Final Report
Technical Review of FEMA CCAMP for Ventura County

Prepared for:

The County of Ventura

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EXECUTIVE SUMMARY

The Federal Emergency Management Agency (FEMA) is performing detailed coastal engineering analyses and mapping of the Pacific coast of California. The analysis and mapping will revise and update the flood and wave data for the Ventura County Flood Insurance Study (FIS) report and Flood Insurance Rate Map (FIRM) panels along the open coast. FEMA distributed Preliminary FIRMs and supporting documentations for the County of Ventura and Incorporated Areas on September 30, 2016. There are significant changes in Special Flood Hazard Area (SFHA) zone designations within the jurisdiction of the Cities of Ventura, Oxnard and Port Hueneme (the Cities) and the County of Ventura.

GENERAL FINDINGS

This technical review evaluated the information provided by FEMA and its study contractor (BakerAECOM) that details the basic parameters, assumptions and methods used to characterize the 100-year coastal storm hazards along Ventura County, as well as the mapping results. The general findings that apply to either the entire analysis or a significant number of transects are listed below:

Methods

- The analysis profile relied on a single LiDAR data set. The Most Likely Winter Profile (MLWP) analysis was not performed as requested in the Pacific Guidelines. This would lead to underestimates of both flood hazard extent and BFE.
- Primary Frontal Dunes (PFD) analysis was not conducted nor an explanation provided as to why the preliminary FIRM mapping effort failed to identify any PFD outside of Transect 68.
- Event-Based Erosion analysis was not conducted in the preliminary FIRM mapping analysis outside of Transect 68.

Backshore Analysis

- The description of the method used to delineate d_{toe} and d_{crest} in the IDS is lacking and the vagueness may affect the mapping of the inland extent of flooding. In addition, there is no discussion of the presence or mapping of the d_{heel} which may affect the PFD determination.
- The BFE analysis was based on a single 2009 LiDAR dataset with wide beaches and high dunes in many areas. The topographic profiles can vary greatly between seasons, dredge cycles, and years (such as pre- and post-El Niño winters). In some cases, beach widths can change up to 200 feet over a few years. Therefore, it is important to consider a range of potential morphologies when determining flood elevations and extents.
- Cobbles and the role they have seasonally in dissipating or reducing wave run up was not considered in the PFIRM mapping.

Transects

- The transect numbering scheme in the IDS should correspond to the PFIRM transect numbers allowing reviewers to understand the technical approach and results applied at each location.
- There are large differences in BFE between neighboring transects. PFIRMs for the Ventura

County show that the difference in BFEs between neighboring transects is more than 10 feet around the following transects: 1-2, 4-5, 6-7, 10-11, 11-12, 30-31, 79-80, 87-88, 88-89. It is very difficult for floodplain managers and planners to interpret and implement the map results. This is particularly true for transacts separating neighboring residential properties. This practice is also not consistent with Pacific Guidelines (Section D.4.9.6) which states: *"Transition zones may be necessary between areas with high runup elevations to avoid large differences in BFEs and to smooth the changes in flood boundaries."*

- Additional transects may be warranted in locations where the BFE between neighboring transects exceeds a certain threshold regardless of the shore feature similarities, additional transect(s) should be added between those neighboring transects as a transitional reach to transit the BFE from one to another.

<u>Hydraulic Conditions – Waves and Water levels</u>

- The pattern of BFE should be close to the typical pattern of refracted waves inside the Santa Barbara Channel.
- Wave analysis transects begin at a depth of ~40 m. Using wave parameters at the 40-m depth from the nearshore wave model as input parameters for the wave runup analysis is a poor choice for reaches with oblique wave approach angles and wave refraction such as around the many headlands in the north County. Some of the 2-D wave phenomena captured in a 2-D refraction model are not adequately represented in 1-D transect based analysis, potentially leading to overestimates of the BFE.
- Wave approach angle is not considered, which could lead to up to a 10% overestimate of wave heights and thus in BFE. Waves approach the shore in an oblique angle in many reaches along the Ventura coastline as a result of wave refraction around headlands. It should be considered in the runup analysis.
- The wave periods are not homogeneous across the region or even adjacent transects at 40-m depth for a single storm event.
- The shore slopes are not considered in determining the wave breaking criterion (ratio of wave height to water depth), which may lead to underestimate of wave height. Using appropriate ratio of wave height to water depth is recommended.
- Consistence checks of parameters used between neighboring transects showed that in some reaches (such as between Transects 4 and 5, 12 and 13, 16 and 17, etc.), there are substantial differences. It is strange that the neighboring transects would have different wave periods and sometimes different SWL for the same storm event at the 40-m depth.

<u>Coastal Structures</u>

- Treatment of shore protection structures has a significant impact on BFEs. Many rock revetments along the County coastline were engineered with multiple layers of rock sized to resist extreme wave forces and survived equivalent to and larger than the 1% annual chance storm event. Per the Pacific Guidelines (Section D4.7.3), these structures may be recognized on flood hazard maps. However, no structures are recognized in the study.
- For Transects 4, 6, 9, 11, 14, 21, 22 ,25, 56, 59, 60, 67, 71, 72, 73, 76, 82 and 88 where engineered revetments survived the 1% annual chance flood, a more representative failure

mode for analysis is partial failure mode.

- Roughness factor due to presence of cobbles, offshore reefs, and rock from failed revetment structures were not considered, which would lead to overestimate of BFE. A composite roughness factor should be used instead of using roughness factor of sandy or earthen materials. Rock revetments were completely removed from the transect geometry and the roughness factor was replaced with that of sand for the analysis of the structure failure scenario. The roughness treatment was not consistent with Section D.4.7.3.2 of the Pacific Guidelines, which states: "*the Mapping Partner shall select an appropriate roughness factor when conducting runup and overtopping analyses on the failed structure."*

Mapping

- A 35-foot minimum distance criterion was applied in the mapping for transects with overtopping. If the resulting landward runup zone was less than 35 feet, the overtopping runup zones were either integrated into the primary coastal Zone VE or, where the VE and AO overtopping zones together were at least 35 feet, combined to create a secondary zone VE. The resulting mapped BFE in the runup zones is often 5 feet higher than the calculated BFE. This practice is inconsistent with Pacific Guidelines (Section D.4.9.4) as the community officials were not consulted about setting 35-foot as the minimum mappable distance criterion.

