted for beach bluff erosion control.

A number of exotic plant species were found in the study area (Appendix A). Some of these species are characterized as invasive due to their high rate of spread, naturalized abundance in native habitats, and competitive or direct damage to native species.

SENSITIVE PLANT HABITATS AND SPECIES

No sensitive plant habitats were found within the study area. Historically, prior to the intense public use of Twin Lakes Beach, a native coastal strand community may have existed in this area. However, no native coastal strand species were found. All species encountered were assessed for rarity. No rare, threatened, or endangered species were found on the study site, nor would most on the list below (Table 1) be expected.

ATTACHMENT 1 6

p1n05

Table 1. Special-Status Plants with Potential to Occur at Study Site

SENSITIVE SPECIES				
SCIENTIFIC NAME	**COMMON NAME**	**USFWS***	**State****	**CNPS*****
Arabis blepharophylla	Coast rock cress	None	None	4.3
Arenaria paludicola	Marsh sandwort	E	E	1B.1
Campanula californica	Swamp harebell	None	None	1B.2
Carex comosa	Bristly sedge	None	None	2.1
Carex saliniformis	Deceiving sedge	None	None	1B.2
Chorizanthe pungens var. *pungens*	Monterey spineflower	T	None	1B.2
Chorizanthe robusta var. *rob.*	Robust spineflower	E	None	1B.1
Collinsia multicolor	San Francisco collinsia	None	None	1B.2
Cordylanthus rigidus ssp. *littoralis*	Seaside birds'-beak	None	E	1B.1
Erysimum ammophilum	Coast wallflower	None	None	1B.2
Grindelia hirsutula var. *maritima*	San Francisco gumplant	None	None	1B.2
Horkelia cuneata ssp. *sericea*	Kellogg's horkelia	None	None	1B.1
Horkelia marinensis	Pt. Reyes horkelia	None	None	1B.2
Leptosiphons grandiflorus	Large-flowered linanthus	None	None	4.2
Lomatium parvifolium	Small-leaved lomatium	None	None	4.2
Microseris amphibolus	Mt. Diablo cottonweed	None	None	3.2
Microseris paludosa	Marsh microseris	None	None	1B.2
Pentachaeta bellidiflora	White-rayed pentachaeta	E	E	1B.1
Piperia michaelii	Michael's rein orchid	None	None	4.2
Plagiobothrys chorisianus var. *chorisianus*	Choris's popcorn-flower	None	None	1B.2
Plagiobothrys chorisianus var. *hickmanii*	Hickman's popcorn-flower	None	None	4.2
Sidalcea malachroides	Maple-leaved checkerbloom	None	None	4.2
Silene verecunda ssp. *verecunda*	San Francisco campion	None	None	1B.2
Stebbinsoseris decipiens	Santa Cruz microseris	None	None	1B.2
Trifolium depauperatum var. hydrophilum	Saline clover	None	None	1B.2

ATTACHMENT 16

*US Fish and Wildlife Service Listing Status: E=endangered, T=threatened (USFWS 2006).
**CA Dept. of Fish and Game Listing Status: E=endangered, T=threatened (CNDDB 2006a) and Nature Conservancy Heritage Program Status Ranks for natural communities: G2 = 6-20 viable occurrences worldwide and/or 2,000-10,000 acres, G3 = 21-100 viable occurrences worldwide and/or 10,000-50,000 acres, S2 = 6-20 viable occurrences statewide and/or 2,000-10,000 acres, S3 = 21-100 viable occurrences statewide and/or 10,000-50,000 acres, 0.1 = very threatened, 2 = threatened, 0.3 = no current threats known (Sawyer and Keeler-Wolf 1995)
***California Native Plant Society Status: 1B=List 1B, Plants Rare, Threatened, or Endangered in California and Elsewhere; 2, Plants Rare, Theatened, or Endangered in California but More Common Elsewhere; 3, Plants About Which We Need More information – A Review List; 4, Plants of Limited Distribution–A Watch List. 0.1-Seriously threatened in California (high degree/immediacy of threat), 0.2-Fairly threatened in California (moderate degree/immediacy of threat), 0.3-Not very threatened in California (low degree/immediacy of threats or no current threats known) (Tibor 2001, CNPS 2009).
****County of Santa Cruz designated sensitive habitat
n/a = not applicable

WILDLIFE HABITATS

The principal habitats within the project alignment include iceplant-ruderal, eucalyptus and open beach. Their wildlife values are discussed below.

Beach

In general, open sands of beaches primarily offer habitat for a variety of waterbirds, shorebirds and gulls. Waterbirds, such as double-crested cormorants (*Phalacrocorax auritus*) and California brown pelican (*Pelicanus occidentalis californicus*) may occasionally bathe in the small lagoon that forms on Twin Lakes Beach or roost in small numbers on the open sands, when recreational use is absent to low. Most shorebirds occur in fall and winter, foraging along the shoreline and roosting on the sandy beach. These include black-bellied plover (*Pluvialis squatarola*), snowy plover (*Charadrius alexandrinus*), willet (*Catoptrophorus semipalmatus*), marbled godwit (*Limosa fedoa*) and sanderling (*Calidris alba*). Gulls roost on the beach year-round and include western gull (*Larus occidentalis*), California gull (*L. californicus*) and ring-billed gull (*L. delawarensis*). Heermann's gull (*L. heermanni*) may also be present seasonally on the beach, arriving in late spring/early-summer and departing in late winter.

Habitat values along the alignment are negligible, due to traffic along the East Cliff Drive, the close proximity of residential development and heavy recreational use of the beach.

ATTACHMENT 1.4
pln056

Eucalyptus

The eucalyptus trees occur as a linear, discontinuous band of mature trees on the beachside of East Cliff between the State Parks restroom to Ninth Avenue. Eucalyptus also occurs along the shore of Schwan Lake (J. Gilchrist & Associates 2009) nearby, but outside the project area.

Eucalyptus groves can support a wide variety of bird species, depending on location and extent of habitat. Many bird species that use eucalyptus trees are those typically found in oak woodland, coniferous forest and mixed-evergreen forest habitats in the region. The eucalyptus trees provide a seasonal source of nectar in winter, and because of their tall heights they offer roost and nest sites for raptors and herons.

During the 7/21/09 nesting survey, five bird species were recorded within the project alignment, including chestnut-backed chickadee (*Poecile rufescens*), brown creeper (*Certhia americana*), American crow (*Corvus brachyrhynchos*), European starling (*Sturnus vulgaris*) and Brewer's blackbird (*Euphagus cyanocephalus*). No confirmed nesting evidence was recorded. One inactive nest, possibly of American crow, was observed in a eucalyptus tree behind the existing pump station, although no crows were observed at the nest during the survey time. The eucalyptus trees in the project area were reviewed for presence of double-crested cormorant (*Phalacrocorax auritus*) nests since large colonies of cormorants nest in nearby Schwan Lagoon (J. Gilchrist & Associates 2009). These trees do not appear suitable as nesting habitat for double-crested cormorants, due to the lack of snag limbs and heavy pedestrian uses nearby; no cormorant nests were observed.

The overall wildlife value of the eucalyptus trees is limited because they lack breadth, are confined to a small beach area and are adjacent to heavy recreational uses. Additionally, the habitat is continually subjected to visual and noise disturbances from vehicular traffic along East Cliff Drive. The trees could, however, provide nesting habitat for a variety of landbirds commonly found in urban settings. No special-status species are expected to use these trees for nesting.

Iceplant and Non-Native Grassland

Iceplant and non-native grassland ruderal vegetation occur as a discontinuous narrow band along parts of the project alignment. Habitat values of the non-native grassland are absent due the sparse and discontinuous nature of the community, and continued disturbance from recreational uses. Wildlife habitat values of the ice plant are also minimal. Species expected to occur in this habitat include rodents, such as Botta's pocket gopher (*Thomomys bottae*), house mouse (*Mus musculus*) and Norway rat (*Rattus norvegicus*), species common in disturbed habitats of urban settings.

SPECIAL-STATUS WILDLIFE SPECIES

In the context of this report, special-status species include species with State and/or Federal endangered or threatened status, Federal proposed or candidate species for listing, California species of special concern, species identified as rare by CNPS, locally significant species, or those which could be protected under the California Environmental Quality Act review process. The following special-status wildlife species were considered potential inhabitants of the project vicinity, based on field reconnaissance, knowledge of their patterns of occurrence and distribution, and review of the CNDDB.

Special-status species associated with the sandy beach habitat include double-crested cormorant, California brown pelican, western snowy plover (*Charadrius alexandrinus nivosus*) and California legless lizard (*Anniella pulchra).* Depending on the extent of the lagoon that forms on the state beach, cormorants and pelicans may occasionally bathe in the lagoon and roost on the nearby sands. Their occurrence, however, is expected to be infrequent and occur only when recreational use of the area is absent. Occasional wintering snowy plovers may be seen foraging along the shoreline or roosting on the beach sands, but nesting habitat is absent due to heavy recreational use of the beach. And while California legless lizards are associated with sandy coastal habitats, suitable dune scrub vegetation is lacking in the project alignment.

Monarch butterflies (*Danaus plexippus*) are associated with coastal eucalyptus groves in the project region. Monarchs, however, are not likely to roost in the eucalyptus trees on the project site due to the lack of breadth and structure of the eucalyptus habitat.

Southern sea otters are known to inhabit the kelp forests offshore in the project area. But the project will not affect offshore areas.

Table 2 summarizes the status of relevant special-status species of the project area.

Table 2. Special-Status Wildlife Known or Potentially Occurring in the Project Vicinity

Species	Status	Occurrence and Habitat
Monarch Butterfly (*Danaus plexipplus*)	LU	Roost sites known to occur in the project region. Roost habitat lacking within the project area. Eucalyptus and cypress trees are unsuitable, due to close proximity to ocean winds and the lack of habitat breadth and structure.
California legless lizard (*Anniella pulchra*)	FT	Beach habitat lacks suitable dune scrub vegetation
Western snowy plover (*Charadrius alexandrinus nivosus*)	FT	Beach nesting habitat unsuitable due to high recreational use; no successful nesting observed on popular Santa Cruz beaches in a number of years.
California Brown Pelican (*Pelicanus occidentalis californicus*)	SE, FE	Present along the coast mostly from summer and fall as a non-breeder. May bathe and loaf in beach lagoon, and feed in nearby coastal area. Project site is outside of nesting distributional range.
Double-crested Cormorant (*Phalacrocorax auritus*)	CSC (Nesting)	Rookery present at Schwan Lagoon but not known from project site. Nesting habitat absent in eucalyptus trees on site. May roost and bathe in the beach lagoon.
Southern Sea Otter (*Enhydra lutris nereis*)	FP, FT	Occurs exclusively along the coast offshore.

Key: CSC = California species of special concern; FP = California fully protected species; FE = Federal endangered species; FT = Federal threatened species; LU = Locally unique species; SE = State endangered species.

BIRD SPECIES PROTECTED BY THE MIGRATORY BIRD TREATY ACT (MBTA)

The MBTA prohibits the take (e.g., capture, harm, killing, etc.) of virtually all birds, their eggs and nestlings, except for rock pigeon (*Columba livia*), European starling (*Sturnus vulgaris*) and house sparrow (*Passer domesticus*), which are introduced non-native species.

Bird nesting surveys were conducted along the project alignment and in the project vicinity in summer 2009. During those surveys, species were recorded, including those protected by the MBTA.

Double-crested Cormorant

Double-crested cormorants (rookery sites) are considered both state (CDFG 2009b) and MBTA protected. Double-crested cormorant nests have been identified at Schwan Lake in 2005, 2007 and 2009 (J. Gilchrist and Associates 2009). Due to the proximity of Schwan Lake to the subject area, site surveys focused on possibility of cormorant nesting in eucalyptus trees. No confirmed evidence of nesting was detected, and eucalyptus trees in the study area lacked snag limbs that are common to nest sites at Schwan Lake. Double-crested cormorants at Schwan Lake do not appear to be sensitive to normal, ongoing human activities such as car, bicycle and pedestrian traffic on East Cliff Drive. However, heavy seasonal pedestrian and recreational use under and around the eucalyptus trees in the project area make nesting within the project site unlikely.

Other Nesting Birds

No confirmed nesting for other native species was recorded in 2009. However an inactive platform type nest was seen and believed to be from an American crow (*Corvus brachyrhynchos*). In addition, during the 2009 site survey other species were observed including chestnut-backed chickadee (*Poecile rufescens*), Brewer's blackbird (*Euphagus cyanocephalus*), brown creeper (*Certhia americana*) and house finch (*Carpodacus mexicanus*). These and other land birds have the potential to nest in the trees along the project alignment.

Raptors were not considered further in this report due to heavy pedestrian use beneath the eucalyptus trees in the project alignment, rendering the trees unsuitable as nesting sites. These trees, however, may be used as occasional roost sites.

ATTACHMENT 16

IMPACTS and MITIGATION

The proposed project involves construction of a series of improvements to facilitate traffic, parking, pedestrian and bicycle circulation. The installation of bluff stabilization and landscaping is also part of the project. The standard thresholds of significance presented in CEQA were used to evaluate project impacts and to determine if the proposed project poses significant impacts to biological resources. For this analysis, significant impacts are those that substantially affect either:

- A plant species or community listed as sensitive or rare by the State
- A wildlife species listed or proposed for listing by State or Federal governments as rare, threatened or endangered, including its habitat.
- Nesting habitat for a State species of special concern.
- Nesting birds protected under the Federal Migratory Bird Treaty Act or Section 3503.5 of CDFG Code.
- A habitat recognized as sensitive by State and County of Santa Cruz (i.e., riparian or wetland habitat, native coastal strand community).

VEGETATION

Impact: The project occurs largely within non-native ruderal vegetation, requiring removal of that vegetation type. This is not considered a significant biotic impact. In fact iceplant (*Carpobrotus edulis*) is considered an invasive species and its removal would be beneficial. The disjunct non-native annual grassland areas are also not biologically important. The mature eucalyptus and cypress trees will be retained and incorporated into the landscape plan for the project site. Measures are planned (temporary fencing, contractor education) to identify and isolate these trees from the construction zone.

1. **Recommended Mitigation:** None needed

WILDLIFE

Impact--Double-crested Cormorant and other Nesting Birds. Construction-related disturbances and habitat removal could result in the disruption of nesting activities of birds inhabiting the project alignment. No nesting was found during the 2009 surveys, however those surveys were conducted late in the nesting season and during a single year. Nesting of native land bird species is a possibility in trees and large shrubs within the project site. All native bird species that could nest in the project area are protected by the Migratory Bird Treaty Act. No special-status species are expected to use trees as nesting habitat.

Recommended Mitigations—Nesting Birds:

2. Updated pre-construction nesting surveys should be conducted by a qualified wildlife biologist prior to the start of construction activities. Results of those surveys should be incorporated into contractor construction documents. Construction activity conducted after September 1 and before March 1 does not require a nesting survey.

3. If active nesting or nesting behavior is observed, a 60-foot buffer shall be established around a songbird nesting area or a minimum of 250 feet from a cormorant rookery or raptor nest. A monitoring biologist should be present to record the behavior of nesting cormorants and to

pln056

increase the buffer zone distance, as needed. No construction activities should be allowed within these buffer zones. Construction activities would be allowed elsewhere outside of the buffer areas. If the wildlife biologist determines evidence of nesting is no longer observed, project activities can be allowed to start immediately

REFERENCES

Ainley, D. G. and R. J. Boeckelheide. 1990. Seabirds of the Farallones Islands. Stanford University Press.

California Department of Fish & Game. 2009a. Natural Diversity Data Base, Rare Find 3 (dated March 2009), Santa Cruz and Soquel Quadrangles.

California Department of Fish and Game. 2009b. California Department of Fish and Game Natural Diversity Data Base Special Animals, July 2009.

California Native Plant Society (CNPS). 2009. Inventory of Rare and Endangered Plants. Online edition, v7-09c, 7-14-09. California Native Plant Society, Sacramento, CA. http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi. Accessed 9/1/09.

CNDDB (California Natural Diversity Data Base). 2009. Biographic Data Branch, Vegetation Classification and Mapping Program. http://www.dfg.ca.gov/whdab/html/vegcamp.html. July.

County of Santa Cruz Redevelopment Agency. 2008. Staff Report to Board of Directors, County of Santa Cruz Redevelopment Agency on Twin Lakes Beachfront Conceptual Design, 9/12/08 Agenda.

Hall, E. R. 1981. The Mammals of North America. John Wiley and Sons, New York, NY.

Hatch, J. J. and D. V. Weseloh. 1999. Double-crested Cormorant (*Phalacrocorax auritus*). *In* Birds of North America, No. 441 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.

Hickman, J.C. (Ed.). 1993. The Jepson Manual; Higher Plants of California. University of California Press, Berkeley, CA. 1400 pp.

Ingles, L.G. 1965. Mammals of the Pacific States. Stanford University Press, Stanford, California. 506 pp.

Jameson, E. W. And H. J. Peeters. 1988. California Mammals. University of California Press, Berkeley.

John Gilchrist & Associates. 2007. Draft Biotic Assessment – Schwan Lake Pedestrian Pathway, Santa Cruz County, CA. Prepared for Santa Cruz Co. Redevelopment Agency. January 2007.

John Gilchrist & Associates. 2009. Biotic Assessment – Schwan Lake Pedestrian-Bicycle Pathway, East Cliff Dr., 9th to 12th Ave. , Santa Cruz County, CA. Prepared for Santa Cruz Co. Redevelopment Agency. August 31, 2009.

Kuhnz, L. 2001. Moss Landing Marine Labs Earthquake Reconstruction California Legless Lizard Relocation Project. Moss Landing Marine Laboratories and ABA Consultants. Moss Landing, CA.

ATTACHMENT 1 A
pln056

Morgan. R.L. 2005. An Annotated Checklist of the Vascular Plants of Santa Cruz County, CA

Remsen, J. V. June 1978. Bird Species of Special Concern in California. California Department of Fish and Game.

Sawyer, J.O. and T. Keeler-Wolf. 1995. A Manual of California Vegetation. California Native Plant Society, Sacramento, CA. 471 pp.

Shuford, D. V. and T. Gardali (Eds). 2008. California Bird Species of Special Concern. Studies of Western Birds No. 1. Western Field Ornithologists and California Department of Fish and Game.

Suddjian, D. L. 1990. Santa Cruz County Breeding Birds Atlas Project - Atlasser's Assistant. Santa Cruz Bird Club.

Tibor, D. (Ed.). 2001. California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California. The California Native Plant Society, Sacramento, CA. Special Publication No. 1, Sixth Ed. August. 386 pp.

U.S. Forest Service. 1999. Dead and Dying Trees: Essential for Life in the Forest. Science Findings Issue 20/November 1999.

USFWS (U.S. Fish and Wildlife Service). 2006. USFWS Threatened and Endangered Species System (TESS). http://ecos.fws.gov/tess_public/SpeciesReport.do?dsource=plants. July.

_____. 2003a. Listed, Proposed and Candidate Species that Occur in Santa Cruz County, California. Ventura Field Office Web Site, December 2003.

_____. 2003b. Final Revised Recovery Plan for the Southern Sea Otter (Enhydra lutris nereis). USFWS Region 1, Portland, Oregon.

_____. 2001. Western Snowy Plover (Charadrius alexandrinus nivosus) Pacific Coast Population Draft Recovery Plan. USFWS Region 1, Portland, Oregon.

_____. 1983. The California Brown Pelican Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon.Williams, D. F. June, 1986. Mammalian Species of Special Concern in California. California Department of Fish and Game.

Personal Communications:

Randall Morgan, Botanist, Santa Cruz, CA
David Suddjian, Biologist, David Suddjian Biological Consulting, Capitola, CA.

APPENDIX A

PLANT SPECIES LIST

Twin Lakes Beachfront Project

ATTACHMENT 16
pln056

EXOTIC*	SCIENTIFIC NAME	COMMON NAME
	Class Angiospermae, Subclass Dicotyledoneae (Dicots)	
	Aizoaceae - Fig-Marigold Family	
xx	*Carpobrotus edulis*	Hottentot fig
	Anacardiaceae - Sumac Family	
	Toxicodendron diversilobum	Poison oak
	Apiaceae - Carrot Family	
x	*Anthriscus caucalis*	Bur chervil
xx	*Conium maculatum*	Poison hemlock
	Araliaceae - Ginseng Family	
xx	*Hedera helix*	English ivy
	Asteraceae - Sunflower Family	
	Ambrosia chamissonis	Beach bur
	Baccharis pilularis	Coyote brush
xx	*Carduus pycnocephalus*	Italian thistle
x	*Cirsium vulgare*	Bull thistle
	Grindelia stricta var. *angustifolia*	Marsh gum plant
	Brassicaceae - Mustard Family	
x	*Cakile maritima*	Sea rocket
x	*Raphanus sativus*	Wild radish
	Fabaceae - Pea Family	
xx	*Medicago polymorpha*	CA burclover
x	*Vicia sativa* ssp. *sativa*	Common vetch
	Fagaceae - Oak Family	
	Quercus agrifolia	Coast live oak
	Geraniaceae - Geranium Family	
x	*Geranium dissectum*	Cut-leaved geranium
	Malvaceae - Mallow Family	
x	*Malva nicaeensis*	Bull mallow
	Myrtaceae - Myrtle Family	
xx	*Eucalyptus globulus*	Blue gum

ATTACHMENT 1 6

EXOTIC* SCIENTIFIC NAME	COMMON NAME
Oxalidaceae - Oxalis Family	
x *Oxalis corniculata*	Creeping wood sorrel
xx *Oxalis pes-caprae*	Bermuda buttercup
Plantaginaceae - Plantain Family	
xx *Plantago coronopus*	Cut-leaved plantain
x *Plantago lanceolata*	English plantain
Primulaceae - Primrose Family	
x *Anagallis arvensis*	Scarlet pimpernel
Solanaceae - Nightshade Family	
Solanum douglasii	Douglas' nightshade
Class Angiospermae, Subclass Monocotyledoneae (Monocots)	
Liliaceae - Lily Family	
x *Amaryllis belladonna*	Naked lady
Poaceae - Grass Family	
x *Avena barbata*	Slender wild oat
x *Bromus catharticus*	Rescue grass
xx *Bromus diandrus*	Ripgut
xx *Bromus hordeaceus*	Soft chess
x *Cynodon dactylon*	Bermuda grass
x *Hordeum murinum* ssp. *leporinum*	Farmer's foxtail
x *Vulpia myuros*	Rattail fescue
Total Number of Taxa	**32**
Total Number of Native Taxa	**6**
Total Number of Plant Families	**17**

* X Exotic taxa are those not native to Santa Cruz County. XX signifies invasive.

pln056

APPENDIX B

WILDLIFE SPECIES LIST

ATTACHMENT 16

Appendix B. Wildlife Species Observed at or Near the Twin Lakes Beachfront Improvement Project, 2005-2009.

Key: **y** - Species likely to be observed year-round; **m** - Spring/fall migrant; **n** – Predicted/known to nest in the project vicinity; ***** - Nesting confirmed within or immediately adjacent to the project alignment; **s** – Summer resident; **w** – Winter resident; **r** – Predicted/known to roost in the project vicinity.