Based on results of general technical review, five sites were selected for detailed review. The detailed review evaluated the general site condition, historical aerial photos, wave patterns, historical profiles for sandy beaches, as well as the parameters and methodology used in the transect analysis. The detailed analysis and findings were summarized site by site from north to south in Section 5.0. The findings included whether the BFE is under- or overestimated and whether an appeal may be warranted. The recommendations for communities were also summarized in Section 7.2.

LIST OF RECOMMENDATIONS FOR FEMA

Comment 1. Consistence check of parameters used between neighboring transects is recommended. It is strange that the neighboring transects would have different wave periods and sometimes different SWL for the same storm event at the 40 m depth. For example, during the March 1, 1983 (3/1/1983 23:00) storm, the wave period varies significantly from 11.9 to 19.2 seconds among neighboring transects from 75 through 80, and from 19.2 seconds at Transect 87 to 15.9 seconds at both Transects 86 and 88. Although wave height can vary greatly due to the refraction patterns, the wave period and SWL is typically homogeneous across the region at 40-m depth during any given storm event. (from Section 4.1 of this report)

Comment 2. Please consider wave approach angle which could likely lead to a reduction in BFE. Waves approach the shore at oblique angles in many reaches along the Ventura coastline and should be considered in the runup analysis. (Section 4.1)

Comment 3. The pattern of BFE shall be close to the typical pattern of refracted waves inside the Santa Barbara channel. Please check and explain. (Section 4.1)

Comment 4. Correct AE zone mapping errors for the reach between transects 44 and 45, and between 46 and 47. There are some odd discrepancies around the Rio de Santa Clara Land Grant where no coastal flood mapping has been identified despite the fact this area was flooded during the 1969 riverine flood event and is exposed to both riverine and coastal flood hazards (Section 4.2)

Comment 5. Add transects to support the VE zone designations for coast between transects 88 and 89, and south of transect 90. (Section 4.2)

Comment 6. It is recommended that transects begin at a shallower depth around -15 to -20 m bathymetry contours instead of -40 m. Using wave parameters at the 40-m depth from the nearshore wave model as input parameters for the wave runup analysis is a poor choice for reaches with oblique wave approach angles and wave refraction. As some of the 2-D wave phenomena captured in the 2-D model cannot be captured in 1-D transect based analysis. These may lead to overestimate of the BFE. Please update the analysis. (Section 4.2)

Comment 7. The transect numbering scheme in the IDS shall correspond to the PFIRM transect numbers allowing reviewers to understand the technical approach and results applied at each location. Please renumber transects accordingly. (Section 4.2)

Comment 8. Limit the difference on BFE between neighboring transects. PFIRMs for the Ventura County show that the difference in BFEs between neighboring transects is more than 10 feet around the following transects: 1-2, 4-5, 6-7, 10-11, 11-12, 30-31, 79-80, 87-88, 88-89. If the difference in BFE between neighboring transects exceeds a certain threshold regardless of the shore feature similarities, additional transect(s) should be added between those neighboring transects. If an isolated feature resulted in large BFE variations, a minimum of two transects should be used to bracket the BFE around the feature, and a transitional reach be provided to transit the BFE from one to another. Otherwise, it is very difficult for floodplain managers to interpret and implement the map results. This is particularly true for transacts separating neighboring residential properties. This practice is also not consistent with Pacific Guidelines (Section D.4.9.6) which states: Transition zones may be necessary between areas with high runup elevations to avoid big differences between BFEs and to smooth the changes in flood boundaries. (Section 4.2)

Comment 9. Please identify the Primary Frontal Dunes (PFD) or explain why the preliminary FIRM mapping effort failed to identify any PFD outside of transect 68. (Section 4.4)

Comment 10. Please justify the use of a single topographic data set without performing the Most Likely Winter Profile (MLWP) analysis. The BFE analysis was based on a single 2009 LiDAR dataset with wide beaches and high dunes in many areas. The topographic profiles can vary greatly between seasons and years (such as pre- and post-El Niño winters). In some cases, beach widths can change up to 200 feet over a few years. Therefore, it is important to consider a range of potential morphologies when determining flood elevations and extents. The study contractor should follow the Pacific Guidelines, determine the Most Likely Winter Profile (MLWP) before performing wave runup analysis. Skipping the step of determining the MLWP would lead to underestimates of both flood hazard extent and BFE. (Section 4.5)

Comment 11. Please perform Event-Based Erosion analysis or explain why the preliminary FIRM mapping effort failed to perform Event-Based Erosion analysis outside of transect 68. (Section 4.6)

Comment 12. Treatment of shore protection structures has a significant impact on BFEs. Many rock revetments (at Transects 4, 6, 9, 11, 14, 21, 22 ,25, 56, 59, 60, 67, 71, 72, 73, 76, 82 and 88 along the County coastline) were engineered with multiple layers of rock sized to resist extreme wave forces and survived equivalent to and larger than the 1% annual chance storm event. Per the Pacific Guidelines (Section D4.7.3), these structures may be recognized on flood hazard maps. However, no structures were recognized in the study as they are not certified. For these structures, a more representative failure mode for analysis is partial failure mode. Please apply the partial failure mode and appropriate roughness coefficient in the analyses of these transects. (Section 4.7.1)

Comment 13. Please consider the beach slope effect on the wave breaking criterion (ratio of wave height to water depth) and use an appropriate ratio of wave height to water depth in the analysis. Without considering the slope effect would lead to underestimate of wave height. (Section 4.9)

Comment 14. Please provide methods used to define and identify dtoe and dcrest in the IDS. Please also include a discussion of the dheel and incorporate those into the hazard mapping. (Section 4.9)

Comment 15. Roughness factor due to presence of cobbles, offshore reefs, and rock from failed revetment structures were not considered, which would lead to overestimate of BFE. A composite roughness factor should be used instead of using roughness factor of sandy/earthen materials. Rock revetments were completely removed from the transect geometry and the roughness factor was replaced with that of sand for the analysis of the structure failure scenario. The roughness treatment was not consistent with Section D.4.7.3.2 of the Pacific Guidelines, which states: *the Mapping Partner shall select an appropriate roughness factor when conducting runup and overtopping analyses on the failed structure. Please correct.* (Section 4.9)

Comment 16. Minimum mappable distance criterion: A 35-foot minimum distance criterion was applied in the mapping for transects with overtopping. If the resulting landward runup zone was less than 35 feet, the overtopping runup zones were either integrated into the primary coastal Zone VE or, where the VE and AO overtopping zones together were at least 35 feet, combined to create a secondary zone VE. The resulting mapped BFE in the runup zones is often 5 feet higher than the calculated BFE. This practice is inconsistent with Pacific Guidelines (Section D.4.9.4) as the community officials were not consulted about setting 35-foot as the minimum mappable distance criterion. With today's technology, it is recommended to include the secondary VE zones and the AO zones with calculated width in the digital FIRMs, which can have much higher resolution than the hard copy maps. (Section 6.2.4)

Comment 17. Transects 13, 23, 24, 25 and 33, where Stockdon runup method may have been misapplied to cobble beaches, or revetment backed beaches as opposed to using the more appropriate TAW runup equations, which likely lead to overestimate of runup. Please check that the appropriate equation was used and recalculate the BFE if necessary.

Appendix C listed above comments applicable to each transect.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

LIST of ACRONYMS and ABBREVIATIONS

AM	Annual Maxima
BFE	Base Flood Elevation
CA	California
CCAMP	California Coastal Analysis and Mapping Project
OPC	Open Pacific Coast
CEM	Coastal Engineering Manual
CDIP	Coastal Data Information Program
the Cities	Cities of Ventura, Oxnard, and Port Hueneme
the County	Ventura County
DWL	Dynamic Water Level
DWL2%	2% Dynamic Water Level
DIM	Direct Integration Method
the District	Ventura County Watershed Protection District
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
GIS	Geographic Information Systems
GEV	Generalized Extreme Value
HAT	Highest Astronomical Tide
H_o	Deep Water Significant Wave Height
HOT	Highest Observed Tide
IDS	Intermediate Data Submittal
LiDAR	Light Detection and Ranging
m_f	Beach Slope
MHHW	Mean Higher High Water
MHW	Mean High Water
MLW	Mean Low Water
MLLW	Mean Lower Low Water
MLWP	Most Likely Winter Profile
MSL	Mean Sea Level

MTL	Mean Tide Level
NAVD	North American Vertical Datum of 1988 (NAVD88)
NFIP	National Flood Insurance Program
NOAA	National Oceanographic and Atmospheric Administration
NOS	National Ocean Service
OPC	Open Pacific Coast
OWI	Ocean Weather Inc.
Pacific Guidelines	Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States
PFD	Primary Frontal Dune
PFIRM	Preliminary Flood Insurance Rate Map
PMR	Physical Map Revision
SFHA	Special Flood Hazard Area
SIO	Scripps Institution of Oceanography at University of California San Diego
SOMA	Summary of Map Actions
SPM	Shore Protection Manual
SWEL	Stillwater Elevation (statistical value)
SWL	Stillwater Level (hourly value)
TAW	Technical Advisory Committee for Water Retaining Structures
T_p	Peak Wave Period
TWL	Total Water Level
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
Zone AE	Areas that could be inundated by the 1-percent-annual-chance flood.
Zone AO	Areas of shallow and slow moving floodwaters below the criteria for zone AE.
Zone VE	Coastal Hazard areas where waves and fast moving water can cause damage during the 1-percent-annual-chance flood
Zone X	Flood hazard areas that could be inundated by the 0.2-percent-annual-chance flood or inundated by the 1-percent-annual-chance flood hazard with average depths of 1 foot or less.
ξ	Surf similarity parameter

1 INTRODUCTION

FEMA distributed Preliminary Flood Insurance Rate Maps (PFIRMs), Flood Insurance Study (FIS) reports, Summary of Map Actions (SOMA) and GIS database for Ventura County (the County) and Incorporated Areas on September 30, 2016. This is a part of the Open Pacific Coast Study of California Coastal Analysis and Mapping Project (CCAMP). The PFIRMs are intended to supersede the current effective FIRMs. There are significant changes in Special Flood Hazard Area (SFHA) zone designations within the jurisdiction of the Cities of Ventura, Oxnard and Port Hueneme (the Cities) and the County of Ventura. These coastal communities are working hard to ensure that citizenry and leadership have the tools they need to make informed, pragmatic, and thoughtful decisions for managing the risk to resources in the coastal flood zone.

The Moffatt & Nichol/Revell Coastal team was contracted by the Ventura County Watershed Protection District (the District) to provide technical review of the PFIRMs and FIS documentations for the County. The scope of work for the review includes the following tasks:

1) <u>Project Coordination and Meetings</u>: The project team shall coordinate with the District, the Cities, FEMA Region IX and its contractor (BakerAECOM) throughout the review process. The coordination will consist of emails and phone calls from the team to obtain information and/or share information as the technical review progresses.

2) <u>Data Collection and Review</u>: The project team shall collect data from the District, Cities, FEMA, BakerAECOM and other online sources to verify parameters used in the analyses and mapping effort. The project team shall also provide an inventory (summary) of data collected along with access to the material electronically through an ftp site or other file sharing system.

3) <u>Technical Review</u>: The technical review shall evaluate the information provided by FEMA and BakerAECOM that details the basic parameters, assumptions and methods used to characterize the 100-year coastal storm hazards along Ventura County's coastline.