CLASS: AMPHIBIA	
ORDER: ANURA	
Family: Ranidae	
Bullfrog (*Rana catesbeiana*)	y
CLASS: REPTILIA	
ORDER: TESTUDINES	
Family: Emydidae	
Pond Slider (*Trachemys scripta*)	y
CLASS: AVES	
ORDER: PODICIPEDIFORMES	
Family: Podicipedidae	
Pied-billed Grebe (*Podilymbus podiceps*)	y, n
Western Grebe (*Aechmophorus occidentalis*)	m, w
ORDER: PELICANIFORMES	
Family: Phalacrocoracidae	
California Brown Pelican (*Pelecanus occidentalis*)	y
Double-crested Cormorant (*Phalacrocorax auritus*)	y, n*, r
ORDER: CICONIIFORMES	
Family: Ardidae	
Great Blue Heron (*Ardea herodias*)	y, n, r
Green Heron (*Butorides virescens*)	y, n, r
ORDER: ANSERIFORMES	
Family: Anatidae	
Mallard (*Anas platyrhynchos*)	y, n
ORDER: FALCONIFORMES	
Family: Accipitridae	
Red-shouldered Hawk (*Buteo lineatus*)	y, n
ORDER: GRUIFORMES	
Family: Rallidae	
American Coot (*Fulica americana*)	y, n
ORDER: CHARADRIIFORMES	
Family: Laridae	
Heerman's Gull (*Larus heermanni*)	m
California Gull (*Larus californicus*)	y
Western Gull (*Larus occidentalis*)	y

ATTACHMENT 1 45

pln056

Caspian Tern (*Sterna caspia*)	y
Forster's Tern (*Sterna forsteri*)	s
ORDER: COLUMBIFORMES	
Family: Columbidae	
Rock Pigeon (*Columba livia*)	y, n
Mourning Dove (*Zenaida macroura*)	y, n
ORDER: APODIFORMES	
Family: Trochilidae	
Anna's Hummingbird (*Calypte annae*)	y, n
ORDER: PICIFORMES	
Family: Picidae	
Hairy Woodpecker (*Picoides villosus*)	y, n
ORDER PASSERIFORMES	
Family: Tyrannidae	
Pacific-slope Flycatcher (*Empidonax difficilis*)	m, n
Black Phoebe (*Sayornis nigricans*)	y, n
Family: Vireonidae	
Warbling Vireo (*Vireo gilvus*)	m, n*
Family: Hirudinidae	
Violet-green Swallow (*Tachycineta thalissina*)	m, n
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)	m, n
Barn Swallow (*Hirundo rustica*)	m, n
Cliff Swallow (*Petrochelidon pyrrhonota*)	m, n
Family: Corvidae	
Western-Scrub Jay (*Aphelocoma californica*)	y, n
American Crow (*Corvus brachyrhynchos*)	y, n
Family: Paridae	
Chestnut-backed Chickadee (*Poecile rufescens*)	y, n*
Oak Titmouse (*Baeolophus inornatus*)	y, n
Family: Aegithalidae	
Bushtit (*Psaltriparus minimus*)	y, n*
Family: Sittidae	
Pygmy Nuthhatch (*Sitta pygmaea*)	y
Family: Certhidae	
Brown Creeper (*Certhia americanus*)	y, n
Family: Mimidae	
Northern Mockingbird (*Mimus polyglottis*)	y, n
Family: Sturnidae	
European Starling (*Sturnus vulgaris*)	y, n
Family: Bombycillidae	
Cedar Waxwing (*Bombycilla cedrorum*)	w
Family: Parulidae	
Yellow Warbler (*Dendroica petechia*)	m
Common Yellowthroat (*Geothlypis trichas*)	y, n
Family: Emberizidae	
California Towhee (*Pipilo crissalis*)	y, n
Spotted Towhee (*Pipilo maculatum*)	y, n*
Song Sparrow (*Melospiza melodia*)	y, n*
Family: Cardinalidae	
Black-headed Grosbeak (*Pheucticus melanocephalus*)	y, n
Family: Icteridae	
Red-winged Blackbird (*Agelaius phoeniceus*)	y, n*

Brewer's Blackbird (*Euphagus cyanocephalus*)	y, n*
Brown-headed Cowbird (*Moluthrus ater*)	m, n
Family: Fringillidae	
House Finch (*Carpodacus mexicanus*)	y, n*
Lesser Goldfinch (*Carduelis psaltria*)	y, n
Family: Passeridae	
House Sparrow (*Passer domesticus*)	y, n

CLASS: MAMMALIA

ORDER: RODENTIA	
Family: Sciuridae	
Fox Squirrel (*Sciurus niger*)	y
Family: Muridae	
Norway Rat (*Rattus norvegicus*)	y

ATTACHMENT 16

pln056

GRADING REPORT FOR

Public Right-of-Way and Road Improvements for East Cliff Drive at Twin Lakes Beachfront

Santa Cruz, California
County of Santa Cruz

Prepared for
County of Santa Cruz - Public Works

Prepared by

rrmdesigngroup

creating environments people enjoy®

July 19, 2011

ATTACHMENT 17

TABLE OF CONTENTS

TITLE PAGE	1
TABLE OF CONTENTS	2
INTRODUCTION	3
BASIS & METHOD OF CALCULATIONS	3
CONCLUSIONS	3
ROADWAY PAVING AND GRADING VOLUME CALCULATIONS	4

ATTACHMENT 1

1.0 INTRODUCTION

The proposed project is located on East Cliff Drive between the cross streets of 5th Avenue and 7th Avenue in the Leona Creek Drainage Basin of Flood Zone 5 in Santa Cruz County. Project improvements cover an area of approximately 1.71 acres. The project consists of bluff stabilization and coastal armoring along the Twin Lakes beach front, along with an all new parking configuration and multi-use path layout. The new parking configuration along the beach front will lend itself to a slightly revised road alignment along with proposed curb and sidewalk along the entire frontage of the project.

2.0 BASIS & METHOD OF CALCULATIONS

Site paving quantities are computed by quantifying the amount of area for the proposed paved area and multiplying by the depth of each material. Overall grading quantities have been determined through proposed vs. existing surface analysis in Autocad Civil 3D.

3.0 CONCLUSIONS

The overall grading quantities show that the project site will produce an excess cut of soils and beach sand. All cut shall be hauled off site and disposed of at a county landfill or other appropriate facility. However, a large portion of the cut generated will be from beach sand and can be reused at Twin Lakes Beach as part of the beach re-nourishment program. Required demolition on the project site will also generate materials in the form of asphalt, base rock, and concrete. These materials will need to be hauled off to an appropriate facility as well.

Public Right-of-Way and Road Improvements for East Cliff Drive at Twin Lakes Beachfront				
Roadway Paving Calculations	**Area (SF)**	**Depth (ft)**	**Vol (CF)**	**Vol (CY)**
Existing AC Removal (3" Depth assumed)	37070	0.25	9268	343
Existing Baserock Removal (9" Depth assumed)	37070	0.75	27803	1030
Proposed AC Pavement	40850	0.25	10213	378
Proposed Baserock	40850	0.75	30638	1135
Overexcavation and Recompaction	40850	0.5	20425	756

Grading Volume Calculations		
Project Site Area	**Cut Vol (CY)**	**Fill Vol (CY)**
5th Ave. to 7th Ave.	1158	2338

Total Cut: 1158 CY

Total Fill: 2338 CY

Project Site Net Total : 1180 CY (FILL)*

Notes: * A large portion of the cut shown above is excavated beach sand and can be reused at Twin Lakes Beach as part of a beach re-nourishment program.

County of Santa Cruz, PLANNING DEPARTMENT

Discretionary Application Comments 111134

APN --

Your plans have been sent to several agencies for review. The comments that were received are printed below. Please read each comment, noting who the reviewer is and which of the three categories (Completeness, Policy Considerations/Compliance, and Permit Conditions/Additional Information) the comment is in.

Completeness: A comment in this section indicates that your application is lacking certain information that is necessary for your plans to be reviewed and your project to proceed.

Policy Considerations/Compliance: Comments in this section indicate that there are conflicts or possible conflicts between your project and the County General Plan, County Code, and/or Design Criteria. We recommend that you address these issues with the project planner and the reviewer before investing in revising your plans in any particular direction.

Permit Conditions/Additional Information: These comments are for your information. No action is required at this time. You may contact the project planner or the reviewer for clarification if needed.

Accessibility Review

Routing No: 2 | Review Date: 12/19/2011

SHEILA MCDANIEL (SMCDANIEL) : Complete

Comments were pasted from Email to Hansen.

This Development Application, 111134, is up for a 2nd review.

Comments were not addressed in revised plans. Condition the project to require the project to address the following prior to building permit/construction.

1.□Abrupt changes in level adjacent to the cliff side paths of travel, exceeding 4 inches in a vertical dimension, shall be identified by curbs projecting at least 6 inches in height above the walk or sidewalk surface to warn the blind of a potential drop off. When a guard or handrail is provided, no curb is required when a guide rail is provided centered 3 inches plus or minus 1 inch above the surface of the walk or sidewalk, the walk is 5 percent or less gradient or no adjacent hazard exists. (CBC 1133B.8.1)

2. An accessible curb ramp at the passenger loading zone is required. (CBC 113

3. Directional signage to identify accessible beach access point(s) to be located stairs and accessible parking space. (CBC 1117B)

Coastal Commission Review

Routing No: 1 | Review Date: 08/30/2011

SHEILA MCDANIEL (SMCDANIEL) : No Response

ATTACHMENT 18

County of Santa Cruz, PLANNING DEPARTMENT

Discretionary Application Comments 111134

APN --

Coastal Commission Review

Routing No: 1 | Review Date: 08/30/2011

SHEILA MCDANIEL (SMCDANIEL) : No Response

Drainage Review

Routing No: 2 | Review Date: 12/19/2011

SHEILA MCDANIEL (SMCDANIEL) : Complete

APP 111134-
Sent via email 12/16/11
Plans and Drainage Report dated 11/22/11 has been received.

Compliance/Condition Comments:

1) The drainage analysis does not include evaluation of drainage at the intersection of 5th and East Cliff except to say that it drains down the harbor. Based on input from road maintenance personnel this area currently has ponding and drainage problems. Please provide evaluation of proposed drainage patterns in this area including flow line profiles, cross-sections and update the plans to include drainage facilities as needed to provide positive drainage in this area considering sand build-up from the beach.

2) Provide valley gutters at road intersections.

3) There are inconsistencies in the response to comments, drainage report, and plans regarding the existing storm drain facilities. Please update all notes so that it is clear that these pipes will be replaced with this project. The proposed replacement storm drains in East Cliff Drive should be 18" HDPE pipes to meet the County Design Standard minimum.

4) The response to comments states that the landscape island at 5th Avenue will be depressed but the proposed grading plan does not show this. Please add information on the grading and/or landscape plans consistent with this concept. Please also describe how road runoff will be allowed to enter this landscape area (curb cuts, flush curb, etc.) and provide overflow drains as necessary based on site soils.

5) Per DPW road maintenance the proposed 18" square inlets for water quality treatment are too small for maintenance with the County vactor equipment. Please consult with road maintenance to determine what the minimum size inlet is that is acceptable if the standard sized G-O inlet is not proposed. How will the eco rain drainage cell and the gravel bed at the base of the water quality inlets be designed so as to withstand maintenance and cleaning with vactor equipement?

6) Provide a final drainage plan and analysis demonstrating that the drainage facilities located within the project boundaries (existing to remain and proposed) meet design criteria requirements. Add

Drainage Review

Routing No: 2 | Review Date: 12/19/2011

SHEILA MCDANIEL (SMCDANIEL) : Complete

final details such as invert elevations, slopes, etc. to the plans. Assume full pipe or expected water surface flood elevation (the total water level shown on sheets 8.1 and 8.2 are adequate) in the drainage system analysis for conservative outlet boundary condition. The final analysis will be checked relative to County Standard Figure SWM-6. Add an additional inlet or enlarged inlet at the bottom of Basin B as necessary to capture the 10 and 25 year flows in the system. The final plans should provide elevation and drainage patterns for the proposed sidewalk areas.

7) Per discussion with the design engineer infiltration of small storms via the treatment boxes and perforated pipes will be the mode of water quality treatment. Please provide elevation information on the plans that described how runoff will first be directed to the treatment boxes. Provide analysis based on site soils demonstrating the proposed surface areas in the boxes will be adequate to treat the water quality treatment rates quantified in the drainage report. Soil infiltration data should take into account compaction occurring due to construction and traffic. Provide construction details for the proposed perforated pipes. Are there perforated pipes outlets to the beach? What are the grey lines shown from the infiltration inlets toward the beach meant to represent? Provide analysis demonstrating that standing water in the infiltration inlets and perforated pipes will infiltrate within 48 hours so as not to cause vector control problems.

9) Provide details/specifications for the proposed outlets. Please include some type of signage or marker at the outlets for ease of maintenance.

10) Will the proposed drainage facilities outside of the County road right of way be maintained by County Roads or State Parks? If these facilities are to maintained by the County an easement for the installation and maintenance of these facilities is required. Please provide a copy of the easement prior to recordation for review and a copy of the final recorded document for our records.

11) Final drainage plans shall be consistent with final landscape and grading plans.

12) Provide a final geotechnical review letter approving of the proposed drainage plan and confirming that the infiltration rate/percolation rates used for water quality treatment design are appropriate for the site conditions.
Informational Items

13) The perforated pipes and existing pipes and shown on sheet 5.1 are very difficult to see. Please use a different line type so that they are legible. If these pipes are to be replaced they should show up as proposed pipe linetypes.

INFORMATIONAL ITEMS

Drainage Review

Routing No: 2 | Review Date: 12/19/2011

SHEILA MCDANIEL (SMCDANIEL) : Complete

14) Public Works will inspect the installation of the drainage items. Provide specifications/construction notes on the plans regarding any specific guidelines such as non-disturbance areas to limit soil compaction, construction staging, infiltration rate testing for amended soils, decompaction of soils. Prior to building permit issuance, once all other reviewing agencies have approved the plans, submit a copy of reproducible civil plans to DPW for routing and signature (allow 1-2 weeks for this process). A deposit will be required for inspection fees which will be charged at cost.

15) Construction activity resulting in a land disturbance of one acre or more, or less than one acre but part of a larger common plan of development or sale must obtain the Construction Activities Storm Water General NPDES Permit from the State Water Resources Control Board. Construction activity includes clearing, grading, excavation, stockpiling, and reconstruction of existing facilities involving removal and replacement. For more information see: http://www.waterboards.ca.gov/water_issues/programs/stormwater/gen_const_faq.shtml

Driveway/Encroachment Review

Routing No: 1 | Review Date: 08/25/2011

DEBRA LOCATELLI (DLOCATELLI) : Complete

Completeness Comments: Application Complete? _X_ Yes ____ No

Policy Considerations and Compliance Issues:

The following items shall be addressed at the time of BUILDING PERMIT SUBMITTAL:

1. Construction notes - Sheet 5.1 of plans indicate the installation of new fire hydrants. Please indicate location on plans. Also, please include dimensions for sidewalk transition at obstruction, for the obstructions that can not be placed behind the curb, (obstructions include utility poles, fire hydrants, etc.) with a 4' clear sidewalk per County of Santa Cruz Design Criteria FIG ST-12.
2. Curb ramps, driveway approaches (including ADA wraps) - Construction notes on Sheet 5.1 indicate the construction is "modified" from the detail noted. Please note on plans that the details are per the County of Santa Cruz Design Criteria. If modification is required, please contact Encroachment Section to discuss, prior to submittal of building plans.
3. Please provide construction details, for improvements within the County right-of-way, per the County of Santa Cruz Design Criteria.

Permit Conditions and Additional Information:

Encroachment Permit required for all work proposed within County right-of-way; to be submitted at the time of building permit submittal. Please submit an Encroachment Permit Application with two copies of full set of plans.

Environmental Planning

Routing No: 3 | Review Date: 03/16/2012

ATTACHMENT 18

County of Santa Cruz, PLANNING DEPARTMENT

Discretionary Application Comments 111134

APN --

Environmental Planning

ANTONELLA GENTILE (AGENTILE) : Complete

Project conditions:

1. Project shall comply with all recommendations provided in the Engineering Geology Report dated 6/4/2009 and the Revised Preliminary Plan Review dated 2/21/2012 by Rogers E. Johnson and Associates.
2. Project shall comply with all recommendations provided in the Geotechnical Engineering Report dated 6/4/2011 and Geotechnical Review of Conceptual Plans dated 2/23/2012 by Haro, Kasunich, and Associates, Inc.
3. Project shall comply with all requirements set forth in the Biotic Report Review Acceptance Letter by Matt Johnston.

Fire Review

Routing No: 1 | Review Date: 08/17/2011

KAREN MILLER (KMILLER) : Complete

Date: August 12, 2011

To: County of Santa Cruz Public Works

Applicant: same

From: Tom Wiley

Subject: 111134

Address N/A

APN: None

OCC: None

Permit: 20110161

We have reviewed plans for the above subject project.

The following NOTES must be added to notes on velums by the designer/architect in order to satisfy District requirements when submitting for **Application for Building Permit:**

Show on the plans new public fire hydrants, meeting the minimum required fire flow. Place one new hydrant in the area of 6th and East Cliff on the N/W corner, and one fire hydrant next to 027-182-04 prior to the corner of East Cliff Dr.

Show on the plans DETAILS of compliance with the District Access Requirements outlined on the enclosed handout. The roadway(s) are required to be designated as fire lanes, and painted with a red curb with FIRE LANE NO PARKING in contrasting color every 30 feet on the top of the red curb. If the roadway is 27' or less, both sides of the street/roadway shall be painted, 35' and down to 28' in width, the roadway curbs shall be painted on one side, and 36' and wider no red curb is required. All cul-de-sacs shall be fire lane, red curbed.

Submit a check in the amount of $115.00 for this particular plan check, made payable to Central Fire Protection District. A $35.00 **Late Fee** may be added to your plan check fees if payment is not received within 30 days of the date of this Discretionary Letter. INVOICE MAILED TO APPLICANT. Please contact the Fire Prevention Secretary at (831) 479-6843 for total fees due for your project.

If you should have any questions regarding the plan check comments, please call me at (831) 479-6843 and leave

Fire Review

Routing No: 1 | Review Date: 08/17/2011

KAREN MILLER (KMILLER) : Complete

a message, or email me at tomw@centralfpd.com. All other questions may be directed to Fire Prevention at (831)479-6843.

CC: File & County

As a condition of submittal of these plans, the submitter, designer and installer certify that these plans and details comply with applicable Specifications, Standards, Codes and Ordinances, agree that they are solely responsible for compliance with applicable Specifications, Standards, Codes and Ordinances, and further agree to correct any deficiencies noted by this review, subsequent review, inspection or other source. Further, the submitter, designer, and installer agrees to hold harmless from any and all alleged claims to have arisen from any compliance deficiencies, without prejudice, the reviewer and the Central FPD of Santa Cruz County.
East Cliff-081211

Road Engineering Review

Routing No: 1 | Review Date: 08/31/2011

RODOLFO RIVAS (RRIVAS) : Complete

Completeness Comments:

Permit Conditions and Additional Information:

1) Replace pavement bike symbol with "BIKE LANE" legend.
2) Provide ADA parking signs and markings per CAMUTCD.
3) Provide road striping and marking details.

ATTACHMENT 18

plnO56

County of Santa Cruz

REDEVELOPMENT AGENCY

701 OCEAN STREET, ROOM 510, SANTA CRUZ, CA 95060-4073
(831) 454-2280 FAX: (831) 454-3420 TDD: (831) 454-2123
BETSEY LYNBERG, AGENCY ADMINISTRATOR

July 31, 2008

Agenda: August 12, 2008

Board of Directors
County of Santa Cruz Redevelopment Agency
701 Ocean Street
Santa Cruz, CA 95060

TWIN LAKES BEACHFRONT CONCEPTUAL DESIGN
East Cliff Drive from 5TH Avenue to 9TH Avenue

Dear Members of the Board:

Presented herein for your Board's consideration is a conceptual design for improvements to East Cliff Drive, between 5th Avenue and 9th Avenue in the Twin Lakes Beach area of Live Oak. This concept was initiated as a result of the community's interest in pedestrian, bicycle and vehicle circulation improvements to East Cliff Drive. This letter describes the project background and setting, community process, plan goals and the proposed conceptual design.

BACKGROUND

East Cliff Drive, from 5th Avenue to 9th Avenue, provides access to the Santa Cruz Harbor, access to adjacent residential properties, serves as access and parking for Twin Lakes State Beach, serves as one of the few east–west corridors through Live Oak, and boasts scenic views of the Monterey Bay. The demands on this section of road are heavy, yet the roadway itself is relatively unimproved and does not include sidewalks, continuous bike lanes or organized parking. These conditions result in a variety of pedestrian, bicycle, and vehicle circulation issues. In addition, parking, congestion, and difficulties negotiating through the area interfere with the scenic quality of the beach and Monterey Bay.

Heavy multi-modal use, combined with a lack of standard public improvements and crumbling roadway infrastructure, has resulted in community interest and the need for improving this area. Planning efforts begun in 2000 have resulted in the construction of initial improvements along the harbor frontage of Lake and 5th Avenues (Phase 1), plans for improvements to the lakeside edge of East Cliff Drive between 9th and 12th Avenues (Phase 2 concept design approved in November 2004), as well as conceptual design proposals for the beachfront areas of East Cliff Drive. The final planning effort for the beachfront area of East Cliff Drive (Phase 3) began with community meetings in the fall

of 2007. Through the community workshop process, goals and objectives for improvements to the area have been developed, and consensus reached on a conceptual design for future improvements. These include new pedestrian paths, crosswalks, bicycle lanes, curbs, gutters, drainage, roadway and parking improvements, utility work, landscaping, and bluff stabilization. The proposed improvements will connect to the existing improvements at the end of 5th Avenue and extend to the proposed improvements at 9th Avenue and Schwan Lake (Phase 2).

EXISTING CONDITIONS AND SETTING

East Cliff Drive

This section of East Cliff Drive is an east-west arterial street that provides a scenic route along the Monterey Bay beginning at the East Lower Harbor entrance at the end of 5th Avenue, and follows along the beachfront to Schwan Lake. The area is heavily used by pedestrians, bicyclists, and motor vehicles especially during weekends and the summer.

East Cliff Drive is designated as an arterial street in the County's General Plan, and has a 60-to-110-foot right-of-way in the project area. The existing two lane road from 5th to 7th Avenues has no bicycle lanes and has a narrow or no shoulder, with informal and unorganized parking, and no sidewalks. Pedestrians and bicyclists in the area have a difficult time negotiating between the traffic and the parked vehicles. The main entrance to the harbor concession area is located at the west end of East Cliff Drive providing access to restaurants, a bait shop and commercial spaces. The Port District recently completed a new plaza and beachfront walkway at the end of 5th Avenue. Current conditions in the circle at the end of 5th Avenue make it difficult for large vehicles to negotiate. East Cliff Drive serves as an important cross town link for the residents of Live Oak and Santa Cruz. In addition, it also provides the main emergency access route for the port district businesses and the entire western portion of the beach area.

Between 7th and 9th Avenues the road is wider and carries a higher volume of traffic; there are bicycle lanes on each side, some sidewalk area, and informal parking. In many areas the terrain adjacent to the roadway slopes steeply down to the beach, and in some areas is protected by rip rap. There are a number of large eucalyptus trees between 7th and 9th along the beachfront.

In certain locations the bluffs, roadway, and public improvements are subject to high surf and storm conditions. Winter storm events will often pull sand off of the beach, revealing existing rip rap and bed rock. This condition has been mitigated in recent years by the harbor dredging operation which pumps sand just off shore and onto the beach. Large storm events throw debris onto East Cliff Drive at Schwan Lake and can result in temporary road closures.

Twin Lakes State Beach

Other than the harbor area at the end of 5th Avenue, all of the parcels along the beachfront are owned by the State of California and operated by California State Parks as Twin Lakes State Beach. Beach goers enjoy views of the bay and boats coming and going from the harbor. Wave and water conditions are generally safe for swimming and the harbor restaurants and neighborhoods are an easy walk. As a result, Twin Lakes State Beach is popular with local residents and visitors alike, and is a favorite spot for family and group gatherings throughout the year. The beach is heavily used with over one-half million visitors a year. Access to the beach is convenient and informal from parking spaces located along the eroding road edge. However because the state does not have any parking facilities to support the beach, parking along the road edge creates safety and circulation problems along East Cliff Drive. The only state facility is an old shower house/restroom building which is in need of repair and improvement. Beach goers also use the restrooms located in the new O'Neill building located in the harbor. State Parks runs the lifeguard program, beach patrol, and also collects refuse from containers located near and on the beach. The County Sanitation District also operates the sanitary sewer pump station located near the shower house.

Adjacent Residential Properties

Residential properties line the north side of East Cliff Drive. The roadway serves as the only access to most of these properties, and in many cases driveways and front yard landscaping extend into the right-of-way, out to the existing paved road edge. Because of the high demand for beach parking, residents contend with unauthorized parking blocking driveways, ad hoc parking along the road edge, and have also observed unauthorized use of private property.

Parking

This area is included in the Live Oak Parking Program (County's Department of Public Works) which issues visitor parking permits during weekends and holidays from late spring to the fall from a trailer parked at the intersection of 9th Avenue and East Cliff Drive. Program staff also provides parking enforcement during the permit season. Based upon parking surveys conducted by RDA staff, it is estimated that under the current unorganized, ad hoc parking conditions up to about 70 standard size vehicles can park in the study area. Staff estimates that during the off-peak season parking demand on weekdays is from about 22 to 24 vehicles. During the peak season parking demand on weekdays is from about 31 to 53 vehicles. All parking areas are used during most peak season weekends.

COMMUNITY PROCESS

The current proposed project has developed out of three separate community meetings over the past year led by the Redevelopment Agency in conjunction with the Department of Public Works. The first meeting was held on September 27, 2007. Over 150 residents and interested community members were presented with a summary of the Redevelopment Agency's efforts to date to develop pedestrian improvements for the

area. Attendees were given the opportunity to review the previous design concept plan prepared for the beachfront in 2001, and were asked to discuss issues and concerns in smaller workshop groups and respond to a questionnaire. Verbal reports for each group were presented at the end of the meeting. The majority of attendees stated that the 2001 concept plan closely reflected the key issues and opportunities they identified. These included:

- Pedestrian access and safety features
- Safe bicycle access
- Parking and vehicular circulation improvements
- Maintaining scenic qualities
- Planning for other improvements including drainage, undergrounding utilities, bluff stabilization, restricting large vehicles from obstructing views and the roadside, and utilizing more of the public right-of-way for the proposed project.

At the second community meeting, on January 8, 2008, staff presented goals and objectives summarizing the key issues and opportunities stated by the participants at the first meeting (see attachment). Numerous concepts were presented illustrating different approaches and options for pedestrian access, bicycle access, and parking layouts. The advantages and disadvantages of the various approaches, as well as community priorities for resolving key issues were discussed. Meeting participants discussed the options in working groups and reported back to the larger group at the end of the meeting. This process re-affirmed that the primary goal for the community is to address pedestrian access and safety concerns with the recognition that this may require some compromise with regards to solutions for other potentially competing goals. Comment cards from the participants showed that a strong and decisive majority agreed that the design process was on track and addressed the priorities of the group. Many expressed appreciation for being included in the process, and for being asked to share their ideas.

After retaining the services of Bellinger Foster Steinmetz Landscape Architects, staff worked closely with them to prepare a conceptual design for the beachfront. On May 1, 2008, a third and final community meeting was held to present that plan. After a brief review of the previous meetings and a summary of the goals and objectives, the concept plan was presented along with several sections, renderings and examples of similar coastal projects. The resulting comment summaries from the meeting attendees showed overwhelming approval of the proposed concept plan.

TWIN LAKES BEACHFRONT DESIGN CONCEPT

The overall proposed design concept for East Cliff Drive between 5th Avenue and 9th Avenue provides for continuous pedestrian access (separated from bicycles and vehicles), and bicycle lanes through the area, while also organizing parking and improving vehicle circulation. It does so in a manner that results in an improved but

informal and natural beachfront character. The proposed concept plan, with sections, is included in Attachment 1.

Pedestrian and Bicycle Improvements

The concept plan provides a continuous 6 to 10 foot wide pedestrian pathway along the beach side of East Cliff Drive from the 5th Avenue circle to the headwall of the Schwan Lake overflow weir, sidewalk infill from 7th to 8th Avenues (inland side), and an informal path between 6th and Assembly Avenues (inland side). The west end of the beachfront pathway will connect to the existing sidewalk at the harbor concession parking lot and Marine Sanctuary Interpretive Site where there is an existing crosswalk and connecting sidewalk at 5th Avenue. An additional crosswalk will be added to connect pedestrians from the 6th Avenue neighborhood (from the north) to the beachfront pathway. The existing crosswalk at the end of 9th Avenue will be upgraded. This will allow pedestrians to have access to Schwan Lake and to the planned pathway around the lake up to 12th Avenue (Phase 2) where it ties in to an existing sidewalk. The plan also provides for continuous 5-foot wide bike lanes on each side of East Cliff Drive through the area.

The proposed pathway will be resin stabilized decomposed granite, similar to the nearby Lake and 5th Avenues Improvements project. The material has a more natural character and has been positively received by the community. Many areas along the pathway will include native landscape plantings and boulders. Bike racks will be strategically located along the pathway. During most of the year the pathway surface between the harbor and Assembly Avenue will be flush with the beach to provide direct accessibility. In addition, at the east end of the pathway at the Schwan Lake outfall, an accessible ramp down to the sand will be provided. The service road down onto the beach from the 9th Avenue circle will also provide an accessible path of travel. Other access points to the beach include two stairways down the slopes just southwest of the state restroom, and north of the Sanitation District pump station.

Circulation and Parking Improvements

Vehicle circulation, in particular for trucks and buses, is improved by increasing the diameter of the traffic circle at 5th Avenue harbor parking lot entrance, by modifying the road layout changing the 7th Avenue curve radius to the west along the beach, and by realigning the road to the north of its existing location (away from beach parking). The proposed plan fully utilizes the right-of-way, providing room for new improvements, while limiting encroachment onto beach areas. The design also provides passenger loading areas at the 5th Avenue circle and on East Cliff Drive across from 8th Avenue, providing a safe location to pull out of the flow of traffic during peak use times when beach goers must park in other locations. Two alternative locations for the Live Oak parking permit sales are also shown. Future planning work will also include new area signage.

The plan calls for organizing parking in diagonal parking spaces between 5th and 6th Avenues (on the inland side), between 5th and Assembly Avenues (beach side), between 8th and 9th Avenues (beach side), and parallel parking spaces around the

modified 9th Avenue circle, plus motorcycle parking east of Assembly Avenue (inland side). The diagonal parking arrangement maximizes the number of parking spaces, while allowing sufficient room to also provide for pedestrian and bicycle improvements. The total number of proposed parking is approximately 60 spaces as compared to the existing, random parking that numbers about 70 spaces. Clustering the parking will also improve views to the beach and bay, and provide visual relief from long rows of parked cars and large vehicles such as RV's and commercial trucks.

Staff also prepared conceptual design plans for redesign of the parking area at the 11th Avenue spur where East Cliff curves around Schwan Lake at the east end of Twin Lakes Beach (see Attachment 2). With community support for parking and scenic overlook improvements, staff now recommends including this work in the Phase 2 project currently in the planning stage.

Coastal Protection and Other Improvements

Protection of the proposed and existing public improvements along East Cliff Drive from winter storm events and coastal erosion will be an important component of any future project. Recommendations for coastal protection measures have been prepared to address several distinct problems and situations along different areas of the beachfront. These include:

- 5th Avenue to the curve at 7th Avenue: Exposure to significant storm wave run up results in the scouring of sand deposits that cover the Purissma bedrock. A concrete retaining wall with simulated rock facing (as used on the bluff along East Cliff Drive in Pleasure Point) is proposed from bedrock to desired finish grade. The beach face of the wall will be backfilled with sand and replenished regularly as part of the harbor dredging work to maintain on-grade beach access.

- Curve at 7th Avenue north to State Park restroom: The grade change in this area is exposed to significant storm wave run up impact. A stepped concrete retaining wall is proposed from finished bluff grade to bedrock, then backfilled with sand and planted with native vegetation to stabilize the slope. A split rail fence would be installed near the top to discourage access down the sandy slope.

- Segment from 7th Avenue intersection curve to Schwan Lake headwall: This area has less exposure to storm wave run up. Short retaining walls with drilled piers are proposed to support pedestrian improvements at the top and conform to existing hillside slopes. Existing rip rap would be retained.

These conceptual approaches will require further study and technical analysis as planning and design for this project moves forward. In addition, storm drainage and water quality enhancement and requirements for undergrounding of overhead utility lines will be studied and incorporated into future preliminary design plans. Based upon

the conceptual design plans which are very preliminary in nature, it is estimated that construction of the proposed improvements to East Cliff Drive, including coastal protection measures, will range from $3 to **$4** million.

The community also expressed interest in replacement of the existing State Park restroom and showers. We have learned that replacement of this facility is low on the State priority and funding list. Staff recommends engaging the regional State Park staff in further discussions on the feasibility of replacing this structure and potential funding arrangements, including cost share approaches, with a future report back to your Board on options for replacement of this facility.

East Cliff Drive has also been identified for a future utility undergrounding project. Once preliminary design plans have been prepared, further coordination with PG&E, cable, and phone companies will be required, if the undergrounding is to occur prior to the construction of the planned improvements.

NEXT STEPS

With approval of the conceptual design, additional steps will need to be taken to move forward with this project, including a tidal study, coastal erosion report, biotic study, drainage assessment, input from and coordination with Coastal Commission and State Parks staffs, and the preparation of project development plans for the Planning permit application. It will be necessary to use consultant services for much of this work. Funds are available in the current RDA budget to complete these next steps. Easement acquisition and preparation of final construction documents will follow the permit process. Construction could begin in 2011 pending funding.

CONCLUSION

We are pleased to have successfully concluded this phase of the community input process. Difficult trade-offs are often required when addressing the need for public improvements in existing developed areas. However, community interest and support for improvements to the Twin Lakes Beachfront area of Live Oak is strong. Staff believes that the proposed concept plan addresses the goals of the community, and that implementation of this plan will improve the community's enjoyment and use of this scenic and recreational area along the beach. With approval of the conceptual design, staff will move forward with the preparation of studies and design plans necessary for the permit process, and continue to coordinate these efforts with staff of reviewing agencies and State Parks.

It is therefore RECOMMENDED that your Board, as the Board of Directors for the Redevelopment Agency, take the following actions:

1. Accept and file this report;

2. Approve the proposed design concept for the Twin Lakes Beachfront – East Cliff Drive from 5th to 9th Avenues as shown in Attachment 1 and described in this report; and

3. Direct staff to include scenic overlook and parking improvements at the 11th Avenue spur of East Cliff Drive, as shown in Attachment 2, in the Phase 2 – East Cliff Drive Pedestrian Walkway 9th to 12th Avenues Project;

Very truly yours,

Betsey Lynberg
Redevelopment Agency Administrator
BL:jd

RECOMMENDED:

Susan A. Mauriello
Redevelopment Agency Executive Director

Attachment 1: Twin Lakes Beachfront Conceptual Plan Exhibit Package
Attachment 2: Conceptual Design for the Scenic Overlook and Parking at the 11th Avenue Spur

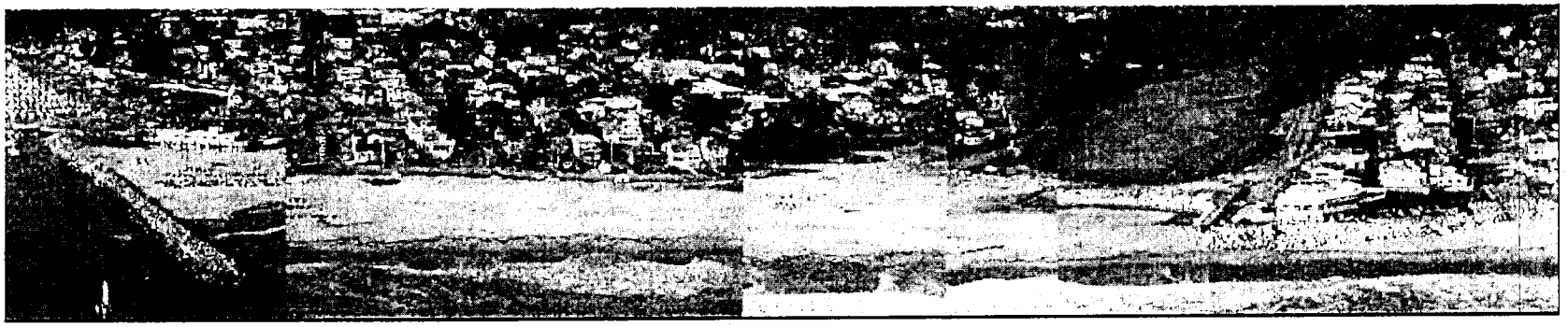
cc. Department of Public Works
Parks Department
California State Parks
Santa Cruz Port District

ATTACHMENT 1

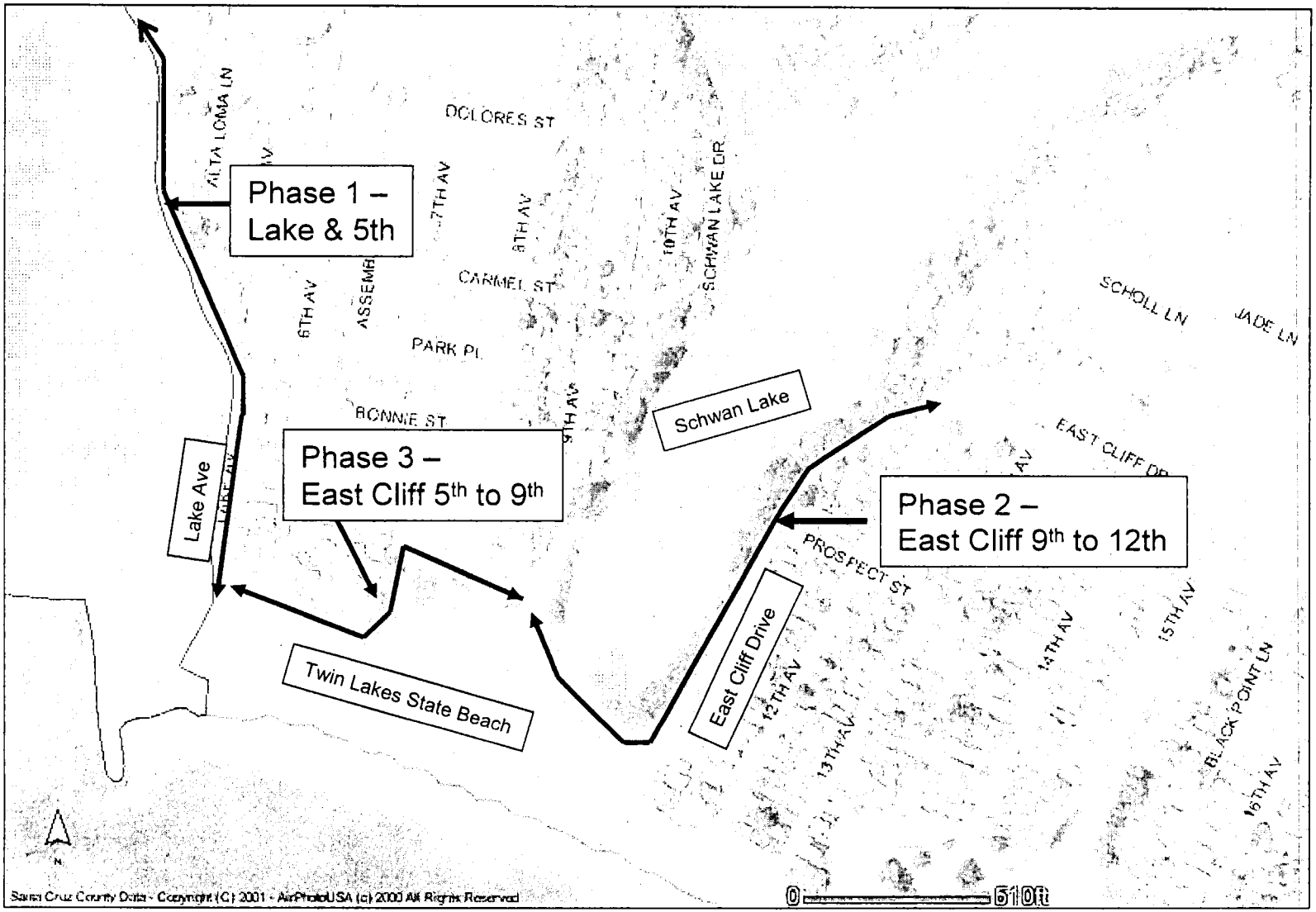
TWIN LAKES BEACHFRONT - PHASE 3
ATTACHMENT 1 - CONCEPTUAL PLAN EXHIBIT PACKAGE
AUGUST 12, 2008

Page	Item
1	Vicinity Map
2	Existing Conditions (photos)
3,4,5	Photo Sections (existing conditions)
6	Project Goals and Objectives
7	Concept Plan
8,9,10	Concept Plan Sections
11	Concept Plan Sketch
12	Design Images

Concept Plan 11X17 on file with Clerk of Board



ATTACHMENT 1 S



Vicinity Map

Santa Cruz County Redevelopment Agency

TWIN LAKES

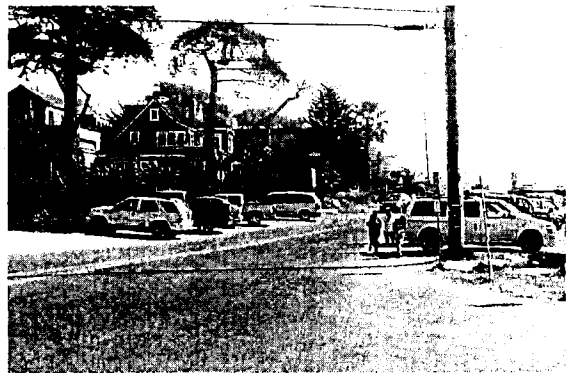
PROJECT

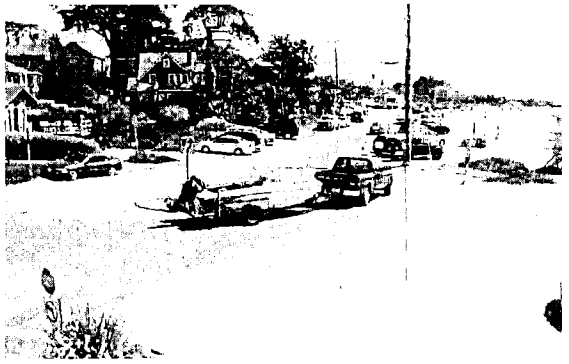
ATTACHMENT 19

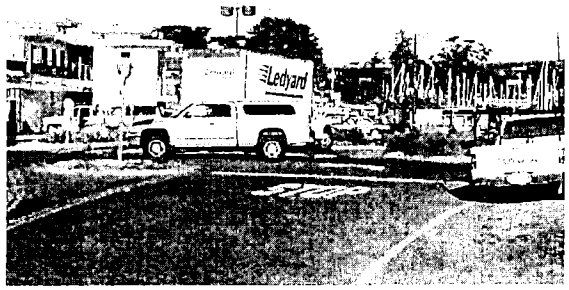
pln056

Santa Cruz County Redevelopment Agency

TWIN LAKES PROJECT

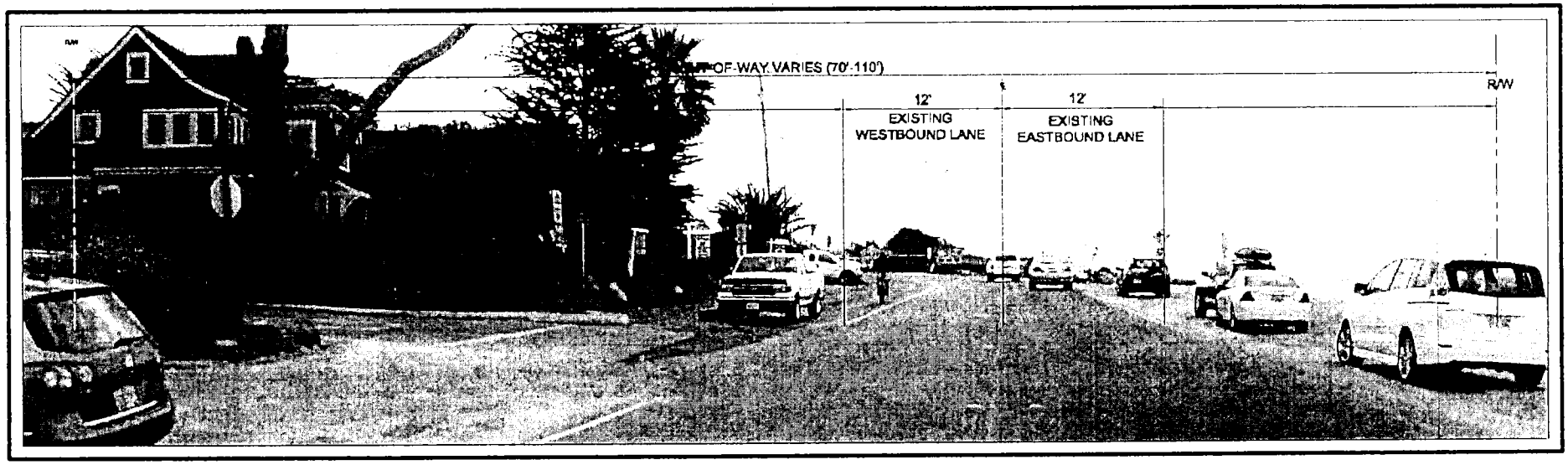






EXISTING CONDITIONS

ATTACHMENT 19

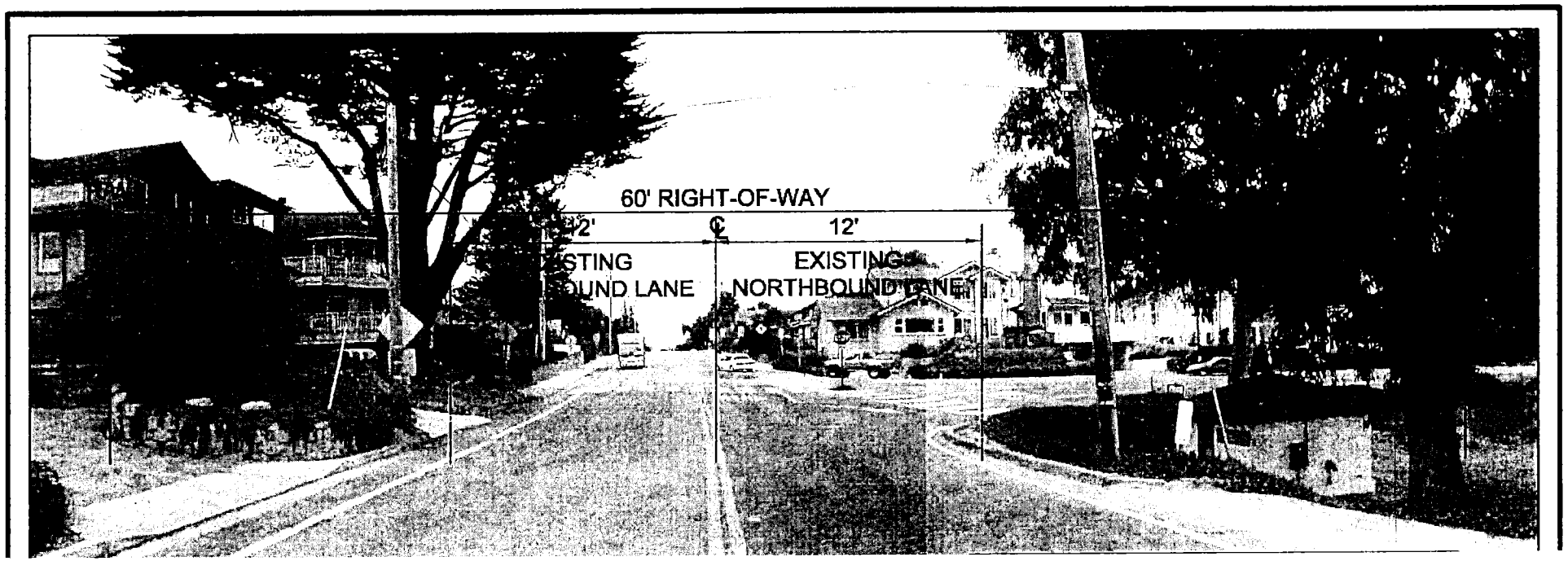


Section A
East Cliff Drive at 6th Avenue looking east

Santa Cruz County Redevelopment Agency
TWIN LAKES
PROJECT

ATTACHMENT 19

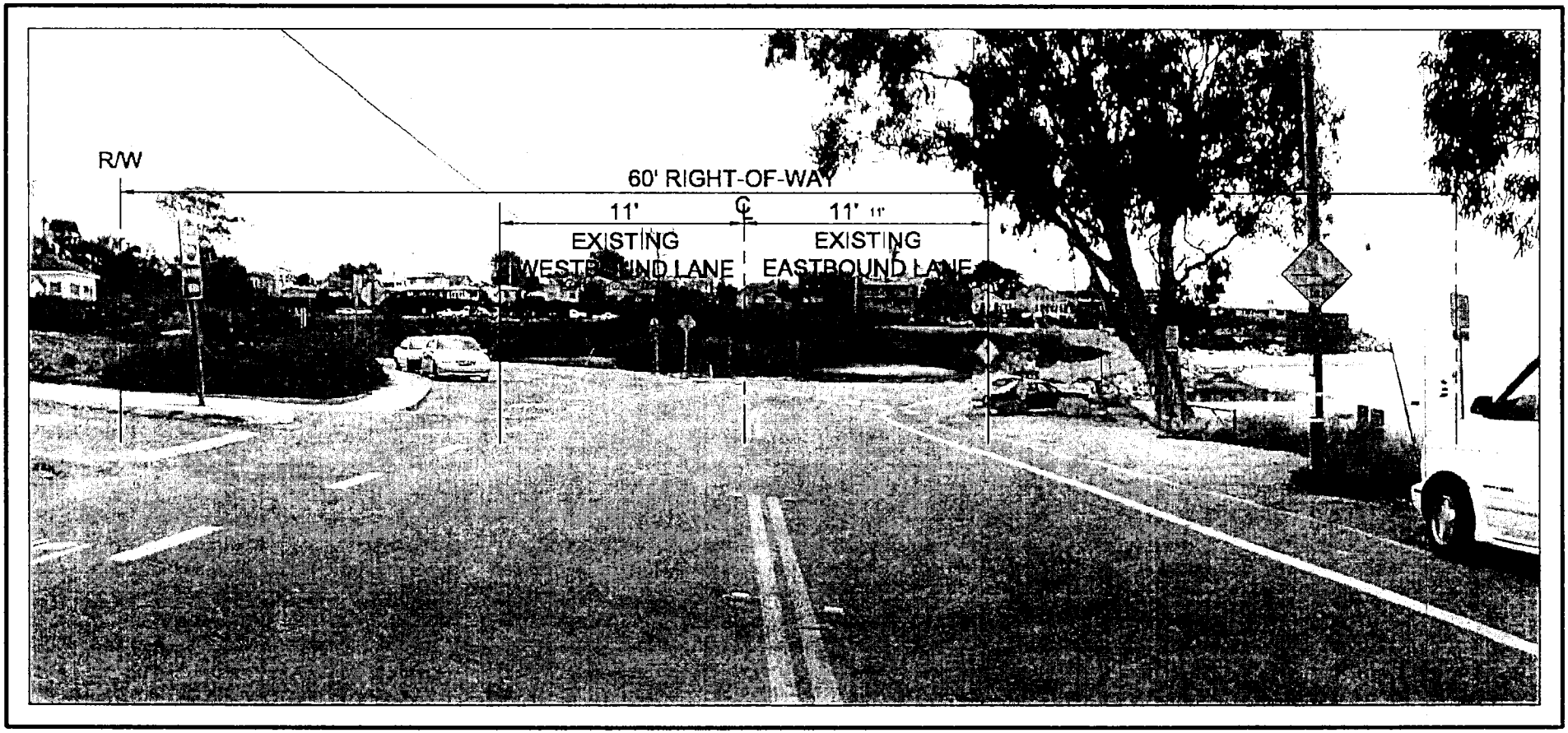
pln056



Section B
7th Ave at East Cliff Drive looking north

Santa Cruz County Redevelopment Agency
TWIN LAKES
PROJECT

ATTACHMENT 1



Section C
East Cliff Drive at 8th Ave looking east

Santa Cruz County Redevelopment Agency
TWIN LAKES
BEACHFRONT
PROJECT

ATTACHMENT 19

Twin Lakes Beachfront Phase 3

GOALS AND OBJECTIVES

Goal A Maximize Pedestrian Access and Safety

1. Provide pedestrian crosswalks at major intersections from the surrounding neighborhoods to the beach.
2. Provide adequate space so that pedestrians and bicyclists are separated and have their own space.
3. As much as possible, provide continuous access along the beach frontage.
4. Provide for additional disabled access to the beach as part of any new improvements.
5. Provide some places for people to sit.

Goal B Provide for Safe Bicycle Access

1. Provide bicycle lanes along East Cliff Drive to conform to current county standards.
2. Provide bicycle parking areas in various locations along the beach front area.
3. Resolve potential conflicts between bicycle lanes and vehicle parking as much as possible.

Goal C Improve Parking and Vehicular Circulation

1. Vehicular circulation and parking should be designed to minimize pedestrian vehicular conflicts.
2. Maintain two-way traffic flow along East Cliff Drive.
3. Organize layout of parking so as to control and limit random parking and conflicts with pedestrians and bicycles. Provide clearly defined parking spaces.
4. Provide sufficient parking to mitigate the demand for additional parking on neighborhood streets, and obtain permit approvals.
5. Provide drop-off and pick-up areas for people to load and unload beach and picnic gear.
6. Enlarge circle/turnaround at Fifth Avenue to accommodate large vehicles.
7. Provide adequate signage to orient first time visitors to the area.
8. Parking layout should minimize disruption of the views to the bay and the beach.
9. Eliminate the bus stop at the foot of Fifth Avenue.
10. A median dividing traffic lanes is not necessary.