4) <u>Detailed Review of Flood Hazard Mapping at Areas of Interest</u>: Results from the technical review and feedback from the District and local communities will likely result in several locations of interest that warrant a more detailed analysis of coastal flood hazards. The project team shall review four of the nine locations listed below, based on priority identified by communities:

    - Rincon Parkway (including the small communities around Pitas Point, Hobson Park, etc.)
    - Emma Wood State Beach (deteriorating structure, access road, and railroad)
    - Surfers Point and Ventura Promenade (evaluate model applicability to cobble beaches)
    - Pierpont street ends (Substantial flooding during the Dec. 11, 2015 storm)
    - Mandalay Beach (proposed Puente Site)
    - Oxnard Shores area, City of Oxnard
    - Silver Strand Area, City of Oxnard
    - City of Port Hueneme (erosion hot spot from lack of dredging)
    - South County Highway 1 corridor

5) <u>Interpretation of Modeling and Mapping Results</u>: A chapter of the final report shall be devoted to providing graphics, diagrams and text in plain language to illustrate and explain

the coastal hazards depicted on the PFIRMs. Consultants shall work with the District and local communities to interpret the hazard maps and their implications on local floodplain ordinances and regulations. This chapter shall help local communities and their floodplain administrators understand and explain these hazards to affected property owners and members of the public.

6) Final Report: A report combining results of tasks 2-5 shall be prepared and submitted to the District and local communities.

7) Ventura County Coastal Flood Hazard Mapping and Awareness Workshop: Consultant team shall conduct a 4-hour workshop at the District's office to provide basic training for local officers, engineers, and floodplain managers on the latest coastal flood risk analysis methodology, floodplain mapping approaches and the interpretation and regulatory application of coastal floodplain maps. The workshop will include a presentation of tools and studies available to the public to help improve resilience of the Ventura County coast.

2 DATA COLLECTION

Data used to develop this technical review largely focused on the PFIRMs and Intermediate Data Submittal (IDS) reports and associated appendices. The IDS reports and their accompanying data provide background, guidelines, data, results, and methods used to develop the PFIRMs. These data were compared to data requirements for coastal flood mapping studies described in the Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States (FEMA 2005), which is referred to as Pacific Guidelines in the report. Additional data were also collected to supplement data used by the FEMA contractor. These data include reports, maps, topographic and bathymetric data, photos of flooding and erosion, and beach profiles. A summary of data is provided in Table 2-1. A full data inventory is provided in Appendix A.

Table 2-1: Summary of Data

Type	Dates
Effective Flood Insurance Rate Maps / Studies	2010
Preliminary Flood Insurance Rate Maps / Studies	2016
IDS Reports	2016
FEMA Pacific Guidelines	2005
LiDAR	1997, 1998, 2009, 2014, 2016
Drawings (structures, beach profiles, and shorelines)	1996, 1997, 1998, 2016
Ground Photos	Various
Aerial Imagery	2009, 2014, 2015, 2016, 2017

2.1 Terrain Data Used for Geomorphic Analysis

As listed in Table 2-1, five topographic lidar data sets were acquired: May 2016, September 2014, November 2009 (used by FEMA contractor for the PFIRM analysis and mapping), April 1998, and October 1997. Topographic changes between the data sets were examined to evaluate geomorphic variability. The variability provided information to evaluate the validity of using a single topographic data set (November 2009) for the preliminary flood mapping, and the implications of changed topography on the Total Water Level (TWL) calculations and mapping completed in the PFIRMs.

The following data sets were acquired in a digital elevation format with an accuracy of 1 m, and profiles were extracted at same transect locations used in the PFIRM analysis. The following geomorphic features were analyzed and interpreted for all the sandy beach shoreline sections identified for detailed analysis for Sites 4 and 5 described in Section 5:

- Foreshore slope[1]
- Dune toe elevation
- Dune crest elevation
- Dune heel elevation[2]
- Beach widths
  - MHW[3] to toe
  - MHW to crest
  - Crest to curb wall survey or urbanized line
- Storm Erosion (1997-98 El Niño changes)
  - Beach width changes
  - Dune erosion
- Long term shoreline changes (2016 to 1997)
  - Beach Width
  - MHW Shoreline
  - Dune location and elevation

[1] Defined as slope from Mean Sea Level to the Highest Observed Tide – 2.7 feet NAVD to 7.5 feet NAVD (based on Santa Barbara tide gage ID 9411340)
[2] There is some vagueness in the discussion of the dune crest in FEMA methods as applied to bore propagation in sandy shores. In this study, it was interpreted to be the dune heel used in the bore calculation, not the actual dune crest (Ecrest) as stated in the IDS3 (p. 26)
[3] Mean High Water at Santa Barbara tide station 4.64 feet NAVD

3 DESCRIPTION OF FEMA METHODOLOGY

The Open Pacific Coastal (OPC) Study Contractor performed the FIS and prepared PFIRMs for Ventura County based on FEMA Guidelines along with additional coastal engineering resources and available data for the region. A one-dimensional (1-D), transect-based wave hazard analysis was used for the County. The results define the 1-percent-annual-chance TWL at the shoreline that provide the basis of coastal flood data used in the mapping.

3.1 Overview of Technical Approach

This section presents an overview of the technical approach. A simplified flowchart summarizing the technical approach to the Study was provided in IDS3 (FEMA 2016b) and is reproduced in Figure 3-1.