Goal D Maintain Scenic Quality

1. Where possible, underground electric wires along the ocean side of the road.
2. Utilize native plantings for new landscape areas. Major trees in the area should be protected.
3. Minimize the use of tall vegetation which would block views of the beach.
4. Keep improvements simple and utilize natural materials as possible. Character of the area should not be "urban".

Goal E Plan for Other Improvements

1. Provide adequate drainage facilities which meet storm water quality requirements.
2. Provide adequate stabilization for the area where there is danger of erosion of the road and the adjacent bluff. Materials should blend in with the natural character of the area as much as possible.
3. Do not allow campers or RV's to dominate the public access to the area

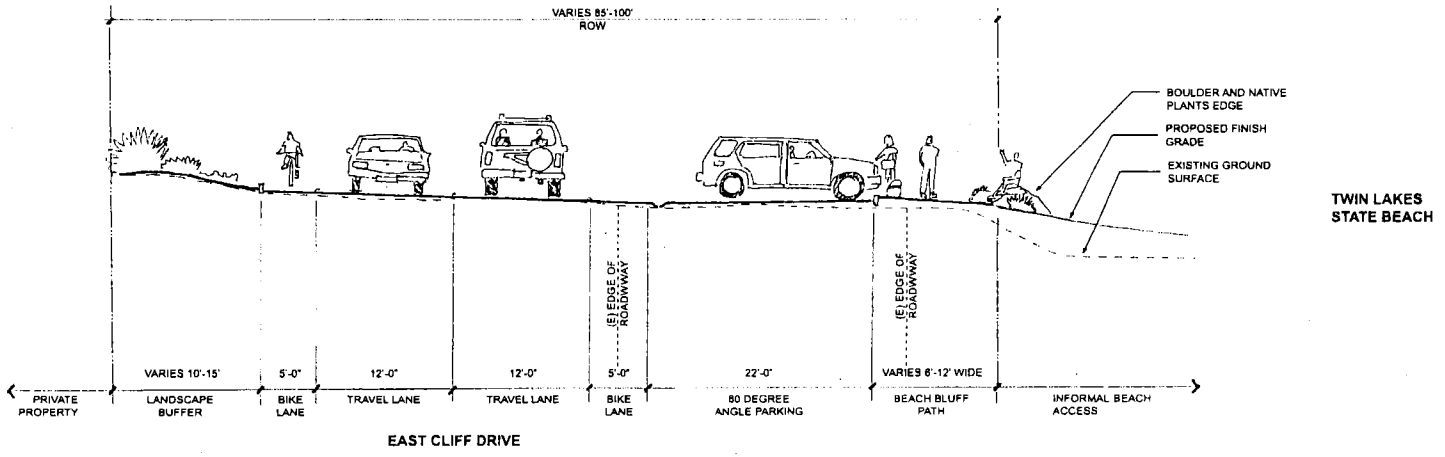
ATTACHMENT 19

ATTACHMENT 19

Santa Cruz County Redevelopment Agency

TWIN LAKES

PROJECT



SECTION A

REVISED JULY 2, 2008

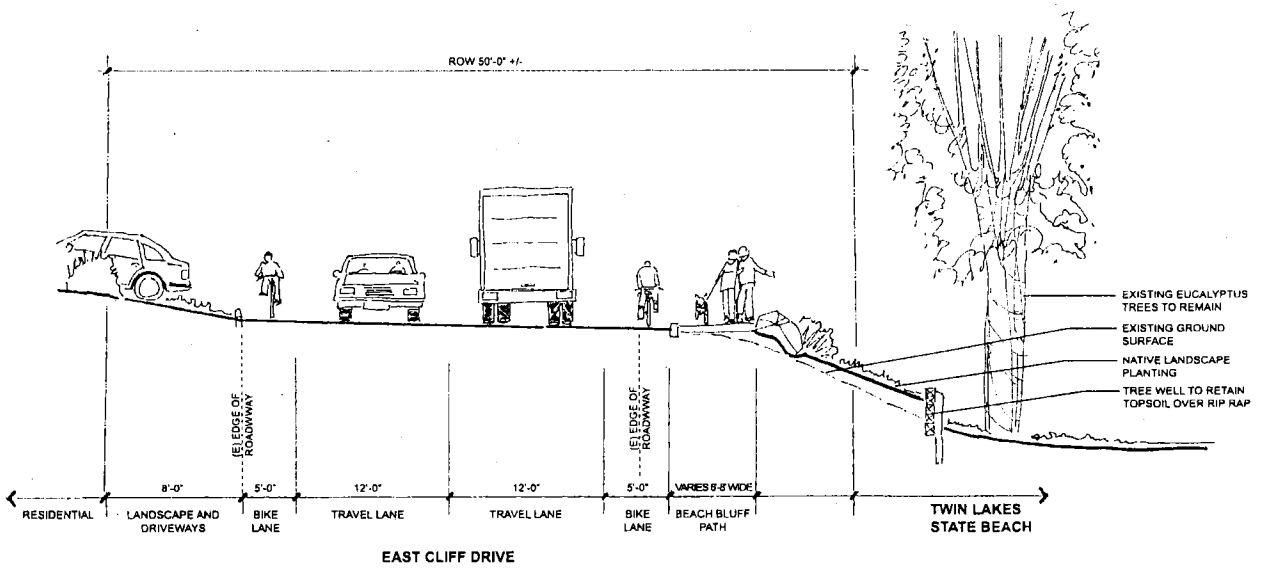
5 0 5 10

ATTACHMENT 19

Santa Cruz County Redevelopment Agency

TWIN LAKES

PROJECT



SECTION B

REVISED JULY 2, 2008

5 0 5 10

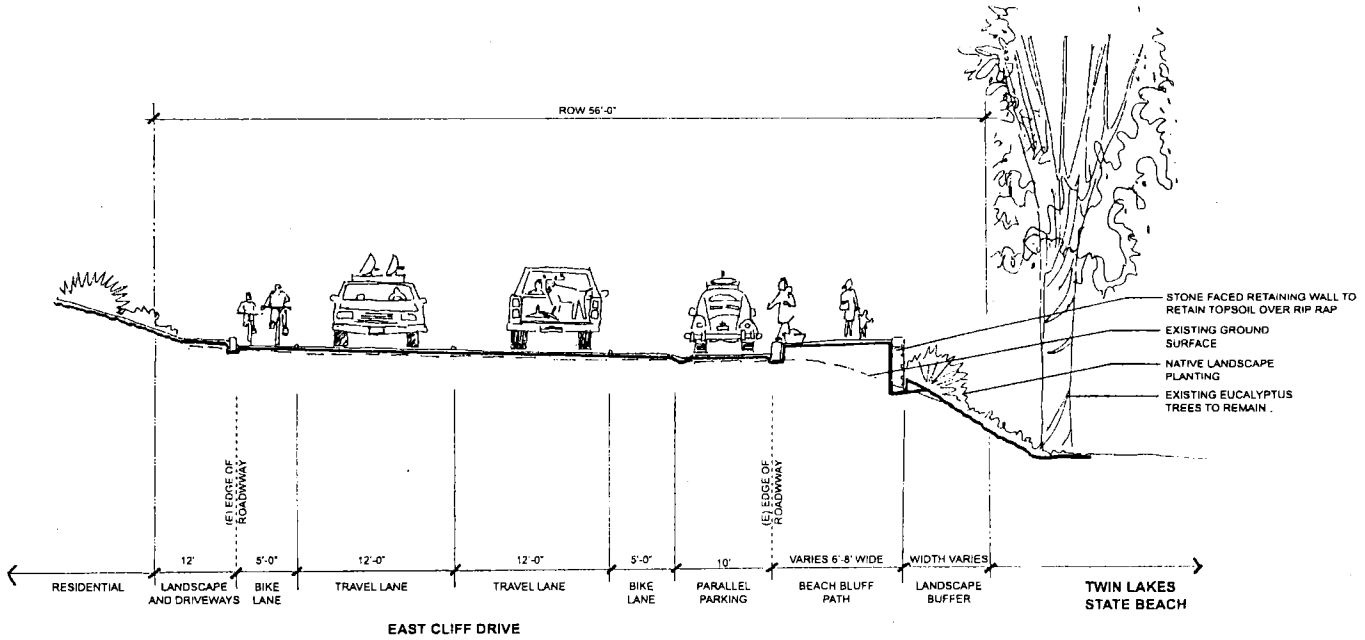
ATTACHMENT 1

plot st

Santa Cruz County Redevelopment Agency

TWIN LAKES

PROJECT



SECTION C

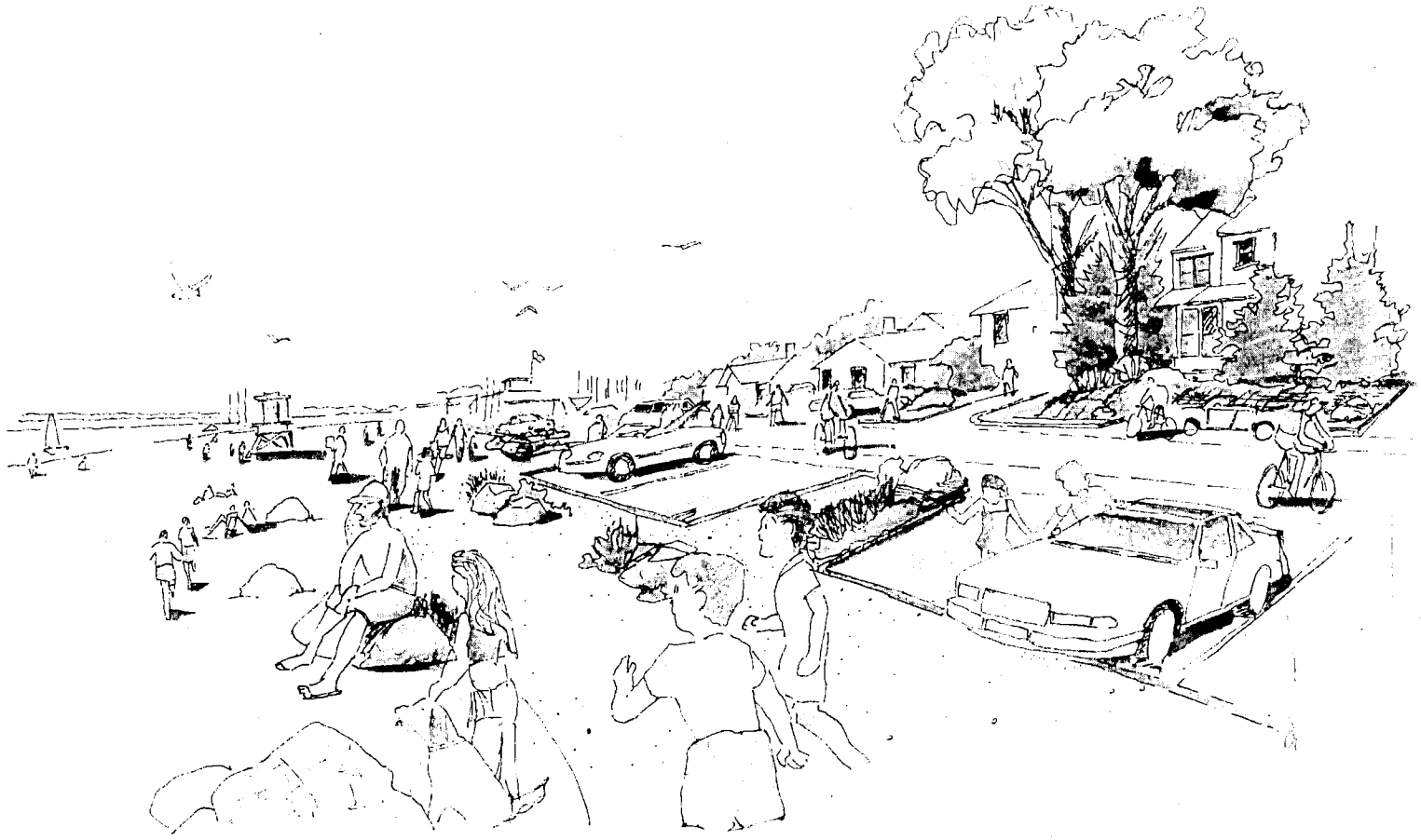
REVISED JULY 2, 2008

5 0 5 10

ATTACHMENT 1 6

Santa Cruz County Redevelopment Agency

TWIN LAKES PROJECT

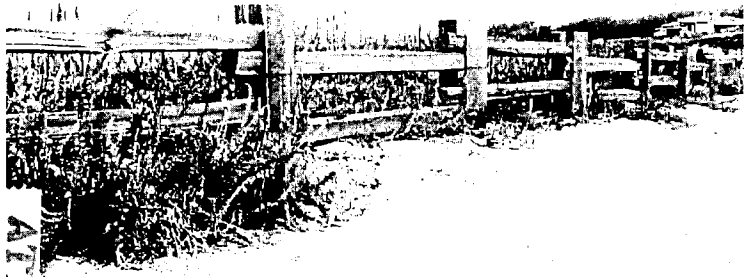


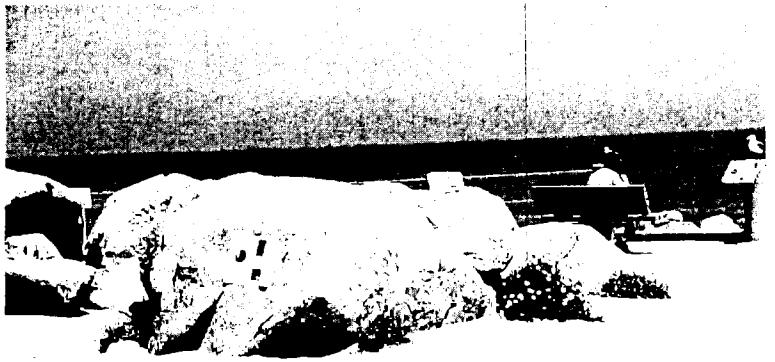
BEACH PATHWAY AND PARKING

ATTACHMENT 19

Santa Cruz County Redevelopment Agency

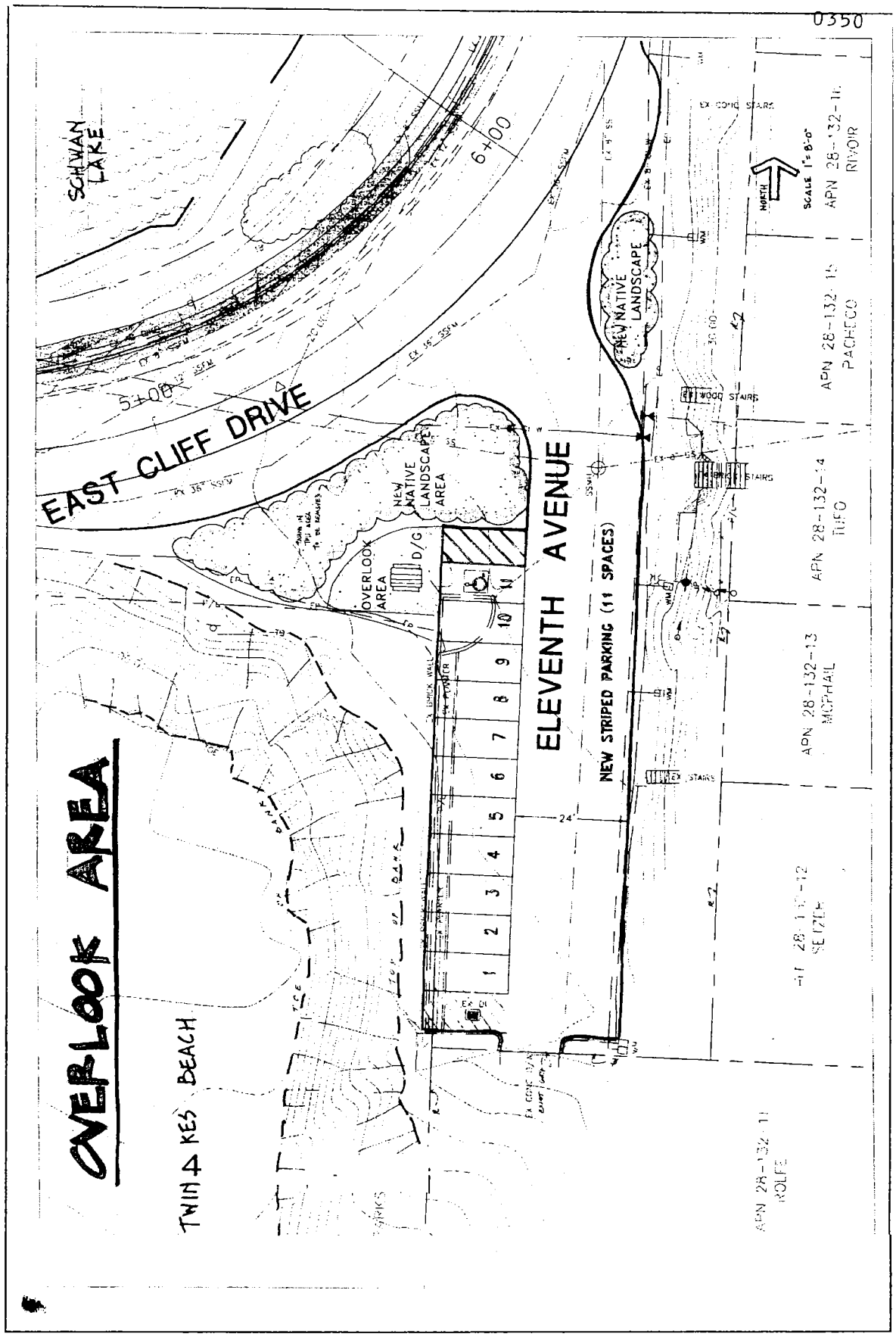
TWIN LAKES PROJECT





ATTACHMENT 7

DESIGN IMAGES


0350
SCHWAN LAKE
EAST CLIFF DRIVE
5+00
6+00
ELEVENTH AVENUE
NEW STRIPED PARKING (11 SPACES)
NEW NATIVE LANDSCAPE AREA
NEW NATIVE LANDSCAPE
OVERLOOK AREA
D/G
WOOD STAIRS
STAIRS
EX STAIRS
EX CONC STAIRS
NORTH
SCALE 1"=8'-0"
APN 28-132-14
TUFO
APN 28-132-13
MCPHAIL
APN 28-132-12
SEIZER
APN 28-132-11
ROLFE
APN 28-132-10
RIVOIR
APN 28-132-15
PACHECO
OVERLOOK AREA
TWIN 4 KES BEACH
1
2
3
4
5
6
7
8
9
10
11
24'
42'

Sheila McDaniel

From: Greg McPheeters [gmcpheeters@gmail.com]
Sent: Monday, April 16, 2012 7:54 PM
To: Sheila McDaniel
Subject: Re: EAST CLIFF DRIVE PEDESTRIAN IMPROVEMENTS PHASE III

That worked - thanks!

Greg

On Mon, Apr 16, 2012 at 8:10 AM, Sheila McDaniel <PLN056@co.santa-cruz.ca.us> wrote:

Greg,

Go to the Planning Department web site and look at the left hand column in blue and you will find "Agendas". Click that and find the Environmental Review Agendas and go to April 4/9/2012. The entire document and mitigations are posted there.

Sheila

From: Greg McPheeters [mailto:gmcpheeters@gmail.com]
Sent: Sunday, April 15, 2012 1:33 PM
To: Sheila McDaniel
Subject: EAST CLIFF DRIVE PEDESTRIAN IMPROVEMENTS PHASE III

Sheila -

I'm looking on the site to see the plans for the project listed in the subject, and having a hard time finding them. Is there a direct link to more information about this project on the page? Can you direct me to where it is either step by step or with a direct link?

Greg

Greg McPheeters
Chair - Sierra Club Transportation Committee

ATTACHMENT 28

Sheila McDaniel

From: Joyce Wrenn [jmwrenn@yahoo.com]
Sent: Sunday, April 22, 2012 12:20 PM
To: Sheila McDaniel
Cc: Monica Cramer; Gus Gregory
Subject: Public Notice on E. Cliff Dr. improvements, appl. #111134

Sheila,
I have read the public notice taped on the pole across the street from my house (2655 E. Cliff Dr.). Would it be possible for you to send me an electronic copy of the notice via email? That way I could email it to many of the other neighbors on this portion of E. Cliff Dr. to keep them informed since many of them don't live here as their primary residence.
I also wanted to make you aware that one of the neighbors, Richard Rivoir, pulled into our driveway this past week and got out of his vehicle. My husband could see this from our side window. My husband went out through our garage door and asked Richard what he was doing. He said he was measuring driveways. Unfortunately, my husband did not ask him 'why'. I felt you should be aware of this since Richard has a history of opposing this project.
My husband and I are very much in favor of the project. I walk my dog twice a day on this stretch of road and find it very very dangerous in its current state. Please let us know if we can help you in any way.
Joyce Wrenn and Gus Gregory (831-475-0817)

ATTACHMENT

Sheila McDaniel

From: Joyce Wrenn [jmwrenn@yahoo.com]
Sent: Monday, April 23, 2012 2:26 PM
To: Beau Hawksford
Cc: Sheila McDaniel
Subject: Re: Application #111134 East Cliff Drive Pedestrian Improvements Phase III

Thank you -- I will forward it to the neighbors.

From: Beau Hawksford <PLN412@co.santa-cruz.ca.us>
To: "jmwrenn@yahoo.com" <jmwrenn@yahoo.com>
Cc: Sheila McDaniel <PLN056@co.santa-cruz.ca.us>
Sent: Mon, April 23, 2012 10:06:31 AM
Subject: Application #111134 East Cliff Drive Pedestrian Improvements Phase III

Good Morning Joyce,

Attached is the Environmental Coordinator's Public Notice of Intent to Adopt a Negative Declaration With Mitigations for the E. Cliff Drive Pedestrian Improvements project as you requested.

Beau Hawksford
Clerk - Planning Commission/Zoning Administrator
Santa Cruz County Planning Department
(831) 454-3371

ATTACHMENT 2 C

Sheila McDaniel

From: Charles Paulden [paulden4supervisor@yahoo.com]
Sent: Wednesday, May 02, 2012 5:15 PM
To: Sheila McDaniel
Subject: App#11134 East Cliff Phase III

Sheila McDaniel

The work to get green stormwater management in the RDA funding seems not to be included in this design.
The cleansing, does not add to recharge and may add to the saltwater intrusion and the call for De Sal.
"The Agency will seek to use new and innovative storm water practices both in site-specific projects and in common infrastructure projects. For common infrastructure projects, such as neighborhood/regional storm water removal, such practices could include, but are not limited to, bio-retention areas, filters (including gravel and organic filters), surface and perimeter filtration areas, vegetated swales, and wetlands, as applicable. For site-specific projects, such as buildings and parks, low impact development practices shall be incorporated in the site planning and design process, including leaving undisturbed pervious areas, and the use of vegetated filter strips, grass channels, retention areas, and permeable pavements"
http://sccounty01.co.santa-cruz.ca.us/red/buildastrongersoquelandliveoak/2010-2014%20IP%20FINAL2.pdf
p. 22 paragraph 3

I was not able to find the material they propose for the pathway.
As seen in Pleasure Pt, decomposed granite makes a permeable and more natural surface, that is ADA compliment.
Or will they continue the use of the stabilized earth, as seen along Lake Ave and Portola from the Library to 30th Ave and Warf Rd from Soquel Dr towards the Freeway?
This more natural aesthetic would help preserve the character of this area.

The Palm would be easy to transplant and is a valuable tree which would cost a lot to buy. It might also be added as a specimen tree at one of our parks. If the County does not want to re-purpose this resource, perhaps SOS or another non profit, could raffle it as a fund raising tool.

Have they set a price on this project? Would that money be better spent on keeping Parks open until we see the economy turn around?

The existing use seems to have served us for 100 years and through a decade of planning, maybe it is not an emergency project at this time.

Thank you
Charles Paulden

ATTACHMENT

Sheila McDaniel

From: Sheila McDaniel
Sent: Wednesday, May 23, 2012 4:22 PM
To: 'Sarah Damron'
Subject: RE: MND for East Cliff Dr. Pedestrian Improvements Project

The project is not scheduled for the June 15th Zoning Administrator Agenda. It will be scheduled for the planning commission. No date has been set yet.

From: Sarah Damron [mailto:sdamron@surfrider.org]
Sent: Wednesday, May 23, 2012 4:23 PM
To: Sheila McDaniel
Cc: Beau Hawksford; Matt Johnston
Subject: Re: MND for East Cliff Dr. Pedestrian Improvements Project

Thanks, Sheila and Beau!

In regards to reports, I am looking for
1. Update to Geologic Investigation by Rogers E. Johnson, dated June 4, 2009
2. Update Geotechnical and Coastal Engineering Investigation by Haro, Kasunich and Associates, revised August 2009
3. Halcrow Sea Wall Design Report, dated August 1, 2011

If those could be placed on hold for me, I would greatly appreciate it. I don't believe I will be up that way until June 7, but I can let you know if that changes.

I will keep an eye out for the June 15 Zoning Administrator agenda, but if you happen to learn when the item might come up before that, please let me know. I understand that our Santa Cruz Chapter has missed the opportunity to comment on the MND, so they are hoping to provide comments at the public hearing.

Thanks!
Sarah Damron
Central California Regional Manager
Surfrider Foundation
sdamron@surfrider.org
cell: 831 239 1520

http://twitter.com/#!/cencalsurfrider
https://www.facebook.com/cencalsurfrider

On May 23, 2012, at 3:58 PM, Sheila McDaniel wrote:

Sarah,

ATTACHMENT 2 P

As noted in the initial study attachments section, if you would like to see reports they can be made available in our records room for review. Should you desire copies, the records room staff will make copies for you with a copy charge per sheet. Please indicate which reports, rather than attachments, you would like, and I will place them with the records room staff.

Thank you,

Sheila

From: Beau Hawksford
Sent: Wednesday, May 23, 2012 3:54 PM
To: 'Sarah Damron'
Cc: Sheila McDaniel; Matt Johnston
Subject: RE: MND for East Cliff Dr. Pedestrian Improvements Project

Hi Sarah,

I do not have electronic copies of the full versions of the Attachments. I am not certain if I could obtain copies from our Environmental Coordinator to email to you or if you would need to come in to obtain them. The item has been postponed, however, I do not have a future date to give you at this time. I am copying this e-mail both the Project Planner as well as the Environmental Coordinator. Hope this helps.

Sincerely,

Beau Hawksford
Clerk - Planning Commission/Zoning Administrator
Santa Cruz County Planning Department
701 Ocean St., 4th Floor
Santa Cruz, CA 95060
(831) 454-3371
pln412@co.santa-cruz.ca.us

From: Sarah Damron [mailto:sdamron@surfrider.org]
Sent: Wednesday, May 23, 2012 3:38 PM
To: Beau Hawksford
Subject: Re: MND for East Cliff Dr. Pedestrian Improvements Project

Thanks, Beau!

Do you happen to have electronic copies of the full versions of Attachments 3, 4, and/or 8, or are those only on file at the County building?

Also, this item was slated to be heard at the Zoning Adminstrator's June 1 hearing, but I noticed it is not on the agenda. Has it been postponed?

Thanks!
Sarah Damron
Central California Regional Manager
Surfrider Foundation
sdamron@surfrider.org

ATTACHMENT 26

cell: 831 239 1520

http://twitter.com/#!/cencalsurfrider
https://www.facebook.com/cencalsurfrider

On May 3, 2012, at 9:29 AM, Beau Hawksford wrote:

Good Morning,

I've attached a link from the Planning Department's website below; it takes you directly to the East Cliff document. Please call or email me if you have any trouble opening the link.

http://sccounty01.co.santa-cruz.ca.us/planning/plnmeetings/PLNSupMaterial/Environmental/Minutes/2012/20120409/001.pdf

Sincerely,

Beau Hawksford
Clerk - Planning Commission/Zoning Administrator
Santa Cruz County Planning Department
701 Ocean St., 4th Floor
Santa Cruz, CA 95060
(831) 454-3371
pln412@co.santa-cruz.ca.us

ATTACHMENT 26

Sheila McDaniel

From: Sheila McDaniel
Sent: Thursday, May 31, 2012 11:17 AM
To: 'Joyce Wrenn'
Subject: RE: E. Cl Dr. redev. project

Thanks for that. It does help! I appreciate the effort spent finding this information.

From: Joyce Wrenn [mailto:jmwrenn@yahoo.com]
Sent: Wednesday, May 30, 2012 8:04 PM
To: Sheila McDaniel
Cc: Jerry & Brie Sweetland
Subject: Fw: E. Cl Dr. redev. project

Sheila, my son-in-law found these pics and I believe they are exactly what you need. Go to the web site below in his email and then scroll to image 8712188 June 1987. By clicking on the image you can magify it. You will see the now Wessbecher and Rivoir property with only one house on it and 2 'heritage' trees. The tree in question in the legal filing is not even there and this is 1987. Then scroll to image 6624 Sept. 30, 2002 and you will see the current 2 houses on that lot and 3 cypress trees. The tree in question is much smaller than it is today but of course the pic was taken 10 years ago. And these two images are apparently part of the California Coastal Records Project. In the image taken 10 years ago, you will see all the other extensive landscaping Richard Rivoir added. Hope this is helpful.
Joyce

----- Forwarded Message ----
From: Jerry Sweetland <jerrybrie2001@yahoo.com>
To: Joyce Wrenn <jmwrenn@yahoo.com>; Brie Wrenn <briewrenn@charter.net>
Sent: Wed, May 30, 2012 3:43:13 PM
Subject: RE: E. Cl Dr. redev. project

http://www.californiacoastline.org/cgi-bin/image.cgi?image=6622&mode=sequential&flags=0&year=2002

"I know in my heart that man is good, that what is right will always eventually triumph and there is purpose and worth to each and every life." RR

Jerry Sweetland

From: Joyce Wrenn [mailto:jmwrenn@yahoo.com]
Sent: Wednesday, May 30, 2012 12:30 PM
To: Jerry & Brie Sweetland; Brie Wrenn
Subject: E. Cl Dr. redev. project

The project was supposed to be on Friday's (6/1) Zone Admin. public hearing but was taken off the agenda because a lengthy legal document was filed by Uwe Wesssbecher and his lawyer regarding the environmental review of the project. It apparently revolves around the cypress tree that the project plans to remove. I would bet that Richard Rivoir is really behind the legal filing. The Wessbecher house is at the corner of 6th Ave. and E. Cliff Dr. and is the one Rivoir remodeled. Some of us think that Richard planted that tree years ago as a way

ATTACHMENT 2 (

of saving more of the front yard of that house because it really encroaches on county property, as you know. Anyway, more work now needs to be done before the environmental review can be concluded.

Do you have any early pictures of this area of E. Cliff which would show the property without the tree or very early in its life? Don't know that it will be needed but if you have one, would really appreciate it if you could scan it and email it to me.

The staff planner today told me that the next meeting on the project may be in front of the Board of Supervisors which may be July 11. Gus and I will be flying back from Alaska that day. Would be super if one of you could attend the meeting if it should occur that day. But chances are it will be later -- who knows? Will keep you posted.

Love you, Mom/J

ATTACHMENT 2 p

CBD BOSMAIL

From: CBD BOSMAIL
Sent: Friday, August 08, 2008 7:16 AM
To: CBD BOSMAIL
Subject: Agenda Comments

Meeting Date : 8/12/2008

Item Number : 41

Name : Michael A. Guth

Email : mguth@guthpatents.com

Address : 2-2905 East Cliff Drive
Santa Cruz

Phone : 831 462-8270

Comments :
In general, I support the proposed plan for the 5th to 7th Avenue beachfront. I greatly appreciate the level of outreach done by the RDA and do believe the goals identified, that of improving pedestrian and bicycle use and safety in this area, are paramount, as well as working towards continuous bicycle and pedestrian pathways from 5th(Lake) Ave to Pleasure Point.

One item that I must point out is this: The concept plan refers to backfilling of the new protection walls with sand, this being done by the Port District's dredging. I believe that the project is fine without depending upon this, and would like confirmation that it indeed is. THE COUNTY SHOULD IN NO WAY BE PUTTING A STAMP OF APPROVAL ON HARBOR DREDGE DISPOSAL PROTOCOLS VIA THIS PROJECT. The disposal of dredge spoils is a complicated issue, involves numerous tradeoffs and of the limited amount of sand in the annual littoral drift, any sand diverted above the tide lines to supplant this beach area is sand removed from the natural flow, and impacts downflow areas, especially Pleasure Point. The Port District's diversion of sand into their own beach area has always needed to be reviewed by a larger regional working group, to review just these sort of issues. The RDA should be very careful of buying into the current system of management here, and should be sure that thier concept plan here works with or without sand being filled up to grade (I believe that it does; this should be confirmed).

I support the RDA work here, I see that is a good compromise to achieve some not completely complementary goals, and urge you to approve the plan, subject to the concern stated above.

Thank you.

41

ATTACHMENT 2 0

CBD BOSMAIL

From: CBD BOSMAIL
Sent: Monday, August 11, 2008 8:34 PM
To: CBD BOSMAIL
Subject: Agenda Comments

Meeting Date : 8/12/2008

Item Number : 41

Name : Linda Wilshusen

Email : l-j-w@pacbell.net

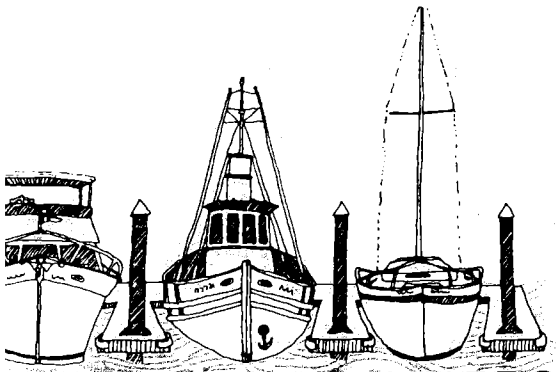
Address : 1115 Live Oak Ave.
Santa Cruz 95062

Phone : 462-6241

Comments :
I enthusiastically support this project. It will be a terrific enhancement to the Twin Lakes/Live Oak beach neighborhood, which is used primarily by local Santa Cruz County residents. There is demonstrated strong community support for these much needed and long overdue pedestrian and parking improvements along our local beachfront.

Thank you very much to the Redevelopment Agency and our 3rd & 1st District Supervisors for their ongoing support of improvements to the beautiful Twin Lakes area.

Linda Wilshusen, Founder and Steering Committee, Live Oak Neighbors



SANTA CRUZ HARBOR

Gateway to the Monterey Bay National Marine Sanctuary

July 31, 2012

Ms. Sheila McDaniel, Planner
Santa Cruz County Planning Department
701 Ocean Street, 4th Floor
Santa Cruz, California 95060

Subject: ***East Cliff Drive Pedestrian Improvements Phase III***

Dear Ms. McDaniel:

I am writing to express our support for the above-referenced project and encourage the County Planning Department to move it through the permitting process.

Port District staff has been meeting with the County and I am confident that with good communication between the Port District, the County and the construction contractor, any issues related to the construction process will be readily resolved. We also believe that, with some minor operational adjustments, the Port District will be able to comply with the coastal and air quality permit requirements for its ongoing operations following construction of this project. Based on our knowledge of the project, it does not appear that those permits will need to be amended at this time.

The County will need to acquire an easement from the Port District in order to construct the project once the necessary approvals from the County and the Coastal Commission are in place. Negotiations for that easement are expected to produce an agreement between our two agencies that will address any remaining issues.

Please feel free to contact me if you have questions or need any additional information. We look forward to working with the County on this and other future endeavors.

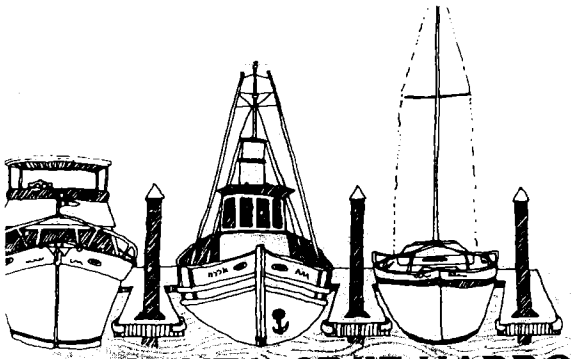
Sincerely,

Lisa Ekers, PE
Port Director

Cc: Supervisor Neal Coonerty
John Presleigh, Director of Public Works

Santa Cruz Port District
135 5th Ave., Santa Cruz, CA 95062 (831) 475-6161 FAX: (831) 475-9558
www.santacruzharbor.org
e-mail: scpd@santacruzharbor.org

ATTACHMENT 20



SANTA CRUZ HARBOR

Gateway to the Monterey Bay National Marine Sanctuary

May 15, 2012

Ms. Sheila McDaniel, Planner
Santa Cruz County Planning Department
701 Ocean Street, 4th Floor
Santa Cruz, California 95060

Dear Ms. McDaniel:

Subject: ***Comments on East Cliff Drive Pedestrian Improvements Phase III***

The Santa Cruz Port District (District) has been working with the County Assessor's Office and Department of Public Works to update ownership records involving a portion of the subject project. Due to an error in the Assessor's records, the beach parcel (APN 027-011-010) between 5th Avenue and 6th Avenue had been incorrectly listed as property of the State of California, and thus assumed to be a portion of Twin Lakes State Beach. We are pleased by the prompt attention this oversight received from County staff who have corrected the Assessor's records. The District's beach properties are hereinafter referred to as "Harbor Beach."

As you know, a significant portion of the proposed project is planned for construction on Harbor Beach. There are elements of the conceptual design that potentially conflict with District operations and facilities, including temporary structures and utilities. Some of the District's facilities are in place as a result of permit requirements issued by the California Coastal Commission, the Monterey Bay Unified Air Pollution Control District and other agencies. District staff is currently involved in discussions with various County staff with the intent of resolving conflicts as the conceptual plans move through the approval process.

The following comments are specific to elements of the Mitigated Negative Declaration related to Harbor Beach, the Santa Cruz Harbor and the Santa Cruz Port District.

1. Non-Local Approvals (page 2): Santa Cruz Port District easements for construction on Harbor Beach will be required.

2. Nearby Watercourse and Environmental Setting (page 4): Harbor Beach should be included with Twin Lakes State Beach[1].

[1] We would suggest a notation in the record indicating that all references to "Twin Lakes Beach" be considered as including "Harbor Beach" for the beach areas between the centerline of 6th Avenue and the Santa Cruz Harbor east jetty.

Santa Cruz Port District
135 5th Ave., Santa Cruz, CA 95062 (831) 475-6161 FAX: (831) 475-9558
www.santacruzharbor.org
e-mail: scpd@santacruzharbor.org

ATTACHMENT 9.0

3. Detailed Project Description (page 6): The description should be amended to include "and on Harbor Beach" prior to "construction of the bluff stabilization structure." The second paragraph (entitled "Right-of-way Improvements"), fourth sentence should be amended to read "An accessible pathway is proposed from the traffic circle to Harbor Beach."

4. Drainage (page 7): The final sentence should be amended to read, "...improve water quality of existing flows before they runoff into Twin Lakes and Harbor Beach and Monterey Bay."

5. Environmental Review Checklist:

   A. Geology and Soils, part 7 (page 11): The discussion of coastal cliff erosion should include reference to Harbor Beach.

   B. Hydrology, Water Supply and Water Quality, part 3 (page 12): The discussion of seiche, tsunami or mudflow should include reference to Harbor Beach.

   C. Visual Resources and Aesthetics, part 3, paragraph 2 (page 19) should include reference to Harbor Beach.

   D. Air Quality, part 2 (page26): The project will impact air quality monitoring operations the Santa Cruz Port District is required to perform during dredging and beach nourishment work between November and April of each year in order to comply with requirements of the Monterey Bay Unified Air Pollution Control District. This potential impact is currently under review by District staff, but is expected to be less than significant with mitigation incorporated.

   E. Public Services, part 1.e (page 27): The project will result in the need for new or physically altered governmental facilities on Harbor Beach to replace or restore Port District facilities currently located in areas proposed for bluff stabilization and pedestrian walkways. The impacts of any new or physically altered governmental facilities that will be required as a result of the project have not been determined, but are expected to be less than significant.

   F. Land Use and Planning, part 1: The project as proposed would require changes to facilities and operations that are governed by the California Coastal Commission, and may require an amendment to the Port District's five-year dredging disposal permit approved in April 2012. District and County staff will be reviewing design alternatives intended to minimize the impacts of the project on the District's permitted activities.

Thank you for this opportunity to comment on the mitigated negative declaration. Please feel free to contact me if you have questions or need any additional information about Harbor Beach or the Santa Cruz Port District. We look forward to working with the County on this and other future endeavors.

Sincerely

Lisa Ekers, PE
Port Director

Cc: John Presleigh, Director of Public Works

WITTWER & PARKIN, LLP
147 SOUTH RIVER STREET, SUITE 221
SANTA CRUZ, CALIFORNIA 95060
TELEPHONE: (831) 429-4055
FACSIMILE: (831) 429-4057
E-MAIL: office@wittwerparkin.com

Jonathan Wittwer
William P. Parkin
Ryan D. Moroney

OF COUNSEL
Gary A. Patton

May 16, 2012

2012 MAY 16 PM 5 00

VIA E-MAIL AND HAND DELIVERY

Sheila McDaniel
County of Santa Cruz
Planning Department
701 Ocean Street, 4th Floor
Santa Cruz, CA 95060
pln056@co.santa-cruz.ca.us

RE: Project: **East Cliff Drive Pedestrian Improvements Phase III**
Applicant: **Santa Cruz County Public Works Department**
Application No.: **111134**

Dear Ms. McDaniel:

This office has recently been retained by Uve Wessbecher, a concerned property owner and neighbor, to comment on the proposed East Cliff Drive Pedestrian Improvements Phase III Project (Project). Based on the comments below, the lack of adequate notice, and the general lack of access to, and inclusion of, essential background materials and Project-related documents in the Initial Study and Mitigated Negative Declaration (IS/MND), we respectfully request that the County extend the Comment Period deadline and continue the hearing before the Zoning Administrator, each for a minimum of thirty (30) days, to allow for additional public comment and environmental review.

As a preliminary matter, our client supports the Project in concept. However, there are simply too many environmental variables and impacts that have not been analyzed adequately, or even in the first instance. Indeed, given the importance of the Project's location, its scope, sensitivity of resources at issue, and clear environmental impacts involved, there is really no question that a full Environmental Impact Report (EIR) is required. Moreover, proceeding with an EIR would allow the public to be more involved in the process and enable a proper environmental review of mitigation measures and potential environmentally superior alternatives, which would likely result in a better end-product.

Since becoming aware that the Project had changed from the version the Redevelopment Agency assured him would preserve heritage trees and parking, my client has become very concerned at minimum as to the impact on those aspects of his property and the impact on coastal resources and safety issues which will result from the revised version of the Project. Our firm

was therefore retained on May 8, 2012 to assist with obtaining the records required to provide thorough comments on the IS/MND for the Project. Later that day my office submitted a formal Public Records Act request to the County for all relevant documents. A portion of these documents consisting of approximately six (6) boxes and several loose folders and papers, were just made available to our office on May 15, 2012. Consequently, neither we nor our experts have had adequate time to thoroughly review these materials, some of which are still being gathered. Even though the law allows comments until the close of the public hearing scheduled for June 1, 2012 (and County Counsel has concurred in this regard), in order to have time to provide more thorough comments and for the County decisionmaker to review same, we would respectfully request that the May 16, 2012 Comment Deadline on the Initial Study and proposed Mitigated Negative Declaration be extended for at least thirty (30) days to allow further public review.

In the short time we have had to review the materials related to this Project, one thing is clear - **an EIR is required in order to proceed with this Project due to numerous potential safety and environmental impacts.**

Summary of Most Significant Inadequacies of IS/MND:

- Land Use, Biological, Aesthetic - the Project violates the County's Significant Tree Protection Ordinance and Local Coastal Program (LCP) because the Project could be altered to accommodate existing heritage trees instead of removing them. Moreover, there is no evidence in the record that the findings required to destroy the trees can be made nor is it possible that such findings can be made. Even more fundamental is the fact that the IS/MND discussion on this issue is internally inconsistent (with respect to how many trees are proposed to destroyed and how many replaced as mitigation) and several important pages related to this issue and identified as being present in the Initial Study have actually been omitted;

- Traffic Safety and Parking Impacts - as explained in the attached letter from Traffic and Civil Engineering Consulting Services, the IS/MND fails to address any potential impacts of the proposed Project and fails to provide any roadway safety information or discuss how the proposed project may impact traffic safety of the affected environment. The traffic analysis also fails to analyze potential impacts that may substantially increases hazards due to a design feature (*e.g.*, establishing a bike lane behind diagonal parking spaces), (See, Exhibit A attached hereto and incorporated by reference);

- Geotechnical Impacts - as explained in the attached letter from consulting engineers and geologists, Cotton, Shires & Associates, Inc, ("CSA") the IS/MND

fails to contain "sufficient technical documentation **has not been presented to allow independent evaluation of potential environmental impacts.**" CSA does point out that the Project contains placement of compacted fill materials, walkways, planters, and a seawall extending approximately 30 to 50 feet seaward of the existing edge of pavement along East Cliff Drive and that as a result it has clear potential to create serious environmental impacts. For example, CSA cannot conclude that the proposed project will not be adversely impacted by liquefaction or lateral spreading and cannot conclude that proposed structures will not result in negative erosional (wave reflectivity) impacts to the beach or nearby bluffs.

(See, Exhibits B & C attached hereto and incorporated by reference);

- The errors, omissions and lack of required information in the IS/MND constitutes a failure to proceed in a manner required by law - more generally, critical information is missing from the MND, and the MND fails to adequately analyze certain impacts of the proposed Project as discussed in more detail in the Comments on IS/MND section below.

In addition to the problems with the Project's environmental review, our preliminary analysis of this Project raises other legal considerations. A couple of these are summarized immediately below.

Summary of other Legal Contentions:

- As part of my client's due diligence in purchasing his home on East Cliff Drive, my client met with the former Project Manager of the Redevelopment Agency and was assured by RDA that the Project would preserve the significant Monterey cypress located in front of the residence, and in reliance on that assurance decided to purchase the home. Based on this representation, the County may be legally estopped from altering the Project to destroy the subject tree.

- My office has requested the title information regarding the "public" right of way intended for use as part of the Project. That information was just provided this morning. Accordingly, it is not clear whether the County is legally authorized to implement to proposed improvements.

Accordingly, we believe that it would be in the best interest of all parties to allow additional time to resolve these and other issues prior to proceeding with final consideration of the Project.

COMMENTS ON MITIGATED NEGATIVE DECLARATION

A. The Project requires preparation of an EIR because the "fair argument" standard is met as to potential traffic, geotechnical and other impacts.

A Negative Declaration is "a written statement by the lead agency briefly describing the reasons that a proposed project ... will not have a significant effect on the environment and therefore does not require the preparation of an [Environmental Impact Report]." CEQA Guidelines, § 15371. By contrast, an EIR is required whenever substantial evidence in the record supports a "fair argument" that significant impacts may occur as a result of the project. Public Resources Code §§ 21080, 21100; CEQA Guidelines, §15064.

The "fair argument" standard creates a "low threshold" for requiring preparation of an EIR. *Architectural Heritage Assn. v. County of Monterey* (2004) 122 Cal. App. 4th 1095, 1110 ("This test establishes a low threshold for initial preparation of an EIR, which reflects a preference for resolving doubts in favor of environmental review.[Citations].") The determination of whether an impact is "significant" should be based on scientific and factual data, as well as the existing environmental setting. *City of Orange v. Valenti* (1974) 37 Cal.App.3d 240, 249 (analysis of project's traffic impacts necessarily depends on existing environmental setting).

Expert evidence that a project may have a significant impact is generally dispositive, and under such circumstances, an EIR must be prepared. *City of Livermore v. Local Agency Formation Commission* (1986) 184 Cal.App.3d 531, 541-542. Indeed, an EIR is required precisely in order to resolve a dispute among experts. *City of Carmel-by-the-Sea v. Board of Supervisors* (1986) 183 Cal.App.3d 229, 245-246 and *Berkeley Hillside Preservation v. City of Berkeley* (2012) 203 Cal. App. 4th 656.

The Project presents serious traffic and parking safety and circulation issues which are neither identified nor analyzed. Indeed, the traffic study prepared by my client's traffic expert concludes that "there has not been sufficient initial design review of this project to 'catch' significant design issues" based on several serious traffic and traffic safety issues which go completely unaddressed. One easily identifiable significant issues in this regard is the design to provide diagonal versus parallel parking for the Project which the former presents significant safety issues (including for bicyclists traveling in the bicycle lane just behind the parked vehicles).

B. Removal of the 50-Foot Monterey cypress tree will have BIOLOGICAL, VISUAL and AESTHETIC impacts, and is inconsistent with adopted County LAND USE

policies, including, but not limited to, the Significant Tree Protection Ordinance and Local Coastal Program (both the Land Use Plan and the Implementing Ordinances).

The approximately 50-Foot tall Monterey cypress tree in front of 2601 East Cliff Drive is a magnificent specimen at least 26" in d.b.h. and is an important part of the visual resources enjoyed by the public along this portion of the Coast. When our client (the current owner of 2601 East Cliff Drive) was considering purchase of this property in 2005, he informed County RDA that he was unwilling to make such purchase unless that Monterey cypress tree could be preserved in light of proposed improvements to East Cliff Drive in the area. County RDA showed him on an aerial photo that the edge of improvements for the Project would be slightly inside the dripline of the tree and he confirmed with an arborist that the tree should be able to remain healthy under those circumstances. Our client then purchased this home in reliance on County RDA's representation.

Moreover, the removal of this tree will cause significant impacts on Biological Resources, Land Use impacts and Aesthetic impacts, which are either not adequately addressed in the Initial Study or which are not adequately mitigated by the Mitigated Negative Declaration. The Initial Study is fatally flawed in this manner and the Mitigated Negative Declaration can therefore not be adopted at this time. Moreover, a Tree Preservation Plan update by Horticultural Consultants Barrie D. Coate and Associates is scheduled for June 7, 2012. The resulting information should be incorporated into any assessment of the significance of impacts of tree removal, and without this information the Mitigated Negative Declaration cannot be adopted.

The Initial Study responds that there is a "Less than Significant Impact" to Question C-6 (Biological Resources), asking whether the project would "[c]onflict with any local policies or ordinances protecting biological resources...[including] the Significant Tree Protection Ordinance."[1] The Initial Study fails to adequately analyze the requirements of the Santa Cruz County Significant Trees Protection Ordinance[2] and whether the project as proposed complies with the Ordinance, thus making such a finding of "less than significant impact" erroneous.

The Monterey Cypress is protected by the Ordinance because it is at least 26 inches in diameter[3] and hence falls within the Ordinance's definition of a "significant tree."[4] Pursuant to Santa Cruz County's Local Coastal Program ("LCP") requirements, the tree must therefore be protected pursuant to the Significant Tree Ordinance. LCP Policy 5.10.8 describes a "Scenic

[1] Initial Study, pages 15-16.
[2] Santa Cruz County Code Chapter 16.34.
[3] *Recommendations for Tree Preservation at 2601 E. Cliff Drive Santa Cruz*, Barrie D. Coate and Associates Horticultural Consultants Report, Dated September 9, 2008 (*hereinafter* "Coate Report"), attached as Exhibit D.
[4] Santa Cruz County Code § 16.34.030(A).

Protection Policy" that protects Visual Resources within the County. The policy is to:

> [m]aintain the standards in the County's existing [Significant Tree Removal Ordinance] which regulates the removal of significant trees...in the Coastal Zone, and provide appropriate protection for significant trees...in areas of the County located within the Urban Services Line.