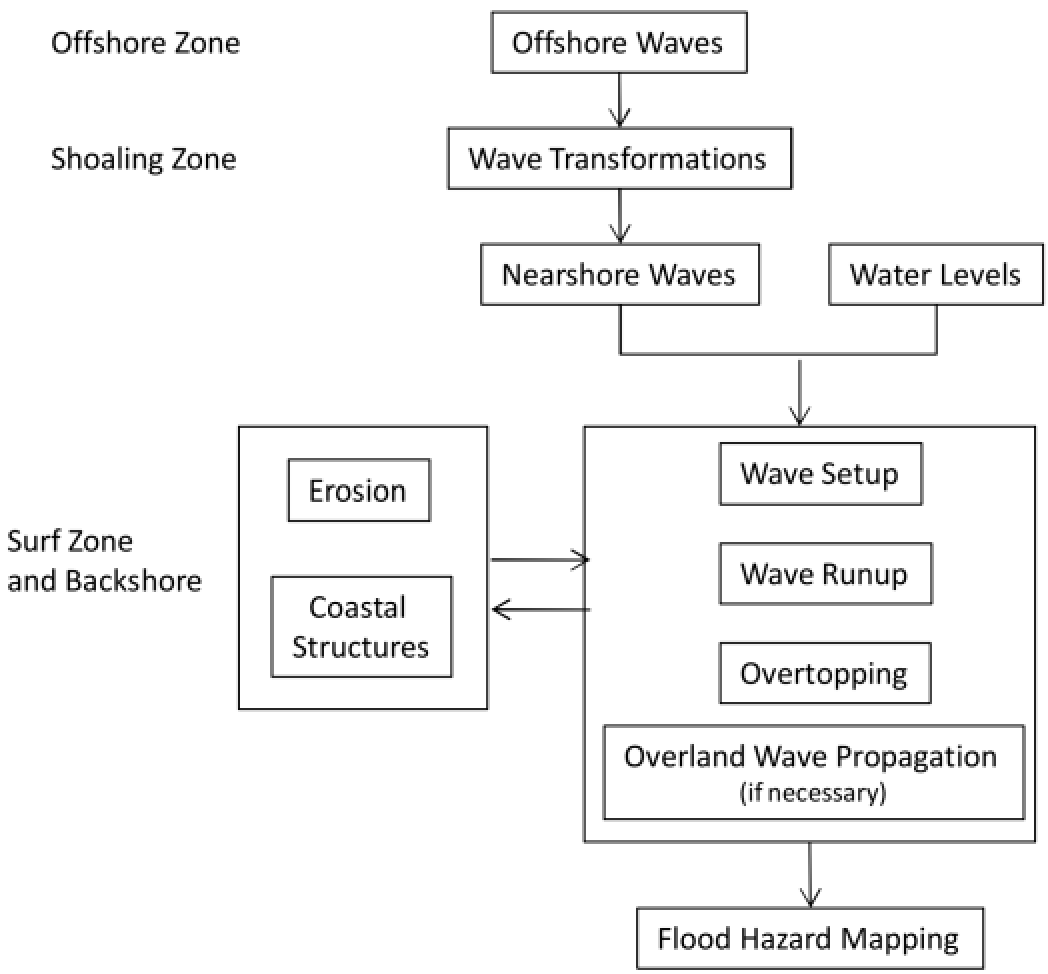

Figure 3-1: Summary of Technical Approach Adapted from *Pacific Guidelines* (FEMA 2016b)

The detailed study methods applied were presented in the IDS3 (FEMA, 2016b) and are briefly summarized in the following sections.

1) Analyze ocean wave, wind, and water level data: To provide wave input data for the 1-D transect-based wave hazard analysis, the BakerAECOM team developed a continuous 50-year hourly deepwater and nearshore wave hindcast for the period of January 1, 1960 to December 31, 2009 at various points along the CA coastline:

- Stillwater Levels (SWLs): a continuous hourly time series of SWLs was reconstructed for the 1960-2009 hindcast period based on water level data recorded at NOAA National Ocean Service (NOS) tide stations. In Ventura County, the open coast reach from Rincon Point to Port Hueneme used the reconstructed tide time series from Santa Barbara Station; and the coastline from Port Hueneme to the southern Ventura border used the reconstructed tide time series from Santa Monica Station.

- Deepwater Wave Parameters: The offshore wave modeling of the study was performed by Ocean Weather Inc. (OWI). The deepwater wave modeling provided boundary wave spectra conditions to drive the shelf-scale (nearshore) wave transformation modeling.

- Nearshore Wave Parameters: The nearshore wave transformation of the CCAMP OPC Study was performed by Coastal Data Information Program (CDIP) research group of the Scripps Institute of Oceanography (SIO). The purpose of the nearshore wave modeling was to transform the deepwater wave conditions to the edge of the surf zone, at the 15-m water depth. The output from the nearshore wave transformation model provided the input wave parameters for the 1-D transect-based wave hazard analysis.

2) Characterize nearshore region using topographic data and other sources.

- Coastal Analysis Transects: The detailed coastal analysis is based on a 1-D transect approach that extends approximately from the edge of the surf zone to the limit of wave runup and overtopping. Wave transects were laid out to generally orient perpendicular to the shoreline and nearshore bathymetry and were placed at a spacing appropriate to capture changes in wave climate, profile morphology, and backshore characteristics. Once transects were defined, station and elevation points were extracted from the terrain surface along each transect to create an elevation profile. Data points were extracted at a point spacing necessary to capture significant slope changes along the profile.

3) Calculate TWLs in the nearshore region:

- Wave runup and wave setup (open coast): Nearshore wave parameters (50-year nearshore hindcast) and transect parameters were used to calculate the dynamic wave setup from breaking waves and runup elevations that wave splash would reach on the various shoreline slopes. Wave runup and wave setup calculations followed the FEMA Pacific Guidelines except that waves were not de-shoaled to deep water equivalents, instead wave parameters extracted at the 40-m water depth were used. The following three different runup calculation methods were used:
    - Stockdon Method: Sandy beaches
    - Direct Integration Method (DIM): Sandy beaches or armored beaches
    - Technical Advisory Committee for Water Retaining Structures (TAW) (2002) Method: Armored beaches and bluff backed beaches

The Stockdon method is based on data collected during ten dynamically diverse field experiments and is newer than methods included in the 1984 Shore Protection Manual (SPM) and the 2002 Coastal Engineering Manual (CEM) published by the U.S. Army Corps of Engineers (USACE).