In order to comply with the Ordinance and the LCP, the County must make findings in order to remove the tree, pursuant to County Code § 16.34.060. Although the Initial Study states in a cursory fashion that "[b]ased on the arborist report...findings can be made for the tree removal[,]" there is no indication any of the requisite analysis or reasoning as to which these findings. As discussed below, the Initial Study does not even include the full arborists' report, further precluding the ability to assess the reasoning of the County supposedly supporting that the project "is in conformance with the significant tree ordinance..." This failure to adequately address compliance with LCP Policy 5.10.8 and the Ordinance makes the Initial Study woefully inadequate.

The failure to adequately address compatibility of the proposed tree removal with applicable LCP policies and the Significant Trees Ordinance also makes the Initial Study flawed in its assessment of whether the project would "[c]onflict with any applicable land use plan [or] policy...including, but not limited to the general plan...local coastal program...adopted for the purpose of avoiding or mitigating an environmental effect[.]"[5] The Initial Study states that there is "no impact." As discussed above, there is no evidence in the Initial Study that any "finding" can be made pursuant to the Ordinance that would allow for removal of the tree, and thus there is indeed be a conflict with both the LCP and the Ordinance, making it erroneous to claim there is "no impact."

The proposed removal of the Cypress tree will also result in unanalyzed and unmitigated aesthetic impacts. In response to the question of whether the project will "[s]ubstantially degrade the existing visual character or quality of the site and its surroundings..." the Initial Study contends that in order to compensate for removal of the Cypress (and a Date Palm tree) "the plans provide three 15 gallon replacement Monterey Cypress trees."[6] In the first place, the Initial Study does not address the specific location of the tree, and the importance of the tree as "one of the few remaining healthy young cypress along this route" and its importance as a "screen between the building and the public area..."[7] There is no discussion of whether the replacement

[5] Initial Study Question P-1 (Land Use and Planning), page 30.
[6] Initial Study Question F-3 (Visual Resources and Aesthetics), page 19.
[7] Coate Report, page 1.

trees will serve the same, or a similar purpose, thus precluding a finding a "less than significant impact" on the aesthetic and visual character of the project area.

Further, this response is inconsistent with what the Initial Study identifies *in the very next sentence* as the significant tree protection ordinance's recommendation "that removed trees be replaced on a three to one basis."[8] A three to one replacement would require *six (6) trees*, not three (3), to replace the two (2) trees removed, If in fact *three* trees are proposed to be removed (**see discussion below** regarding the inconsistency throughout the Initial Study as to whether two or three trees will be removed) then there must be *nine (9) trees* to replace those removed trees. The Initial Study is therefore inaccurate and flawed in its analysis of removal of these trees and the Mitigated Negative Declaration does nothing to address these impacts.

Lastly, but perhaps most dispositive, are the County Planning Department's own Incompleteness Letters dated August 31, 2011 and December 20, 2011 identifying the proposed Project as being out of compliance with County Code §13..20.130 (Coastal Regulations), as follows:

> "... the coastal development regulations require development to minimize vis ual impacts of the project. As discussed with Jim Davies prior to submittal of this application, this project must balance replacement of removed trees with the regulations that protect and minimize impacts to visual resources and flood control. Please address how this can be accomplished with the proposed replacement species (Monterey Cypress) within the right-of-way. Are you intending on limbing-up, if you will, these trees as they mature? Also, has there been community agreement regarding the species selection and location? There may be significant concern by residential property owners who adjoin the right-of-way as some County of Santa Cruz Planning Department creating environments people enjoy may stand to lose existing views as a result of the proposed replacement trees. Depending upon your feedback and the outcome of the flood control analysis (wave runup) by Environmental Planning, consideration may be given to elimination of replacement trees from the proposal. This is a sensitive issue that will need additional analysis by staff as the project moves beyond completeness, the outcome of which cannot be determined at this time . Any background information regarding this issue would be appreciated."

The County Department of Public Works (DPW) provided the following "Response:"

> • As discussed and mutually agreed upon at the 01/19/12 meeting, replacement trees will be located in the Final Design plans to minimize potential viewshed impacts. Locations

[8] Initial Study, page 19.

may occur on-site, off-site, or a combination thereof and the quantity will be per the mitigation ratio determined by SC Planning.

None of the above is discussed in the Initial Study. Nor is the fact that this area of noncompliance could be avoided by keeping the existing 50-Foot Monterey cypress tree in front of 2601 East Cliff Drive.

C. The proposed roadway and parking configuration will have significant TRAFFIC and TRAFFIC SAFETY impacts.

The Project presents serious traffic safety and circulation issues which are neither identified nor analyzed in the IS/MND. Indeed, no data as to traffic safety was collected or analyzed in the IS/MND.

My client's just retained traffic expert has conducted a very preliminary peer review and found that "**[t]he proposed parking lay-out presents a significant traffic safety impact**." Moreover, this preliminary peer review concludes that "**t]he County has come to the conclusion that only a Negative Declaration is required when in fact an EIR would likely be necessary if it considered sufficient traffic and safety information**"based, in part, on the following:

1. there has not been sufficient initial design review of this project to 'catch' significant design issues;
2. The public and the County have not been provided adequate traffic and engineering safety information such as is necessary to provide meaningful input and make an informed decision about the project;
3. No traffic safety issues are addressed in the Initial Study;
4. Diagonal parking creates a safety problem for bicycles in the bike lane just behind the parking.
5. The optimal traffic engineered parking lay-out would be a continuance of he parallel parking method currently in use; and
6. Another downfall of the Initial Study is that no alternative circulation methods have been discussed.

D. The proposed shoreline armoring has not been adequately analyzed, and will likely result in significant GEOTECHNICAL impacts.

The Project has the potential to presents serious geologic and geotechnical issues which are neither identified nor analyzed in the IS/MND. Indeed, no technical data as to geologic or geotechnical issues is contained in the IS/MND. Hence my client's just retained geologic and

geotechnical expert (nor any member of the public with such expertise or having also retained such expertise) can make meaningful input as to the geologic or geotechnical issues. Thus my clients geologic and geotechnical experts found that the lack of "necessary data to complete independent evaluations of technical studies for the project" mean that they: (1) cannot present final professional conclusions regarding merits of the proposed project;"(2) cannot conclude that the proposed project will not be adversely impacted by liquefaction or lateral spreading; (3) cannot conclude that proposed structures will not result in negative erosional (wave reflectivity) impacts to the beach or nearby bluffs. Indeed, my client's experts conclude "sufficient technical documentation **has not been presented to allow independent evaluation of potential environmental impacts.**" See Exhibit B.

As indicated by the Improvement Plans prepared by RRM Design Group (February 10, 2012), the proposed project includes construction of a seawall with a maximum vertical height of 20 feet. In addition, proposed right-of-way improvements include placement of compacted fill materials, walkways, planters, and a seawall extending approximately 30 to 50 feet seaward of the existing edge of pavement along East Cliff Drive. The footprint of proposed improvements will encroach into the existing beach by a distance of approximately 10 to 20 feet along the length of the proposed improvements.

These kind of improvements require full and complete environmental impact evaluation; however, to date the IS/MND does not even begin to contain the information necessary to address many issues. These issues include, but are not limited to (1) potential adverse wave reflectivity impacts of the seawall under winter conditions; (2) potential impacts to long-shore sand transport associated with proposed construction of right-of-way improvements over portions of the existing beach; (3) potential impacts to ongoing sand transport and erosional processes; (4) impacts on beach nourishment; (5) how engineered fill materials will be adequately drained behind the proposed seawall; (6) potential for proposed sand backfill materials to experience liquefaction, piping or otherwise be prone to outflanking by erosion; (7) the potential for an undrained condition to result in shallow groundwater conditions beneath the street and adjoining residential properties; or (8) the potential for loss of sand backfill from behind the seawall, due to flooding, out-flanking erosion and/or piping to lead to rapid deterioration of proposed improvements.

This lack of information or data in the IS/MND is made even more serious by the fact that the County Planning Department's Incompleteness Letter raises numerous significant geologic and geotechnical issues which produced inconsistent or inadequate responses from the three County RDA retained geologic and geotechnical expert firms. See, *e.g.*, Exhibit C.

E. The IS/MND fails to adequately identify, discuss and mitigate existing drainage problems, and fails to adequately analyze the impacts of the proposed Project

drainage features on HYDROLOGY and WATER QUALITY, including the fact that it may exacerbate as yet to be analyzed GEOTECHNICAL issues.

The IS/MND acknowledges that the Proposed Project will result in an increase in impervious surface area but fails to disclose what the increase will be. There is also an inadequate discussion of how run-off may affect the integrity of the proposed seawall (see Exhibit B) and whether the proposed drainage plan will impact water quality on the beach.

F. The IS/MND is riddled with errors and inconsistencies rendering it completely inadequate to inform the public and decisionmakers as to potential environmental impacts of the Project.

A fundamental purpose of the CEQA process is to encourage and facilitate public participation:

> One of the basic purposes of CEQA is to inform governmental decision makers and the public about the potential, significant environmental effects of proposed activities... [this process] protects not only the environment but also informed self-government...[a]s stated in Guidelines section 15200, "The purposes of review of EIR's *and negative declarations* include: (a) Sharing expertise, (b) Disclosing agency analyses, (c) Checking for accuracy, (d) Detecting omissions, (e) Discovering public concerns, and (f) Soliciting counter proposals." Guidelines section 15201 provides that "Public participation is an essential part of the CEQA process."

Burbank-Glendale-Pasadena Airport Authority v. Hensler (1991) 233 Cal. App. 3d 577, 596 (emphasis added). Indeed, as explained in the CEQA Guidelines, "[e]ach public agency should include provisions in its CEQA procedures for *wide public involvement*, formal and informal...[s]uch procedures should include, whenever possible, *making environmental information available in electronic format on the Internet*, on a web site maintained or utilized by the public agency."14 C.C.R. § 15201 (emphasis added)

Here, the IS/MND fails to adequately inform the public as required by CEQA because it excludes relevant information that is necessary for informed public participation. There are numerous examples throughout the Initial Study of documents with crucial missing pages – for example, the Arborists Report[9] only contains pages 10-11, and fails to include either of the attachments, most notably the tree inventory map. The arborist's recommendations on pages 10-11 list tree "numbers," for which one cannot even determine the location of those trees, because

[9] "An Overview Regarding the Impact of the Proposed Street Improvements on Significant Trees Within the Twin Lakes Beachfront Project" dated August 4, 2009 and Updated March 24, 2010, attached to the Initial Study as Attachment 12.

the Initial Study fails to even include the map. This inadequacy means that the public cannot be adequately informed of which trees are where, as a means to understand the aesthetic impacts of the project.[10] Further, an initial study that is circulated as part of a negative declaration must "*document[] reasons to support the finding.*" 14 C.C.R. § 15071. Because the Initial Study includes only ultimate conclusions from the Arborists Report, the public does not have adequate information to assess the County's "reasons to support the finding" of a "less than significant impact" as to impacts on protecting biological resources.[11]

Likewise, the Initial Study omits all but pages 16-18 of the Biotic Assessment.[12] Further, the pages that it does include contain material inconsistent with other portions of the Initial Study. The Initial Study's only referral to the Biotic Assessment (Discussion for Question C-1) does not discuss vegetation (i.e., trees), while the Biotic Assessment states that "[t]he mature eucalyptus ***and cypress trees*** *will be retained and incorporated into the landscape plan for the project site.* Measures are planned (temporary fencing, contractor education) to identify and isolate these trees from the construction zone."[13] Meanwhile throughout the Initial Study the project details *removal* of mature cypress trees:

> The project includes the removal of two significant trees (a 24 inch Monterey Cypress and a 24 inch Palm tree)...[14]
>
> There are three significant trees, two Monterey Cypress trees, and a Date Palm tree, located within the East Cliff Drive right-of-way that are required to be removed for proposed roadway widening.[15]
>
> The project includes the removal of two significant trees, a 20- 24 inch Monterey Cypress tree and a 24 inch Canary Island Date Palm"[16]
>
> In addition, an existing Canary Island Date Palm is located within the construction area and must be removed. The two Monterey Cypress trees are required to be removed due to their location within the roadway widening area.[17]

---

[10] See above for further discussion of the project's impacts in regards to significant tree removal.

[11] Biological Resources addressed in Question C-6; see above/below for detailed discussion of the project's impacts in regards to significant tree removal.

[12] Biotic Assessment Twin Lakes Beachfront Project East Cliff Drive, 5th to 9th Avenues Santa Cruz California dated January 29, 2010, attached to the Initial Study as Attachment 14.

[13] Biotic Assessment at 17 (emphasis added).

[14] Initial Study Question C-6 Discussion, page 16.

[15] Initial Study Question F-3 Discussion, page 19.

[16] Initial Study Summary Project Description, Page 1.

[17] Initial Study Detailed Project Description, Page 7.

The Initial Study is therefore inconsistent with the Biotic Assessment, with no explanation, for example, that the project may have changed from the time when the Biotic Assessment was completed, nor any explanation why, if this was the case, there was not an updated Biotic Assessment performed. Moreover, the Initial Study is internally inconsistent with some sections indicating that one Cypress tree is proposed to be removed (two total trees removed), while other sections state that *two* Cypress trees will be removed (*three* total trees removed). This inconsistency, combined with the above cited failure to even include the tree inventory map from the Arborists Report, make the Initial Study inadequate in informing the public about the potential, significant aesthetic, land use and biological resources effects of the proposed project. *See City of Redlands v. County of San Bernardino* (2002) 96 Cal. App. 4th 398, 406 ("The negative declaration is *inappropriate* where the agency has failed either to provide an accurate project description or to gather information and undertake an adequate environmental analysis. *An accurate and complete project description is necessary for an intelligent evaluation of the potential environmental impacts of the agency's action.* 'Only through an accurate view of the project may affected outsiders and public decision-makers balance the proposal's benefit against its environmental cost, consider mitigation measures, assess the advantage of terminating the proposal . . . and weigh other alternatives in the balance.'") (emphasis added).

In addition to these flaws, the Initial Study is riddled with other inaccuracies and errors, which inhibit the public's ability to adequately understand and provide feedback on the project. For example, the Initial Study informs the public that no discretionary approvals are required when it fails to check the "Coastal Development Permit" box (or any box for that matter) under the Discretionary Approval(s) section of the Overview and Environmental Determination section, even though a Coastal Development Permit is required.[18] **Likewise, as with the Arborist Report, the IS/MND only contains select portions of the geotechnical and biotic reports (i.e. the cover pages and "conclusions) without the actual analysis.**

These errors and omissions result in the IS/MND being inadequate to foster informed public participation and therefore fatally flawed. *County of Amador v. El Dorado County Water Agency* (1999) 76 Cal. App. 4th 931, 946 ("Noncompliance with substantive requirements of CEQA or noncompliance with information disclosure provisions 'which precludes relevant information from being presented to the public agency . . . may constitute prejudicial abuse of discretion...regardless of whether a different outcome would have resulted if the public agency had complied with those provisions.'...In other words, when an agency fails to proceed as required by CEQA, harmless error analysis is inapplicable. The *failure to comply with the law subverts the purposes of CEQA if it omits material necessary to informed decisionmaking and informed public participation.*") (emphasis added).

[18] Initial Study, page 2.

Because significant errors and potential environmental impacts have been identified for which (at a minimum) the Initial Study must be corrected and new mitigation measures must be identified, the County must re-circulate a revised Initial Study and Mitigated Negative Declaration. 14 CCR § 15070(b)(1), stating that a mitigated negative declaration may be proposed when "[r]evisions in the project plans or proposals made by or agreed to by the applicant *before a proposed mitigated negative declaration and initial study are released for public review* would avoid the effects or mitigate the effects to a point where clearly no significant effects would occur..." *See Sundstrom v. County of Mendocino* (1988) 202 Cal. App. 3d 296, 306-307 ("The requirement that the applicant adopt mitigation measures recommended in a future study is in direct conflict with the guidelines implementing CEQA. [CCR § 15070(b)(1)] provides that if an applicant proposes measures that will mitigate environmental effects, the project plans must be revised to incorporate these mitigation measures '*before* the proposed negative declaration is released for public review . . . .' (Italics added.) Here, the...project plans may be revised to incorporate needed mitigation measures after the final adoption of the negative declaration. This procedure, we repeat, is contrary to law.") Moreover, "[i]f significant effects remain after mitigation, an EIR is required." *San Bernardino Valley Audubon Soc'y v. Metro. Water Dist.* (1999) 71 Cal. App. 4th 382, 391.

G. The IS/MND improperly "segments" environmental review of the related Harbor District Project and the acquisition of State Parks land for the Seawall.

The Initial Study fails to address the impacts of the Harbor District Pipeline Project proposed by the Santa Cruz Harbor District which is proposed to be constructed concurrently with this Project. Furthermore, the Project requires the County to acquire land owned by the State of California as parkland. Emails in the County's files demonstrate that this requires an action at the State level. However, the impacts of such parkland acquisition are not identified or analyzed in the IS/MND. CEQA requires that the Project impacts be analyzed as a whole. However, the IS/MND fails to analyze how the either the Pipeline Project or the parkland acquisition will impact the environment, including by exacerbating the impacts discussed herein.

H. The Project Description is not "stable" as required by CEQA.

CEQA requires that the project maintain a stable description so that the public and decision makers are informed as to what is being proposed and/or approved. In this case, there have been so many different proposals and design changes for the Project that the public is not aware of what is presently being proposed. Indeed, it was only just recently through his own independent inquiry that my client became aware that the Project had changed from the version the Redevelopment Agency assured him would preserve heritage trees and parking. ***Moreover, there is evidence in the record that County staff intentionally withheld the most recent proposals from public review.***

There are several other open questions that must be addressed in the environmental review phase, including, whether the Project will proceed with a consolidated Coastal Development Permit or two separate permits, how and to what extent the County will obtain the right to build on State Park lands, whether the alleged "right of way" authorizes the proposed improvements; and how the Harbor District Pipeline Project will affect the proposed Project.

The errors, omissions and inconsistencies discussed above also result in an unstable project description.

Pursuant to Public Resources Code Section 21167(f), I am requesting that the City forward a Notice of Determination. That section provides:

> "If a person has made a written request to the public agency for a copy of the notice specified in Section 21108 or 21152 prior to the date on which the agency approves or determines to carry out the project, then not later than five days from the date of the agency's action, the public agency shall deposit a written copy of the notice addressed to that person in the United States mail, first class postage prepaid."

Thank you for your consideration of these comments. I look forward to the County's written response to these comments.

Very truly yours,
WITTWER & PARKIN, LLP.

Jonathan Wittwer

cc: Betsey Lynberg, (Via E-mail only)
Christopher Cheleden (via E-mail only)
client

EXHIBIT A
ATTACHMENT 20

May 16, 2012

Mr. Jonathan Wittwer
Wittwer and Parkin, LLP
147 S. River Street Suite 221
Santa Cruz, CA 95060

Dear Mr. Wittwer,

I have been retained by your law firm in order to address the East Cliff Drive Pedestrian Improvements Phase III Application, and specifically to address those portions of the #111134 Environmental Review Initial Study which relate to traffic. With this letter I am attaching a copy of my current curriculum vitae. During my career I have performed more than 100 Traffic Impact Analyses and have peer-reviewed Analyses performed by other Traffic Engineers. I have been retained to provide expert consultation in many cases of litigation where a Traffic Impact Analysis was a contributing factor in evidence.

To begin, there has not been sufficient initial design review of this project to 'catch' significant design issues. Accordingly, I would respectfully submit that the public and the County have not been provided adequate traffic and engineering safety information such as is necessary to provide meaningful input and make an informed decision about this project. The County has come to the conclusion that only a Negative Declaration is required when in fact an EIR would likely be necessary if it considered sufficient traffic and safety information.

The proposed physical improvements of the public right-of-way are required to be designed and stamped by California Licensed Civil Engineers; the Application and Initial Study do not provide evidence of same. This makes the job of the project reviewer much more critical, as the designers may not be licensed engineers. In order to ensure that any plans created will stand up to the test for design immunity, stamped plans should be reviewed by a competent Civil Engineer to determine if they meet county, state, and national standards of good design, signing and striping.

Traffic and Civil Engineering Consulting Services
P.O. Box 961 Los Gatos, CA 95031 408-377-6222
info@trafficandcivilengineer.com

One can see from both the Project Plans and Initial Study that the primary roadway design consideration has been maximization of parking. Unfortunately, this has been at the expense of safety for pedestrians, bicyclists, and drivers. Indeed, no traffic **safety** issues are addressed in the Initial Study.

There are circumstances where diagonal parking is appropriate, and there is a reason this design is mostly used in parking lots. Parking lots have slow speeds, generally 15 miles-per-hour, and are without the distractions of bike lanes and, usually, ocean views - which would be categorized for purposes of this discussion as an attractive distraction. A fundamental purpose of sound traffic engineering as applied to roadway design is to minimize significant distractions to the traveling public. The proposed parking lay-out represents a design that maximizes the impact of the roadway elements of this site which are distractions. When backing out of a diagonal parking space, it will not be possible for a driver to 'see through' surrounding parked cars and observe oncoming traffic. A driver backing-up will become aware of an oncoming vehicle only by proximally encountering it. In this particular site, diagonal parking is further ill-advised because of the topography of the roadway, it being designed as a convex curve. This shortens the sight distance for the driver backing up even more, making it a much greater challenge to see and avoid pedestrians and bicyclists, including those in crosswalks, as well as oncoming vehicles. The proposed parking lay-out presents a significant traffic safety impact.

The optimal traffic engineered parking lay-out would be a continuance of the parallel parking method currently in use; this can be seen immediately in reviewing the 'existing condition' shown in the proposed Project Plans attached to the Application on Sheet 1.2 (sheet 2 of 11, of Attachment #2 to Application). Clear sight distance for all is maximized with this solution. But this alternative has not been explored in the Initial Study.

Traffic and Civil Engineering Consulting Services
P.O. Box 961 Los Gatos, CA 95031 408-377-6222
info@trafficandcivilengineer.com

Another downfall of the Initial Study is that no alternative circulation methods have been discussed, i.e. continuing the one-way traffic pattern that presently exists on Lake-5th Avenue.

The Initial Study seems to be built on the premise that just because there may not be an increase in traffic, a more detailed environmental impact review is not necessary. This in fact is not the case. First of all, the creation of bike paths will likely increase bicycle traffic. Also, where there are modifications to existing conditions, whether couched as improvements or not, they are still 'changes of condition', which from a traffic and civil engineering point of view warrant review of proposed design and discussion of alternatives, which was not accomplished in this Initial Study.

The above conclusions are based on the information provided in the Initial Study. However, I understand that you are in the process of gathering additional information regarding prior traffic studies/counts that have been performed for the Project or at the Project Site. Any such studies, counts or analyses should have been identified and analyzed in the Initial Study.

Sincerely,

James C. Jeffery III, P.E., P.T.O.E.

Traffic and Civil Engineering Consulting Services
P.O. Box 961 Los Gatos, CA 95031 408-377-6222
info@trafficandcivilengineer.com

JAMES C. JEFFERY III, P.E., P.T.O.E.
Traffic and Civil Engineering Consulting Services
CURRICULUM VITAE ATTACHMENT

Detailed Description of Experience and Expertise

Roadway Design Defect and Design Immunity

Collision Site Investigation

All Jurisdictions
All Types of Vehicles ***Pedestrians*** ***Bicyclists***
All Land Use Types
All Roadway Types
Freeways and Highways Urban and Suburban Streets
Rural Roadways Intersections Private Roadways, Driveways
Special Sites
Guard Rails, Poles, Medians
Parking Lots (Speed Bumps, Wheel Stops & Pedestrian Access)
Rail Lines Mass Transit

Roadway Design, Construction & Maintenance Evaluation

Sight Distance Evaluation
Dangerous Condition of Public Roadway
Roadway Construction Defects
Signing and Striping Defects
Standard of Care Compliance
Change of Condition Determination
Pavement Condition Rating/Defects
Maintenance Standards & Practices

Construction Zone Accident Investigation

Work Zone Traffic Safety
Traffic Control Plans
Inspection Practices
Contract Compliance

Accident Hazard Review

Roadway Safety Audits
Accident Mitigation Measures
Identifying Conditions Causal to Accidents
Accident Frequency Review for Notice
Risk Assessment/Exposure

Traffic Signal Timing, Design and Maintenance

Designed and reviewed traffic signal plans and lighting studies

P.O. Box 961 Los Gatos, CA 95031-0961 408-377-6222 info@trafficandcivilengineer.com

JAMES C. JEFFERY III, P. E., P.T.O.E.
Traffic and Civil Engineering Consulting Services
CURRICULUM VITAE ATTACHMENT

Detailed Description of Experience and Expertise

Traffic Engineering

Highway Design

Designed streets and highways, including signing and striping
Provided peer review of geometric design of streets and highways
Performed preliminary roadway engineering, including analysis of alternatives with accompanying cost estimates
Conducted sight distance investigations
Determined the best solutions for traffic access to subject site; recommended modifications to access solutions proposed or provided by public agencies
Determined appropriate traffic control devices, including speed humps
Designed traffic control plans for construction zones

Plan Line Studies

Reviewed survey information and existing improvements
Prepared plan lines showing the ultimate right-of-way, curb, gutter and sidewalk, utility easements, medians and roadway cross sections; cost estimates included

Traffic Signal Design and Traffic Systems

Designed and redesigned traffic signal installations
Optimized traffic signals using SOAP, Passer II, TRANSYT 7 and other computer programs
Determined potential regional air quality produced by optimizing region's signalized intersections

Transportation Engineering Studies

Recommended neighborhood traffic control measures in order to mitigate adverse thru traffic in a residential area
Created School Area Pedestrian Safety Policy
Conducted counter programs, license plate surveys, road condition surveys and parking surveys

P. O. Box 961 Los Gatos, CA 95031-0961 408-377-6222 info@trafficandcivilengineer.com

JAMES C. JEFFERY III, P.E., P.T.O.E.
Traffic and Civil Engineering Consulting Services
CURRICULUM VITAE ATTACHMENT

Detailed Description of Experience and Expertise

Transportation Planning
Rural, Small Urban & Metropolitan Areas

Traffic Impact Analyses
Level Of Service (LOS) calculations
Site planning, parking, access, circulation studies
Traffic impact fee nexus
Mitigation measures recommended include on and off-site roadway traffic control devices, roadway and parking lot re-design, signing and striping, signal modification, neighborhood traffic control

Traffic Data Studies
Vehicle count and classification, speed survey, traffic delay, signal pre-emption and traffic signal warrant studies, license plate and origin/destination surveys
Highway Program Monitoring System Inventory including pavement condition

Traffic Data Analysis Reports
Traffic safety, on/off street parking analysis, trip generation rate
Mixed use traffic and parking reduction
Pedestrian flow in non-commercial expressive activity

General Plan Circulation Element
Created comprehensive traffic demand and forecasting studies for the corridor and circulation element of a General Plan using several traffic demand models; prepared accompanying environmental impact analysis

School Site Circulation
Pedestrian safety policy and traffic circulation in school zones

Land Use
Eminent Domain
Prescriptive Easement
Roadway Easement
Public Representation
Public Records Research

P. O. Box 961 Los Gatos, CA 95031-0961 408-377-6222 info@trafficandcivilengineer.com

COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

May 16, 2012
G5052

TO: Jonathan Wittwer
Wittwer & Parkin, LLP
147 South River Street, Suite 221
Santa Cruz, California 95060

SUBJECT: **Preliminary Engineering Geologic Design Evaluation**
RE: East Cliff Drive Seawall and Right-of-Way Improvements
Roadway Segment Between 5th and 7th Avenue
Santa Cruz, California

Dear Mr. Wittwer:

At your request, we have completed a preliminary engineering geologic evaluation of proposed roadway and roadside improvements within the East Cliff Drive right-of-way between 5th and 7th Avenue. As indicated by the Improvement Plans prepared by RRM Design Group (February 10, 2012), the proposed project includes construction of a seawall with a maximum vertical height of 20 feet. We have reviewed the pertinent portions of the Initial Study/Mitigated Negative Declaration and the Improvement Plans you provided to us. Plans indicate that the exposed vertical height of the seawall will not exceed approximately 8 feet during high summer beach levels because the lower portion of the seawall will be buried by sand. However, the exposed height of the seawall will increase with seasonal depletion of the beach sand. Proposed right-of-way improvements include placement of compacted fill materials, walkways, planters, and a seawall extending approximately 30 to 50 feet seaward of the existing edge of pavement along East Cliff Drive. The footprint of proposed improvements will encroach into the existing beach by a distance of approximately 10 to 20 feet along the length of the proposed improvements.