The DIM method was developed for calculating static and dynamic (infragravity) components of wave setup accounting for as much of the relevant physics as possible. This 1-D method accounts for spectral shape and detailed bathymetry, and is based on integration of the governing equations from deep to shallow water. DIM can be applied by a simple set of empirical equations and by full implementation of the numerical model. In this Study, the DIM method was used for: (1) sandy beaches when the slope and wave conditions are outside of application ranges of the Stockdon method; and (2) armored beaches and bluff backed beaches when the DWL 2% is lower than the toe and the TAW method is not applicable.

The TAW method is commonly used for wave runup analyses for beaches backed by structures/ bluffs and is included in the CEM (2002). The TAW method is useful as it covers a wide range of wave conditions for calculating wave runup on both smooth and rough slopes.

4) Backshore Analysis - Profile adjustments

- Consider Primary Frontal Dune (PFD) locations
- Calculate Most Likely Winter Profile (MLWP) based on an average annual storm event. No MLWP was calculated in this study. The profiles were based on single LiDAR data set collected at the end of summer.
- Transects were adjusted for event-based erosion at natural shorelines where appropriate (limited application to one dune, Transect #68).

5) Coastal Armoring Structures: Assess shoreline for presence of coastal structures and consider performance in a wave event.

- Calculate TWL with coastal erosion or failure of coastal structure. No coastal erosion was considered for profiles backed with coastal structures. In other words, no MLWP was calculated for transects backed by coastal armoring structures as required by the Pacific Guidelines.
- Transects with coastal structures were adjusted for a failed condition. The higher TWL was mapped.

6) Calculate Base Flood Elevation (BFE): 1% BFE was calculated based on a statistical extreme value analysis of TWLs calculated at each transect for the highest 100+ selected storm events over the 50-year study period.
7) Select most probable TWL shoreline scenario: In this study the more conservative scenario (higher TWL) was chosen (failed revetments, intact seawalls, or eroded dunes – limited application).
8) Calculate Overtopping: TWLs are compared to the shoreline crest elevation, coastal structure, or other controlling topographic feature to determine if ocean water from waves will wash over the beach and propagate inland. The extent and depth of this flooding was calculated using wave runup and wave setup parameters and topographic features.
9) Map the results on PFIRM and document methods and data in FIS.

3.2 Datums

All elevations presented in the Study documents, maps, and other media are relative to the North American Vertical Datum of 1988 (NAVD88), this datum references a single origin (zero) point for the entire continent. This differs from tidal datums, which are determined by averaging water levels at a tide gage over a tidal epoch. Tidal datums at two tidal gages were used in the study for determining various calculation parameters and were reported relative to NAVD88 in Table 3-1, which was cited from IDS3 (FEMA 2016b). However, this review indicated that there are some discrepancies in tidal datums between those used for the study and those published by NOAA (2017a) for Santa Barbara Station. The differences are generally less than 0.04 ft, except those for highest astronomical tide and highest observed tide. The NOAA published datums based on the most recent tidal epoch (1983-2001) are provided in Table 3-1 for references.

1) The Santa Barbara station (NOAA station ID 9411340) was used on mapping Transects 1-56, northern Ventura County from Rincon Point to Port Hueneme.

2) The Santa Monica station (NOAA station ID 9410840) was used on mapping Transects 57-90, southern Ventura County from Port Hueneme to southern Ventura County border (Sequit Point).

Table 3-1: Datums for the Ventura County Study Area

Datum, feet	Santa Barbara		Santa Monica	
	IDS3	NOAA 2017a	IDS3	NOAA 2017b
HAT (highest astronomical tide)	7.02	7.14	7.06	7.08
HOT (highest observed tide)	7.26	7.54	8.31	8.31
MHHW (mean higher high water)	5.27	5.31	5.24	5.24
MHW (mean high water)	4.51	4.55	4.50	4.50
MTL (mean tide level)	2.68	2.72	2.62	2.62
MSL (mean sea level)	2.66	2.70	2.60	2.60
MLW (mean low water)	0.85	0.89	0.74	0.74
NAVD88	0	0	0	-2.63
MLLW (mean lower low water)	-0.13	-0.09	-0.19	-0.19

3.3 Profile Features

The Study and this report refer to various identifications in the shoreline profiles that were used in calculations and analyses. These profiles were cited from IDS3 (FEMA 2016b) and shown in Figure 3-2 with variables defined in Table 3-2 for convenience.