The IS/MND includes only small portions of completed geologic and geotechnical investigation reports and does not provide the technical data or reasoning for the conclusions. To evaluate engineering geologic design aspects and potential adverse environmental impacts of the proposed project, we have been provided with an executive summary from an oceanographic investigation by Halcrow, Inc. and updates to previous site geologic and geotechnical investigations prepared by Rogers E. Johnson & Associates and Haro, Kasunich and Associates. However, the IS/MND did not include the technical data that forms the basis of these investigations. Consequently, we do not have the necessary data to complete independent evaluations of technical studies

prepared for the project and, therefore, cannot present final professional conclusions regarding merits of the proposed improvements. The full technical supporting documents are needed to complete our evaluations.

To date we have not received evaluations to address potential adverse wave reflectivity impacts of the seawall under winter conditions or potential impacts to long-shore sand transport associated with proposed construction of right-of-way improvements over portions of the existing beach. It is critical that proposed changes to the beach and shoreline be evaluated for potential impacts to ongoing sand transport and erosional processes. We understand that the seawall is intended to arrest bluff retreat and any significant impacts on beach nourishment should be addressed. Seasonal photographs depicting the maximum extent of winter beach scour should be presented.

While it is our preliminary opinion that the basic configuration and foundation support system for the seawall could be effective in protecting the existing bluff and adjacent roadway during the project design life, we have a number of geotechnical questions that should be addressed by project consultants. It is not clear how engineered fill materials will be adequately drained behind the proposed seawall. Details of subsurface drainage should be provided. If fill materials are not fully drained, then evaluations should be presented addressing the potential of proposed sand backfill to experience piping or otherwise be prone to outflanking by erosion. In addition, the potential for an undrained condition to result in shallow groundwater conditions beneath the street and adjoining residential properties should be addressed. Loss of sand backfill from behind the seawall, due to flooding, out-flanking erosion and/or piping could lead to rapid deterioration of proposed improvements. Data from completed subsurface borings is needed to more fully evaluate potential geotechnical concerns with the proposed seawall. Completed subsurface investigations must be sufficient to verify adequate scour resistant properties of supporting bedrock for the project design life.

At this time we do not have sufficient data to conclude that the proposed project will not be adversely impacted by liquefaction or lateral spreading. In addition, the IS/MND does not contain documentation that allows us to conclude that proposed structures will not result in negative erosional (wave reflectivity) impacts to the beach or nearby bluffs. Sufficient technical documentation has not been presented to allow independent evaluation of potential environmental impacts. The IS/MND does not contain an adequate basis to conclude that the project will or will not result in potentially significant environmental impacts.

LIMITATIONS

This preliminary engineering geologic design evaluation has been performed to provide preliminary technical opinions and advice regarding the proposed project. Our services have been limited to review of the documents previously identified, and a reconnaissance of the property. Our opinions and conclusions are made in accordance with generally accepted principles and practices of the engineering geologic profession. This warranty is in lieu of all other warranties, either expressed or implied.

Respectfully submitted,

COTTON, SHIRES AND ASSOCIATES, INC.

John Wallace
Principal Engineering Geologist
CEG 1923

Ted Sayre
Principal Engineering Geologist
CEG 1795

JW:TS:kd

ATTACHMENT 20

Sheryl Bailey

From: Sherrod, Mike S. [MSSherrod@rrmdesign.com]
Sent: Monday, January 30, 2012 2:13 PM
To: Antonella Gentile
Cc: SHERYLBAILEY; Zigant, Domenic
Subject: FW: Twin Lakes Beach - Design Review Letter
Follow Up Flag: Follow up
Flag Status: Red

Hi Antonella,

As I read the discussion below, it's clear there are too many cooks in the kitchen. The problem is that incompleteness comment (#4 in the list) requires that each engineer weigh in as the structural/coastal "Engineer of Record" for this project.

By way of a bit of history, the Rogers Johnson & Associates and Haro, Kasunich & Associates reports were provided to our design team as background information on which the current concept is based. Halcrow then prepared the Conceptual Design of Coastline Protection Structures report which includes an analysis of anticipated Total Water Levels and conceptual coastline protection structure designs.

Halcrow is now the structural/coastal "Engineer of Record" and, as such, is responsible for the shoreline protection structure's design and integrity. Given this fact, we only need one letter from the Engineer of Record (Halcrow) stating that they consider the concept to be consistent with the background documents. Their review letter is attached.

Please give me a call back to discuss resolution to this item.

Thanks and I look forward to hearing from you.

Mike Sherrod, ASLA, LEED AP
rrmdesigngroup
3765 S. Higuera St. Ste. 102
San Luis Obispo, CA 93401
P: (805) 543-1794 | F: (805) 543-4609
www.rrmdesign.com
www.biketraildesign.com

ED AP | rrmdesigngroup

From: Fassardi, Claudio [mailto:FassardiCD@halcrow.com]
Sent: Thursday, January 26, 2012 12:47 PM
To: Sherrod, Mike S.
Subject: RE: Twin Lakes Beach - Design Review Letter

Mike,

Here are my comments:

1. Comments about the seawall.... Parks repeatedly mentions "need", "will need", "must"... that is all fine and we are aware... the comments relevant to final design and specifications. We developed conceptual designs which are not intended for construction and do not address the details that are typically addressed in final design and specifications.

2. I reviewed page 6 of his 2009 report and did not find anything specific about the stretch from 5th to 6th Avenue. In any case, we understand the issues related to the presence and depth of the bedrock and its impact on design. Our design is based on limited information and the spot surveys performed by others in the past. Prior to moving forward with the final design a geotechnical survey will be necessary to fully characterize the site conditions and design accordingly.

3. Parks' SWL estimates are different because in his calculations he accounts for effects that are typically accounted for in the calculation of the total water levels TWL.. he also bases his estimate on the simultaneous occurrence of high events and adds them up.. like extreme high tide and storm surge which have unknown, and very low, probability of occurrence... he uses an estimate of sea level rise that is almost 5 times what it has been determined from measurements at Monterey (5mm/year versus 1.3 mm/year). I tried to engage with him to clarify his concerns and discuss all these things, but he cut me short and told me he knows everything about water levels. In any case what matters for the project are the Total Water Levels.. the SWL estimates where included only at the request of Antonella.

4. I will not engage in discussing FEMA nomenclature and FEMA issues.

5. I have no objection to his desire to review the report.

Pls call me if you'd like to discuss further.

Claudio

From: Sherrod, Mike S. [mailto:MSSherrod@rrmdesign.com]
Sent: Thursday, January 26, 2012 12:03 PM
To: Fassardi, Claudio
Subject: Fwd: Twin Lakes Beach - Design Review Letter
Importance: High

Hi Claudio,

What do you suggest as our approach to resolving Rick's concerns?

Mike Sherrod, ASLA, LEED AP
RRM DESIGN GROUP

Sent from my mobile device

----- Forwarded message -----
From: "Rick Parks" <rparks@harokasunich.com>
Date: Thu, Jan 26, 2012 11:01 am
Subject: Twin Lakes Beach - Design Review Letter
To: "Sherrod, Mike S." <MSSherrod@rrmdesign.com>
Cc: "'Greg Easton'" <greg_easton@sbcglobal.net>, "'Joseph Hanna'" <PLN829@co.santa-cruz.ca.us>

Hello Mike,

It is good to learn the Twin Lakes Beach Project has not been abandoned.

Please let me know who the current contact for the project is at the County of Santa Cruz so that I can get authorization to be paid for providing a plan set review and letter.

Based on my brief review of Sheets 5.1 and 8.1, I will not be able to state the plans are in general conformance to my geotechnical and coastal engineering recommendations.

A composite seawall is proposed; consisting of a reinforced beach sand fill slope tied to a structural concrete face. The integrity of the seawall is dependent upon the sand backfill staying in place. The wall ends and access openings need to be protected from outflanking and wave erosion. The sand backfill will need to be protected from terrestrial drainage and wave overtopping which can induce loss of the sand backfill or piping. The backfill and the wall face will need to be drained unless the structural concrete face is to be designed for undrained conditions (full hydrostatic head and submerged earth active pressure). The street drain system, the reinforced sand backfill drain, and the drain between the reinforced slope face and inside of the concrete wall face must all be designed in a manner not to induce piping.

The project alignment from 5th to 6th Avenue does not contain shallow bedrock and will not support the proposed system. Please refer to Page 6 of my 2009 report.

Also, it appears the Stillwater Levels (SWL) shown on the plan sheets are less conservative than outlined in my report. Also I didn't understand the TWL and reference to FEMA "A" and " V" Zones". I spoke to your design engineer and learned a new coastal engineering analysis and report have been prepared. I would also need to review and accept the new analysis/report if parameters are proposed for the project that are less conservative than my previous recommendations.

Please call me with any questions, my cell phone is best at 831.247.5294.

Thank you,

Rick L. Parks, GE 2603
Senior Geotechnical and Coastal Engineer
Haro, Kasunich and Associates
116 East Lake Avenue
Watsonville, CA 95076
office: 831.722.4175 ext 212
fax: 831.722.3202
cell: 831.247.5294*best number

From: Sherrod, Mike S. [mailto:MSSherrod@rrmdesign.com]
Sent: Monday, January 23, 2012 5:12 PM
To: Rick Parks
Subject: TLB - Design Review Letter

Hi Rick,

I left a message for you this morning and just wanted to follow up with the email. We've been working with Jim Davies and the RDA on the Twin Lakes Beachfront Project. The project has shifted to the County with the dissolution of RDA's in the state and we are now working with Sheryl Bailey in the Public Works Department to wrap up the Design Development plans.

As part of the County's planning review, a letter of design review has been requested from your firm noting that the proposed design development plans appear to be consistent with the recommendations provided in your report. Can you please prepare a design review letter by this Friday? I know it's short notice, but Supervisor Coonerty's office is pushing to get the planning approval done ASAP so the project can move forward. To expedite things, I've drafted a sample design review letter for your use...just edit as you see fit.

Please follow the link below to download the plans.

http://ftp.corp.rrmdesign.com/absolutefs/?f=4079&fid=283535c2

Thanks again for helping out,

Mike Sherrod, ASLA, LEED AP
rrmdesigngroup
3765 S. Higuera St. Ste. 102
San Luis Obispo, CA 93401
P: (805) 543-1794 | F: (805) 543-4609
www.rrmdesign.com
www.biketraildesign.com

Click here to report this email as spam.

This email has been sent from a Halcrow Group server. If originating from the United Kingdom it has been sent by Halcrow Group Limited, a company incorporated in England and Wales (company number 3415971) and having its registered office at Elms House, 43 Brook Green, Hammersmith, London, W6 7EF. Emails originating outside the United Kingdom have been sent by the relevant Halcrow Group company operating in the country concerned. For details see www.halcrow.com/aboutus_companies.
The contents of this email are confidential and for the sole use of the intended recipient at their email address. Emails to and from this account may be monitored. Whilst reasonable care has been taken to avoid virus transmission, no responsibility for viruses is taken and it is your responsibility to carry out such checks as you feel appropriate.
Emails supplied are as found and there is no guarantee that the messages contained within the body of the email have not been edited after dispatch. If you receive this email in error, please contact the sender immediately and delete the message from your system.

BARRIE D. COATE
and ASSOCIATES
Horticutural Consultants
23535 Summit Road
Los Gatos, CA 95033
408/353-1052

RECOMMENDATIONS FOR TREE PRESERVATIONS AT 2601 E. CLIFF DRIVE SANTA CRUZ

Prepared at the Request of:
Richard Rivoir
PO Box 4046
Santa Cruz CA 95062

For:
Uve Westbecker
2601 E. Cliff Dr.
Santa Cruz CA 95062

Site Visit by:
Barrie D. Coate
Consulting Arborist
September 9, 2008

Job #10-05-208-08

ATTACHMENT 20

Assignment
On September 9, 2008, I met Mr. Rivoir at the property at which the Monterey cypress in question stands on to review the condition of the tree and provide commentary on the loss if this tree were removed.

Observations
The tree in question is a relatively young Monterey cypress of 26 inch diameter at 12 inches above grade (above which it divides into multiple trunks), 44 feet tall with a branch spread of 22 feet. The tree is a perfectly symmetrical specimen in excellent health.

A soil cut which would be made by the current plans would remove this tree and all other screening between the existing house and the roadway.

The soil cut as planned would cut back into the existing bank approximately 33 feet and would remove the entire landscape in the front as well as this entire tree.

Since this is one of the few remaining healthy young cypress along this route this tree should be considered unusually important because most of the Monterey cypress in this area are over-mature and declining.

This tree is not currently infected with cypress canker (*Seridium cardinale*), the common problem in Monterey cypress and is such a perfect specimen that it would seem a shame to remove it simply for the goal of expanding the adjacent roadway area.

A soil cut could be made within 10 feet of the trunk on its south side if desired without killing the tree but making the soil cut closer than that would remove so many roots that the tree would either become unstable or would decline.

Conclusion
Since this is such a healthy young specimen and serves such an important screen between the building and the public area I suggest the tree be retained and that no soil cut be made closer than 10 feet from the trunk of the tree.

Respectfully submitted,

Barrie D. Coate

Barrie D. Coate

BDC/sl

Encl.:
Assumptions and Limiting Conditions
Pictures

ATTACHMENT 2 0

BARRIE D. COATE
and ASSOCIATES
Horticutural Consultants
23535 Summit Road
Los Gatos, CA 95033
408/353-1052

ASSUMPTIONS AND LIMITING CONDITIONS

1. Any legal description provided to the appraiser/consultant is assumed to be correct. No responsibility is assumed for matters legal in character nor is any opinion rendered as to the quality of any title.
2. The appraiser/consultant can neither guarantee nor be responsible for accuracy of information provided by others.
3. The appraiser/consultant shall not be required to give testimony or to attend court by reason of this appraisal unless subsequent written arrangements are made, including payment of an additional fee for services.
4. Loss or removal of any part of this report invalidates the entire appraisal/evaluation.
5. Possession of this report or a copy thereof does not imply right of publication or use for any purpose by any other than the person(s) to whom it is addressed without written consent of this appraiser/consultant.
6. This report and the values expressed herein represent the opinion of the appraiser/consultant, and the appraiser's/consultant's fee is in no way contingent upon the reporting of a specified value nor upon any finding to be reported.
7. Sketches, diagrams, graphs, photos, etc., in this report, being intended as visual aids, are not necessarily to scale and should not be construed as engineering reports or surveys.
8. This report has been made in conformity with acceptable appraisal/evaluation/diagnostic reporting techniques and procedures, as recommended by the International Society of Arboriculture.
9. When applying any pesticide, fungicide, or herbicide, always follow label instructions.
10. No tree described in this report was climbed, unless otherwise stated. We cannot take responsibility for any defects which could only have been discovered by climbing. A full root collar inspection, consisting of excavating the soil around the tree to uncover the root collar and major buttress roots, was not performed, unless otherwise stated. We cannot take responsibility for any root defects which could only have been discovered by such an inspection.

CONSULTING ARBORIST DISCLOSURE STATEMENT

Arborists are tree specialists who use their education, knowledge, training, and experience to examine trees, recommend measures to enhance the beauty and health of trees, and attempt to reduce risk of living near trees. Clients may choose to accept or disregard the recommendations of the arborist, or to seek additional advice.

Arborists cannot detect every condition that could possibly lead to the structural failure of a tree. Trees are living organisms that fail in ways we do not fully understand. Conditions are often hidden within trees and below ground. Arborists cannot guarantee that a tree will be healthy or safe under all circumstances, or for a specified period of time. Likewise, remedial treatments, like medicine, cannot be guaranteed.

Trees can be managed, but they cannot be controlled. To live near trees is to accept some degree of risk. The only way to eliminate all risk associated with trees is to eliminate all trees.

Barrie D. Coate

Barrie D. Coate
ISA Certified Arborist
Horticultural Consultant

BARRIE D. COATE
and ASSOCIATES
Horticultural Consultants
23535 Summit Road
Los Gatos, CA 95033
408/353-1052

Definitions of Terms

Tree Canopy – (Tree Crown) - Consists of all portions of the tree bearing foliage. Commonly applied to activity beneath the canopy, also defined as the area inside the drip-line.

Drip-line – The line described on the ground directly below the outer edge of the tree canopy.

The area between the drip-line and the tree trunk contains the majority of the absorbing root tips. Many more are found beyond this line.

Root Mass - The portion of the tree which supplies water and minerals to the foliage crown (absorbing roots) and which provides structural support for the crown (secondary roots).

Root Protection Zone - Nominally, the area beneath the canopy plus 50% the radius of the canopy on any given side of the tree (a 40 foot diameter canopy with a 20 foot radius has a 30 foot wide root protection zone on any side of the tree).

Branch Attachment – The joint at which limbs or branches join the trunk or limb from which they originate.

Co-dominant Leader – A narrow branch attachment most commonly seen where an upright branch is competing with the natural leader or where two or more vertical trunks are joined. When they are of similar or equal diameter, a danger of one of them breaking out is created.

Included Bark – A condition created when co-dominant leaders each produce bark in the narrow crotch, compounding the problem of poor attachment, and often leading to breakage.

Absorbing Root Tips - The roots produced in the upper 2 to 3 feet of soil which absorb water and minerals. The most effective ones are found in the top 2-inches if a mulch is maintained on the soil surface.

Mulch - Any material which insulates the soil surface. Organic mulches are preferred since they decompose to increase the humic acid content of the soil, but rock mulches are better than no mulch, and allows leaves to be blown off their surface.

Stub-cutting – Removal of a limb or branch end at a point where no branches emerge. This is a destructive procedure.

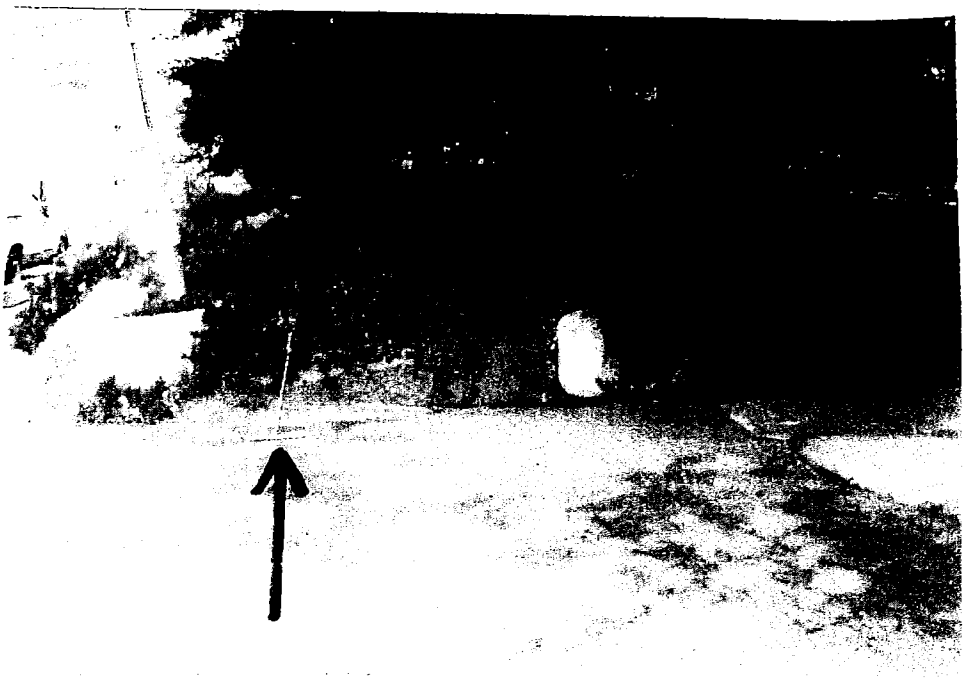
Drop-crotch Pruning - Removal of the end of a branch back to a side branch of at least 50% the diameter of the portion removed (a 4-inch diameter branch cut back to a 2-inch or larger diameter side branch).

Lion's Tail Pruning - Excessive thinning of the interior branches and twigs, leaving foliage only at the ends of long, often poorly tapered limbs. This procedure is destructible.

Recommendations for Tree Preservation at 2601 E. Cliff Drive Santa Cruz

← Photo 1 – The young cypress in question.

↓ Photo 2 – Cutting the soil back to 10 feet from the tree would be acceptable.



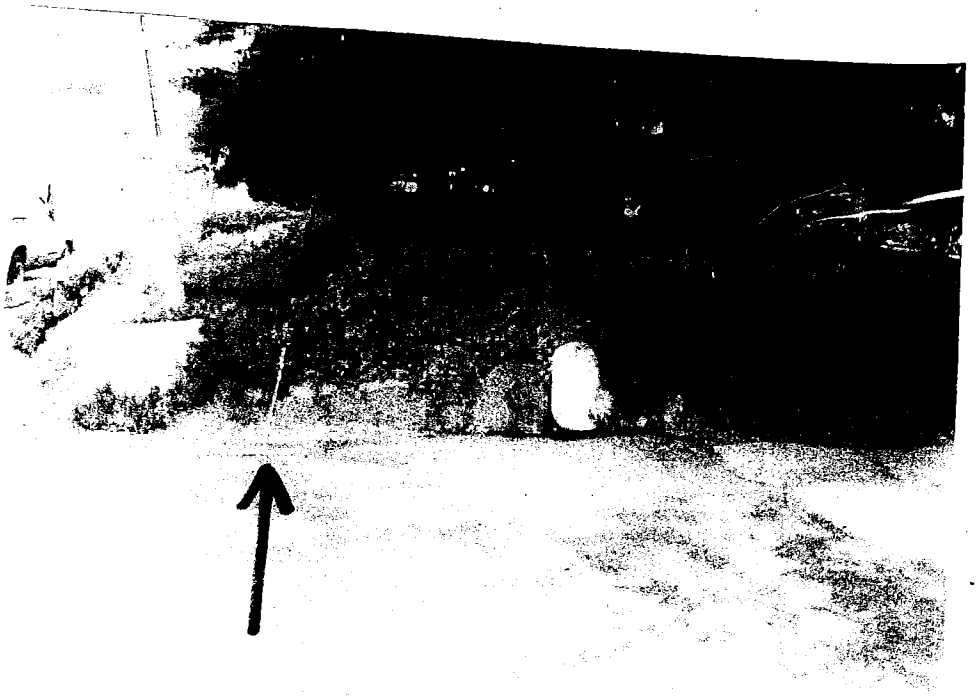
Prepared by. Barrie D. Coate, Consulting Arborist 09/09/08

ATTACHMENT 2 0

Recommendations for Tree Preservation at 2601 E. Cliff Drive Santa Cruz

← Photo 1 – The young cypress in question.

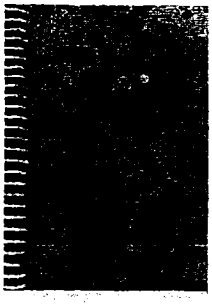
↓ Photo 2 – Cutting the soil back to 10 feet from the tree would be acceptable.



Prepared by, Barrie D. Coate, Consulting Arborist

09/09/08

ATTACHMENT 20



Linda Wilshusen
Planning and Project Management
1115 Live Oak Avenue
Santa Cruz, CA 95062

May 31, 2012

Sheila McDaniel
County of Santa Cruz Planning Department
701 Ocean St.
Santa Cruz, CA 95060

RE: Application #111134 - Initial Study for Twin Lakes Beachfront Improvement Project

Dear Ms. McDaniel:

I'd like to convey my support for the determination of a mitigated negative declaration for the Twin Lakes Beachfront Improvement Project. This project has been anticipated by the wider Live Oak community for over a decade.