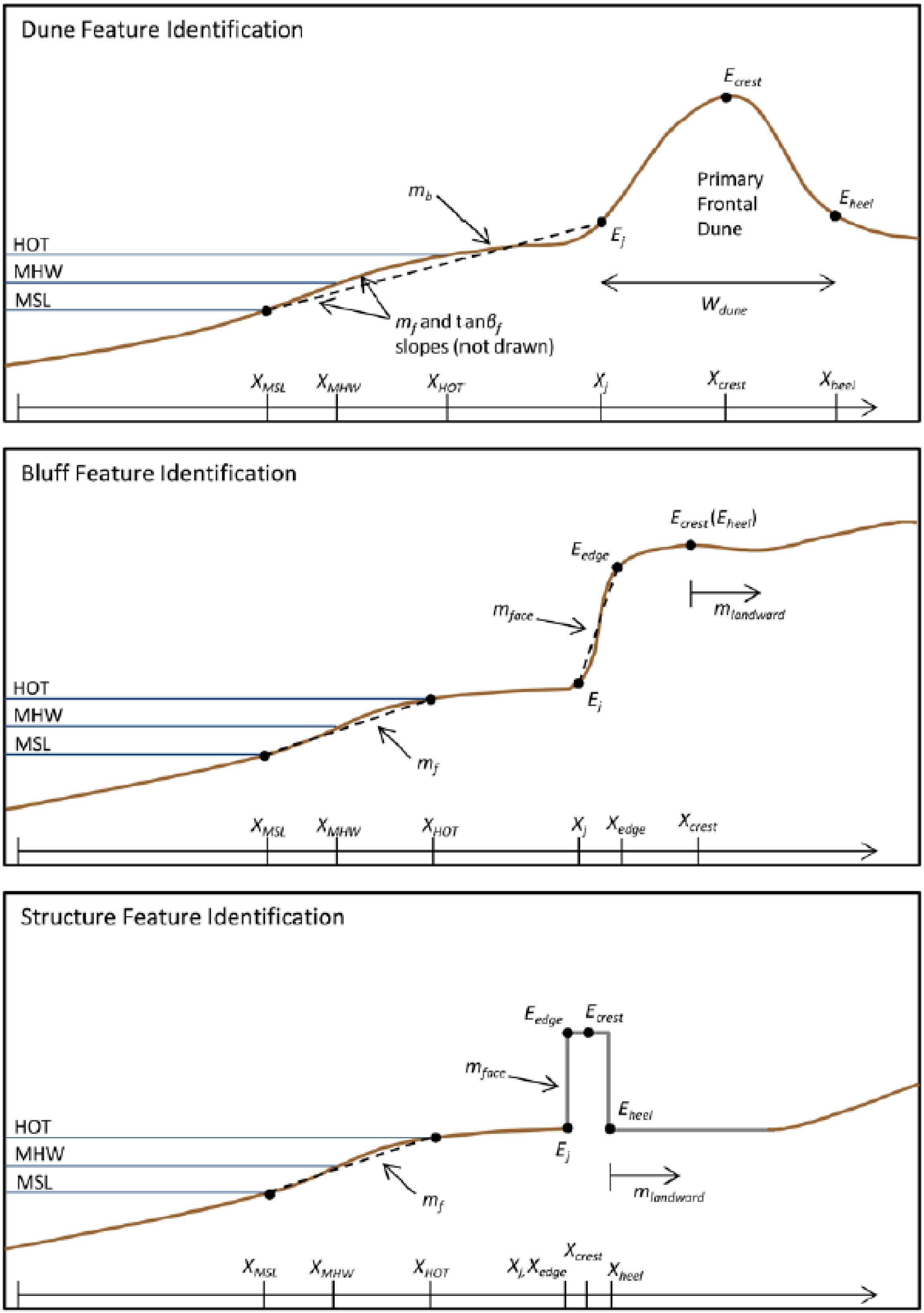

Figure 3-2: Profile Feature Identification Definition Sketch (FEMA 2016b)

Table 3-2: Profile Feature Definitions (FEMA 2016b)

Variable	Description
All Profiles	
X_{MSL}	Cross-shore position of MSL
X_{HOT}	Cross-shore position of HOT
m_f	Average wave runup slope from MSL to HOT If HOT > E_j, then runup slope taken from MSL to E_j
Dune Profiles	
X_{MHW}	Cross-shore position of MHW
X_j, E_j	Dune (or berm) toe (beach/dune junction)
X_{crest}, E_{crest}	Dune (or berm) crest
B	Dune (or berm) height ($B = E_{crest}$ - MHW)
X_{heel}, E_{heel}	Dune (or berm) heel
W_{dune}	Dune width from toe to heel (X_j to X_{heel})
$\tan \beta_f$	Average foreshore beach slope from MSL to MHW
m_b	Average backshore beach slope from MSL to E_j
Bluff Profiles	
X_j, E_j	Bluff toe (beach/bluff junction)
X_{edge}, E_{edge}	Bluff edge
X_{crest}, E_{crest}	Bluff crest
X_{heel}, E_{heel}	Bluff heel (for overtopping calculations; if there is no well-defined heel, the heel is assumed to be the same elevation as the crest)
m_{face}	Bluff face slope (toe to edge)
$m_{landward}$	Landward slope (landward of heel; for overtopping calculations)
Structure Profiles	
E_j	Seawall toe (beach/seawall junction)
X_{edge}, E_{edge}	Seawall edge
X_{crest}, E_{crest}	Seawall crest
X_{heel}, E_{heel}	Seawall heel
m_{face}	Structure face slope (toe to edge)
$m_{landward}$	Landward slope (landward of heel; for overtopping calculations)

Note: In the notation shown above, X indicates stationing along the profile and E indicate

4 TECHNICAL REVIEW

This section summarizes review findings of methods, assumptions and calculations applied in CCAMP analysis and mapped on the preliminary FIRM panels. The following sections describe our major comments, which apply to either the entire analysis or a significant number of transects. Detailed comments at each transect are provided in the spreadsheet in Appendix B.

4.1 Wave Hindcast Data

The patterns of TWL do not match the typical pattern of refracted waves inside the Santa Barbara channel. Looking at the BFEs across the County, reported values are higher along Rincon Parkway, smallest near Ventura Pier and small through the Oxnard plain. Figure 4-1 shows a large wave event (estimated as a 10-year event). The pattern of BFE should be close to this with the highest wave heights along the Santa Clara delta and sheltering along the Rincon Parkway. This pattern is not what the BFE elevations represent despite the use of the same CDIP Model Output Points.

Presently observed refraction patterns from example Figure 4-1 are not consistent with peak event wave characteristics from individual transects. This could result in both overestimates and underestimates of the BFE, depending on how the extreme events are characterized at each transect. The nearshore wave input and geomorphic slope parameters are key elements of the TWL calculations and vary widely between adjacent transects.

The wave period for the same storm event varies significantly between neighboring transects. For example, during the March 1, 1983 (3/1/1983 23:00) storm, the wave period varies significantly from 11.9 to 19.2 seconds among neighboring transects from 75 through 80, and from 19.2 seconds at transect 87 to 15.9 seconds at both transects 86 and 88. Although wave height can vary greatly due to the refraction patterns, the wave period and SWL is typically homogeneous across the region at 40-m depth during any given storm event.