The very important benefits of this project are new, safe, and accessible pedestrian walkways; improved automobile access and parking; safer bike lanes; significantly improved beach access; and a significantly improved visual and aesthetic environment along this heavily used segment of popular Twin Lakes State Beach. We are fortunate that these improvements can all be made within existing public rights-of-way and/or on public property.

Numerous public meetings have been held about the need for and design of this project. Adjacent property owners have been able to have their concerns addressed both via these public meetings and via numerous individual meetings with County staff, members of the Board of Supervisors, and consultants. There is huge support in the community for this project, as indicated by a strong consensus in the design-process community meetings. It's time to get on with it!

Thank you very much for your consideration of my comments.

Sincerely,

Linda Wilshusen

Linda Wilshusen

cc: Supervisor Neal Coonerty

THE LEADING EDGE OF COASTAL ACTIVISM

May 27, 2012

Santa Cruz County Planning Department
701 Ocean Street
4th Floor
Santa Cruz, CA 95060

Re: Negative Declaration on the EIR for the East Cliff Drive Pedestrian Improvement Project Phase III: 5th Avenue to 7th Avenue: OPPOSE

Re: East Cliff Drive Drive Pedestrian Improvement Project Phase III: 5th Avenue to 7th Avenue: OPPOSE

Respectful greetings from Surfers' Environmental Alliance (SEA)

We wish to file our preliminary comments on the proposed East Cliff Drive Pedestrian Improvement Project; Phase III :5th Avenue to 7th Avenue at this time. SEA has been following the lengthy controversy of trying to gain public approval for this coastal project for a long time, and we are very aware that the current proposed project has been scaled-down twice already, due to the concerns of the coastal community about various aspects of this project and subsequent budget restraints. Over and over at "scoping meetings" we have seen various aspects of this project heavily-questioned by local residents with no clear answers offered in public and no public consensus achieved. If "consensus" has been achieved, just exactly with whom?

Regarding the Negative Declaration on the need for a full EIR on this project as required by CEQA, SEA understands the negative declaration cites Mitigation Measures. While these measures are good, we contend that the proposed project will definitely have a serious and prolonged impact on this stretch of beach and will negatively impact public access to the same. Santa Cruz County's public beaches are highly-valued as generators of the county's tourist industry and a major source of recreational opportunities for all county residents. Any public action which reduces or negatively impacts such opportunities should not be allowed in a public agency project. Since a beach environment may not be restored following major construction and our natural environmental features are an irreplaceable source of recreational opportunities as well as an engine that helps drive our local economy, any project which will alter beach and coastal conditions should not be undertaken lightly. SEA firmly insists that a full EIR is necessary under CEQA and required for this project, and offered for public review before fully accepted.

To be clear: real concerns still exist about **(1) the need for this project at all, especially in these lean financial times; (2) violation of the prescriptive right for parking along the roadside, generated by countless drivers who have historically parked along the roadside for beach access; (3) and the unnecessary inclusion of a "bluff stabilization" structure in the plans.**

SEA West Coast/North 410 Seacliff Drive Aptos, CA 95003 scseasurfer@gmail.com

ATTACHMENT 2 0

Regarding this last point: a "seawall" is a "seawall" no matter what you call it and since wave action does not threaten the roadway, we can see no reason for this construction at all. Does "Planning" intend to "armor" the entire mid-county coastline?

As far as threat to the roadway is concerned, Live Oak residents have told us that "nothing has changed over the past 24 years" so why try to "protect" something that doesn't need to be protected? Harbor Beach and the "adjacent parts" of Twin Lakes State Beach are not natural beaches, but are artificially nourished by the dredge operations of the SC Small Craft Harbor. This "intervention in natural processes" annually builds a wide swath of sandy beach between East Cliff Drive and the bay. Therefore, the usual "justifications" for a "bluff stabilization" project ---better known as a "seawall"—do not apply to this proposed coastal construction.

Seawalls are usually "justified" by evidence that the wave action threatens the safety of public or private property situated on or near the coastline. This, furthermore, is evidenced when said construction is on the verge of a coastal bluff and may be undermined by wave action—a situation that clearly does not exist as a real and pressing threat regarding the East Cliff Drive roadway project. Rather, the wide beach, replenished every year by the Harbor's dredge project dumping dredge spoils on the beach or in the waters just seaward of the beach, serves to protect the roadway from the type of wave action customarily associated with the justification for any seawall.

We also ask that all parties note and duly consider the valid prescriptive right for parking along the roadside, established by historical parking along the East Cliff roadside by countless drivers. The many, many years of such parking access being available, creates a right of access that should not be ignored or minimized. Said parking location also serves customers and employees of the numerous harbor businesses which flourish at the Small Craft Harbor.

SEA contends that no publicly-funded project should ever reduce the number of public parking spaces or the methods of easy beach and coastal access afforded by the existing conditions on site. Such action is not in the public interest and is not a reasonable use of scarce public funds when other more necessary and reasonable projects remain undone.

As a preliminary matter, Surfers' Environmental Alliance (SEA) is committed to the preservation and protection of the environmental and cultural elements that are inherent to the sport of surfing. Our goals are achieved through grassroots activism, community involvement, education and humanitarian efforts. We engage in projects that strive to conserve the quality of our marine environment, preserve or enhance surf breaks, protect beach access rights, and safeguard the coastal surf zone from unnecessary development. www.seasurfer.org

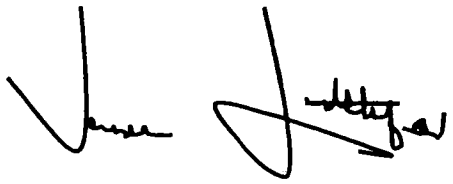
As you may know, SEA is headquartered in California on the West Coast and in New Jersey on the East Coast. Therefore, we try to comment on matters along all country coasts and also overseas when an issue falls under our mission. As the people in the water, we are very interested in any proposed project that tends to comprise beach access or negatively affect beach and ocean conditions.

We believe that the Planning staff should re-think the absolute need for and current desirability for the East Cliff Drive Pedestrian Improvement Project; Phase III. It is not needed due to any perceived threat to the roadway from wave action; it ignores the prescriptive rights of roadside parking long-established; and it requires a "bluff stabilization" construction—or seawall—which is not even necessary or prudent.

SEA West Coast/North 410 Seacliff Drive Aptos, CA 95003 scseasurfer@gmail.com

At the very minimum we, again, firmly request a full EIR on this project, and request that said document be offered for full public review and comment.

For the sea and the surf,



James Littlefield
West Coast Environmental Projects Director
Surfers' Environmental Alliance (SEA)
www.seasurfer.org

cc. Santa Cruz County Board of Supervisors ✓

cc .California Coastal Commission

05-23-12A11:41 RCVD

STATE OF CALIFORNIA
GOVERNOR'S OFFICE *of* PLANNING AND RESEARCH
STATE CLEARINGHOUSE AND PLANNING UNIT

EDMUND G. BROWN JR.
GOVERNOR

KEN ALEX
DIRECTOR

May 17, 2012

Matthew Johnston
Santa Cruz County
701 Ocean Street
Santa Cruz, CA 95060

Subject: East Cliff Pedestrian Improvement Project Phase III
SCH#: 2012042035

Dear Matthew Johnston:

The State Clearinghouse submitted the above named Mitigated Negative Declaration to selected state agencies for review. The review period closed on May 16, 2012, and no state agencies submitted comments by that date. This letter acknowledges that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act.

Please call the State Clearinghouse at (916) 445-0613 if you have any questions regarding the environmental review process. If you have a question about the above-named project, please refer to the ten-digit State Clearinghouse number when contacting this office.

Sincerely,

Scott Morgan
Director, State Clearinghouse

ATTACHMENT 2 O

Document Details Report
State Clearinghouse Data Base

SCH# 2012042035
Project Title East Cliff Pedestrian Improvement Project Phase III
Lead Agency Santa Cruz County

Type MND Mitigated Negative Declaration

Description Note: Reference 2010112022

Proposal to complete roadway and roadside improvements within the East Cliff Drive public right-of-way between 5th and 7th Avenue to include parking and circulation improvements (vehicle, bicycle, and pedestrian) and a bluff protection structure on the south side of the right-of-way.

Lead Agency Contact

Name Matthew Johnston
Agency Santa Cruz County
Phone 831 454 3201 **Fax**
email
Address 701 Ocean Street
City Santa Cruz **State** CA **Zip** 95060

Project Location

County Santa Cruz
City
Region
Lat / Long
Cross Streets East Cliff Drive between 5th and 7th Ave
Parcel No. County Right of Way
Township **Range** **Section** **Base**

Proximity to:

Highways Hwy 1
Airports
Railways
Waterways Schwan Lake
Schools
Land Use Public Facility, County Right of Way

Project Issues Biological Resources; Coastal Zone; Flood Plain/Flooding; Geologic/Seismic; Noise; Soil Erosion/Compaction/Grading; Traffic/Circulation; Water Quality

---

Reviewing Agencies Resources Agency; California Coastal Commission; Department of Fish and Game, Region 3; Office of Historic Preservation; Department of Parks and Recreation; Department of Water Resources; California Highway Patrol; Caltrans, District 5; Air Resources Board, Transportation Projects; Regional Water Quality Control Board, Region 3; Department of Toxic Substances Control; Native American Heritage Commission

---

Date Received 04/17/2012 **Start of Review** 04/17/2012 **End of Review** 05/16/2012

ATTACHMENT 2 (illegible)

Note: Blanks in data fields result from insufficient information provided by lead agency.

Sheila McDaniel

From: Joseph Hanna
Sent: Wednesday, August 01, 2012 9:34 AM
To: Sheila McDaniel
Cc: Matt Johnston
Subject: Comments of the Cotton Shire and Associates Letter

I am writing to address the concerns outlined in Cotton, Shires and Associates' (CSA) May 16, 2012 letter regarding the Initial Study completed for the East Cliff Drive Seawall and Right-of-Way Improvements between 5th and 7th Avenue. These improvements include the construction of a seawall and improvement of the street with a new design for parking, and public beach access. In examining the letter the following issues are raised:

1. ***The Initial Study did not include the technical data that forms the basis of the Summaries of the investigation studies included with the Study.***

Initials Studies do not typically include all of the supporting technical documentation for a project. In this case the Initial Study references a coastal study, geotechnical engineering report, and an engineering geology report that do provide the data that support the Initial Study and Negative Declaration. All of these documents were available to the consultants and we believe that they include the technical data necessary to better understand the summary documents included in with the Initial Study.

2. ***No analysis of the potentially adverse wave reflection is presented in the Initial Study.***

The project has been specifically designed to avoid reflection and refraction of the waves. Specifically, the walls are designed to conform to the same configuration as the existing more resistive Purisima Sandstone, and will extend to a depth sufficient to reduce scour beneath the wall. By conforming to the existing conditions, the wall will avoid a new pattern of wave reflection or refraction of waves, and will reduce the potential for additional adverse coastal erosion. As shown on the transects completed as part of the Halcrow Inc. investigation and documented in their report, the walls are also designed to receive the waves and dissipate the wave energy, reducing the potential for scour at the base of the coastal bluff. The walls are also designed to displace wave energy that could lead to erosion of the coastal to the east. To the west the harbor mouth is armored and the proposed seawall poses little potential to adversely impact this structure.

By mimicking the existing coastline and dissipating the wave energy the proposed seawall will reduce the potential for coastal erosion and compensate for the current baseline conditions. The walls are designed to avoid overtopping by waves, and the wall will be required to be tied into the existing conditions on either side of the new sea wall. The final design will require final review by the project geologist and engineers.

3. ***The improvement may have an adverse impact on the ongoing sand transport and erosion processes.***

The major impact to the littoral flow of sand in this vicinity is the construction of the Santa Cruz Harbor in the early 1960's.[1] This disruption prevented the normal drifting of sand from the beach area of East Cliff Drive between 5th and 7th street. After the problem was recognized sand from the harbor was purposely deposited upon beach in front of the location where the project's improvements are proposed. This has helped to restore the transport system and has produced a substantial beach during the summer months in this location. Halcrow's approach to avoiding an impact to sand transport and erosion is to design the wall in a manner that limits over topping, and resolves the wave energy at the wall. In doing so the affect on existing littoral transport immediately in front of the wall is limited and insignificant.

ATTACHMENT 9.1

The overwhelming obstruction to littoral transport in this area is the harbor, and the proposed wall should compensate for the increased coastal erosion caused at this location during winter months. This lower erosion rate, along with the design of the wall, are appropriate responses to this erosion, and because of their relatively minor nature of the new seawall are unlikely to adversely affect either the Harbor mouth improvements or down coast future improvements to the beach. Essentially, the wall mitigates the affect of the Harbor improvements on the improvements between 5th and 7th street, and will restore the littoral pattern to more of a pre-Harbor condition, reducing erosion.

Although this issue is mentioned in the Initial Study, the writer of the Initial Study intend that the referenced reports would provide clarification should an interested party seek additional information. Cotton, Sires and Associates did not take the opportunity to do so, and we believe that if they do, they will form a similar conclusion as the project engineering geologist and engineers.

4. Affects on Beach Nourishment and winter beach scour are not presented in the Initial Study.

Similar to the previous answer, beach nourishment is complicated by the overwhelming affect of the harbor blocking the flow of sediment to this beach, and placing of dredging from the harbor on the beach in front of the project location. Oblique aerial photographs from the early 1900's, as well as aerial photographs taken throughout the first half of the 20th century demonstrate that a narrow beach protected the edge of East Cliff. Sand moved south along the beach from the Harbor area, and a fraction of beach sand was remobilized by wind and deposited as sand dunes north of the East Cliff Drive. Clearly, some erosion of the more resistive shoreline occurred over time, and at times the sand dunes where cycled into the surf zone, but the process appears to have been slow and the source of sand from Arana Gulch provided a constant of sand that helped protect the beach. By constructing the harbor the transport of sand was disrupted, and the beach was at times was more susceptible to coastal erosion.[ii]

By placing a sea wall at this location, the roadway and improvements will be protected from erosion during intense winter storms. A small amount of sediment maybe lost by protecting the coast at this location, but the impact is very minor in comparison to the vast amount of dredging already placed on the beach.

5. Seasonal photographs depicting the maximum extent of the winter beach scour should be presented.

Photos are included with the Engineering Geology report[2], and demonstrate the conditions addressed in items 3 and 4.

6. They do not understand how the wall will be drained.

Additional analysis is necessary during the design phase of the sea wall. Typically, design level plans are not required or necessary during the project review, and all design aspects of these projects are not worked out in a project at the Initial Study Phase. Haro, Kasunich and Associates have indicated that they believe that the wall can be adequately designed, and Rogers E. Johnson and Associates has identified the designed parameters that must be considered in this design.[iii] We agree with CSA that additional geotechnical questions must be answered, but these are appropriately answered during the design phase of the project, and not at the Initial Study Phase of the project. .

The current seawall is a preliminary design that must be perfected in accordance with the recommendations of the February 23, 2012 letter by Haro, Kasunich and Associates (attachment 6 of the Initial Study), and the study is appropriately cited within the Initial Study. The County's Public Works design criteria requires that the wall be designed in accordance to the California Building Code, and we believe that the state standards are adequate to assist in the development of the seawall for drainage, liquefaction, overtopping, and resistance to wave erosion of the wall.

7. The issue of out flanking of the wall by over topping walls and other conditions is not clearly addressed.

The Halcrow report indicates that the wall has been designed to minimize overtopping. Even so, the wall must be designed to prevent damage from overtopping, and water that overtops will be directed back in the same direction that the wave flows onto the surface above the wall. To avoid out flanking, the wall will be tied back into the slope to reduce the potential of adverse reflection of wave energy. The Initial Study requires an engineered drainage plan and we believe that these issues can be administratively resolved with the review of these plans.

The County's Public Works design criteria require that the wall be designed in accordance to the California Building Code, and we believe that the state standards are adequate to assist in the development of the seawall for drainage, liquefaction, overtopping, and resistance to wave erosion of the wall.

8. No analysis of the shallow ground water impact to the street improvements is included with the study.

High ground water can affect the street, but if adequate design measures are taken to drain the seawall and backfill the impact can be reduced. Here again, we believe that the County design standards are adequate to compensate for the drainage issue. As required by the Initial Study, a design level street plan will be prepared by a civil engineer, and the project geotechnical engineer will review these plans to assure that ground water will not adversely impact the design.

9. Piping or other loss of sand from behind the wall due to storm water or wave action compromising the integrity of the wall.

We agree that piping is always an issue with the design of sea walls. The County's Public Works design criteria requires that the wall be designed in accordance to the California Building Code, and we believe that the state standards are adequate to assist in the development of the seawall. Here again, the County's Public Works design criteria requires that the wall be designed in accordance to the California Building Code, and we believe that the state standards are adequate to assist in the development of the seawall. These conclusions are reflected in the Initial Study.

10. There is insufficient data in the Initial Study to address liquefaction and lateral spreading.

Seawalls are commonly designed and constructed to prevent adverse impacts form liquefaction and especially lateral spreading. The geotechnical engineer has identified some areas of concern, and the project design engineer will need to work with the geotechnical engineer. Here again, The County's Public Works design criteria require that the wall be designed in accordance to the California Building Code, and we believe that the State standards are adequate to assist in the development of the seawall. These conclusions are reflected in the Initial Study.

11. No analysis of negative erosional impacts to the beach is presented in the Initial Study.

The intent of this seawall is to mitigate a problem caused by the construction of the harbor. The wall's design is intended to produce smooth transitions between the edges of the wall and harbor improvements to the northwest, and the surrounding unprotected areas to the east. What the seawall will do is help mitigate the coastal erosion that resulted from the harbor improvements to protect an existing street. By designing the wall to comply with FEMA standards and the California Building Code the wall will perform adequately without resulting in negative erosion.

Joe Hanna
County Geologist
CEG 1313

ATTACHMENT

[i] Rogers E. Johnson and Associates dated October 16, 1995

[ii] Rogers E. Johnson and Associates dated October 16, 1995 and updated June 4, 2009

[iii] Haro, Kasunich and Associates February 22, 2012, and Rogers E. Johnson and Associates dated February 21, 2012

ATTACHMENT 2 1

pln056

COUNTY OF SANTA CRUZ
DEPARTMENT OF PUBLIC WORKS
INTER-OFFICE CORRESPONDENCE

DATE: June 14, 2006

TO: Ron Lechner, Redevelopment Agency

FROM: Jack Sohriakoff, Public Works Department

SUBJECT: PROPOSED ONE-WAY CONVERSION OF EAST CLIFF DRIVE FROM THE SANTA CRUZ YACHT HARBOR TO SEVENTH AVENUE

Based on traffic counts collected between August 18 and 20, 2005, our department conducted a traffic analysis to determine the traffic impacts from converting East Cliff Drive from a two-way street to a one-way eastbound street between the Santa Cruz Yacht Harbor and Seventh Avenue.

Our study indicates that the Seventh Avenue and Eaton Street signalized intersection would be impacted by the additional volume of vehicles that would be diverted to the intersection. As a result, the level of service (LOS) on weekdays during evening peak hour would worsen from an existing LOS C to LOS D. The effect of LOS D would be additional time delay at the intersection and longer vehicular queues for the northbound approach.

Additionally, the Eaton Street and Lake Avenue intersection would also be impacted. The existing storage capacity for the westbound left turn lane at this intersection is 60 feet (three vehicles). This storage capacity would be insufficient to safely accommodate the additional vehicular left turns that would be diverted to this intersection, especially large delivery trucks and vehicles towing boat trailers. Future improvements at this intersection should increase the left turn storage lane to a minimum of 150 feet. This may cause impacts to the adjacent properties due to the need for additional right-of-way to construct the improvements.

Furthermore, southbound motorists on Seventh Avenue approaching East Cliff Drive attempting to access the yacht harbor area, who are unaware that access is now only via Eaton Street, would have to find an appropriate turnaround facility. This could potentially create confusion and inappropriate traffic maneuvers around the Twin Lakes Beach area.

Our department is unable to recommend the proposed one-way conversion on East Cliff Drive since congestion would increase in the area, safety would

be compromised at the Eaton Street and Lake Avenue intersection, and access to the yacht harbor and adjoining businesses could only be achieved via Eaton Street. We do not recognize any benefits from this proposal, but have determined that there can be significant impacts to the surrounding community.

If you have any questions or require additional information, please contact me or Rodolfo Rivas, Traffic Engineer, at extension 2160.

/RR:bbs

ecliffonewayb.wpd

COUNTY OF SANTA CRUZ

INTER-OFFICE CORRESPONDENCE

DATE: August 31, 2012

TO: Sheila McDaniel, Planning Department

FROM: Jack Sohriakoff, Department of Public Works

SUBJECT: East Cliff Drive – Twin Lakes Beach Improvement Project

---

Here are my responses to the James C. Jeffery III letter to Mr. Wittwer dated May 16, 2012

2nd P – "To begin, there has not been sufficient initial design review of this project to "catch" significant design issues. Accordingly, I would respectfully submit that the public and the County have not been provided adequate traffic and engineering safety information such as is necessary to provide meaningful input and make an informed decision about this project."

Response – Mr. Jeffery is obviously unaware of the professional civil and traffic engineering input and review provided by the Department of Public Works staff and engineering consultants that has gone into this project from the very beginning. Mr. Jeffery does not provide any supporting facts or documentation to justify his statement of opinion.

3rd P – "The proposed physical improvements of the public right-of-way are required to be designed and stamped by California Licensed Civil Engineers; the Application and Initial Study do not provide evidence of same. This make the job of the project reviewer much more critical, as the designers may not be licensed engineers. In order to ensure that any plans created will stand up to the test for design immunity, stamped plans should be reviewed by a competent Civil Engineer to determine if they meet county, state and national standards of good design, signing and striping."

Response – Project plans are not required to be stamped for a Planning Department application. All improvement plans to be built within the County maintained road system are required to be stamped by the appropriate professional engineer. For this particular project the County of Santa Cruz Board of Supervisors will have to consider for approval the stamped improvement plans prior to the project being advertised for bidding. These plans will be stamped by the Director of Public Works, the Assistant Director of Public Works, the Senior Civil Engineer, and the consulting engineer who are all licensed Civil Engineers. The Board of Supervisors will also consider for approval the contract that awards the project to the lowest responsible bidder (licensed contractor).

4th P – "One can see from both the Project Plans and Initial Study that the primary roadway design consideration has been maximization of parking. Unfortunately, this has been at the expense of safety for pedestrians, bicyclists, and drivers. Indeed, no traffic safety issues are addressed in the Initial Study."

Response – Mr. Jeffery does not provide any supporting facts or documentation to justify his statement of opinion. The proposed roadway design is a result of many factors, and most all of them are based upon public safety requirements. The proposed roadway design incorporates the basic state and local design criteria standards as required which means that safety concerns and public liability are minimized.

5th P – "There are circumstances ….. The proposed parking lay-out presents a significant traffic safety impact."

Response – A review of traffic collision for this segment of East Cliff Drive indicates that five incidents occurred between June 2007 and May 2010. There were no injuries reported. Three collisions involved a motorist hitting a parked vehicle while conducting a parking maneuver, and the other two involved stopped vehicles in the roadway while other motorists where backing. All incidents were low speed collisions. There were no reports of pedestrian or bicycle related collisions. This review concludes that the street segment does not have a recent history of traffic safety problems. The fact that the proposed improvements will formalize parking and provide specific facilities for multi-modal users (pedestrian walkways and crosswalks, bike lanes, bus stop, and travel lanes), the expectations are that all road users will knowingly anticipate conflict areas and act accordingly. The potential for operational conflicts and safety hazards will be overwhelmingly reduced from existing conditions.

All standard parking types (parallel, perpendicular, and diagonal) adjacent to a roadway will create traffic operational conflicts when motorists are either stopping in the bike and/or travel lane to maneuver into a parking space, or backing/crossing into the bike and/or travel lane when leaving or entering a perpendicular or diagonal parking space. Although these operational conflicts cannot be avoided, any type of standard shoulder parking should not be considered a "significant traffic safety impact".

In this design plan the diagonal parking is proposed on a very short street segment where one end is a multi-way stop intersection and the other end a severe 90 degree curve. Motorists are not expected to reach substantial speeds within this very short road segment to cause an ongoing safety concern. In reference to the California Environmental Quality Act, the term "significant impact" carries substantial weight and should not be used lightly. Mr. Jeffery does not provide any supporting facts or documentation to justify his statement of opinion that "the proposed parking lay-out presents a significant traffic safety impact."

Response to 6th P – Mr. Jeffery states that the "optimal traffic engineered parking lay-out would be a continuance of the parallel parking method currently in use" because "clear sight distance for all is maximized with this solution." As stated above, even parallel parking will create traffic operational conflicts due to the fact that motorists will stop in the bike and/or travel lane in order to back into a vacant space between other parked vehicles. In addition, opening a vehicle door adjacent to a bike and/or travel lane creates potential hazards to bicyclists and to people disembarking the vehicle into the bike and/or travel lane. Mr. Jeffery fails to note these potential traffic hazards associated with parallel parking.

The proposed diagonal parking spaces adjacent to the beach area are designed to be extra deep so people who want to utilize the rear cargo or trunk areas of the vehicle will not have to step into the bike lane and impede the flow of traffic. It reduces the conflicts between vehicle occupants and bicyclists. Also, because the diagonal parking spaces are extra deep, they provide additional sight distance and maneuvering room that reduces conflicts over and above standard dimensional diagonal parking spaces.

7th P – "Another downfall of the Initial Study is that no alternative circulation methods have been discussed, i.e. continuing the one-way pattern that presently exists on Lake-5th Avenue."

Response – The Traffic Engineering section of Public Works analyzed the potential impacts of a one-way East Cliff Drive circulation plan between 5th Avenue and 7th Avenue in the eastbound

direction several years ago. The resulting June 14, 2006, inter-office memorandum is attached. Why it was not included in the Initial Study is unknown.

8th P – "The Initial Study seems to be built …"

Response – For Planning Department response.

This concludes my responses to this letter. Please let me know if you have any questions or require further information.

Attachment