General Review Comments:

1. *Consistence check of parameters used between neighboring transects is recommended. It is strange that the neighboring transects would have different wave periods and sometimes different SWL for the same storm event at the 40 m depth. For example, during the March 1, 1983 (3/1/1983 23:00) storm, the wave period varies significantly from 11.9 to 19.2 seconds among neighboring transects from 75 through 80, and from 19.2 seconds at Transect 87 to 15.9 seconds at both Transects 86 and 88. Although wave height can vary greatly due to the refraction patterns, the wave period and SWL is typically homogeneous across the region at 40-m depth during any given storm event.*

2. *Wave approach angle is not considered, which could lead to up to a 10% overestimate in BFE. Waves approach the shore in an oblique angle in many reaches along the Ventura coastline as a result of wave refraction around headlands. It should be considered in the runup analysis.*

3. *The pattern of BFE shall be close to the typical pattern of refracted waves inside the Santa Barbara channel.*

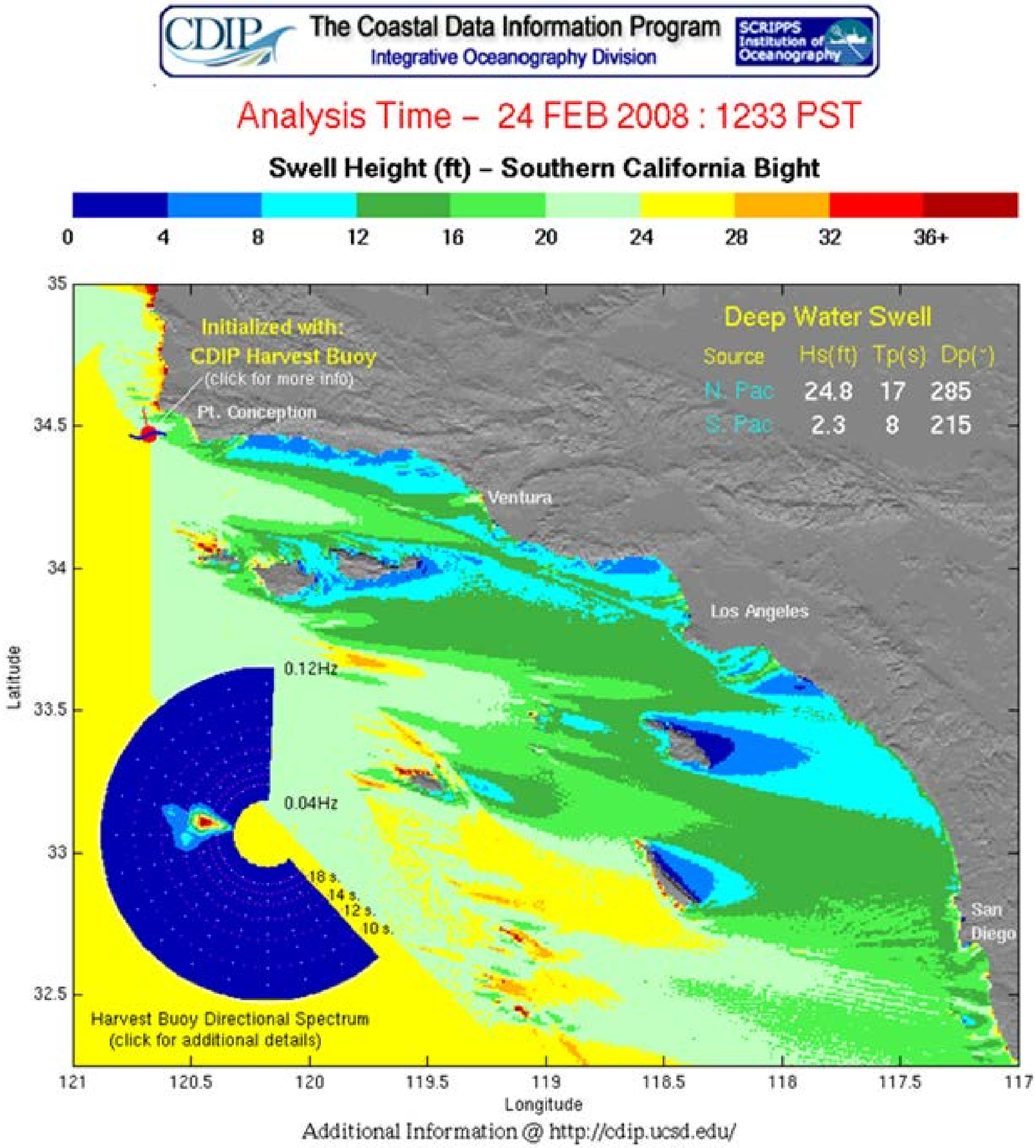

Figure 4-1: Wave Event from 2/24/08 Illustrating a Typical Wave Refraction Pattern (CDIP 2008)

4.2 Transect Layout and Spacing

Coastal transect lines indicate the location that was used to provide the representative topographic information for the coastal flood models. Ninety (90) coastal transects were used to evaluate flood zones and BFEs and were mapped on the PFIRMs for Ventura County. The PFIRM mapping transects were labeled from 1 through 90 from north to south. The PFIRM transects were refined from 678 analysis transects from the SIO SHELF wave transformation model. The analysis transects were labeled in opposite order from the mapping transects, counting down from north to south. Table 1 in IDS4 (FEMA 2016c) provides the mapping transect number and corresponding analysis transect number. The analysis transects were refined by selecting those that captured unique shore type changes and eliminating transects with similar shoreline characteristics and alongshore homogeneity of wave parameters. However, the alongshore homogeneity of wave climate was based on the deepwater wave conditions. The nearshore wave conditions may be different due to nearshore bathymetry conditions, even though the deepwater wave conditions are similar.

Overall, transects spacing and locations seem reasonable and follow the Pacific guidelines, with one notable following exceptions:

a. At Santa Clara River mouth between Transects 44 and 45, and along the sandy beach south of the Santa Clara River between Transects 46 and 47, a strip of AE zone is shown without any technical support, interrupting the continuity of coastal flood hazard zones.

b. Between transects 88 and 89, a new VE was shown without any supporting transect analysis.

c. A VE zone south of transect 90 without supporting transect.

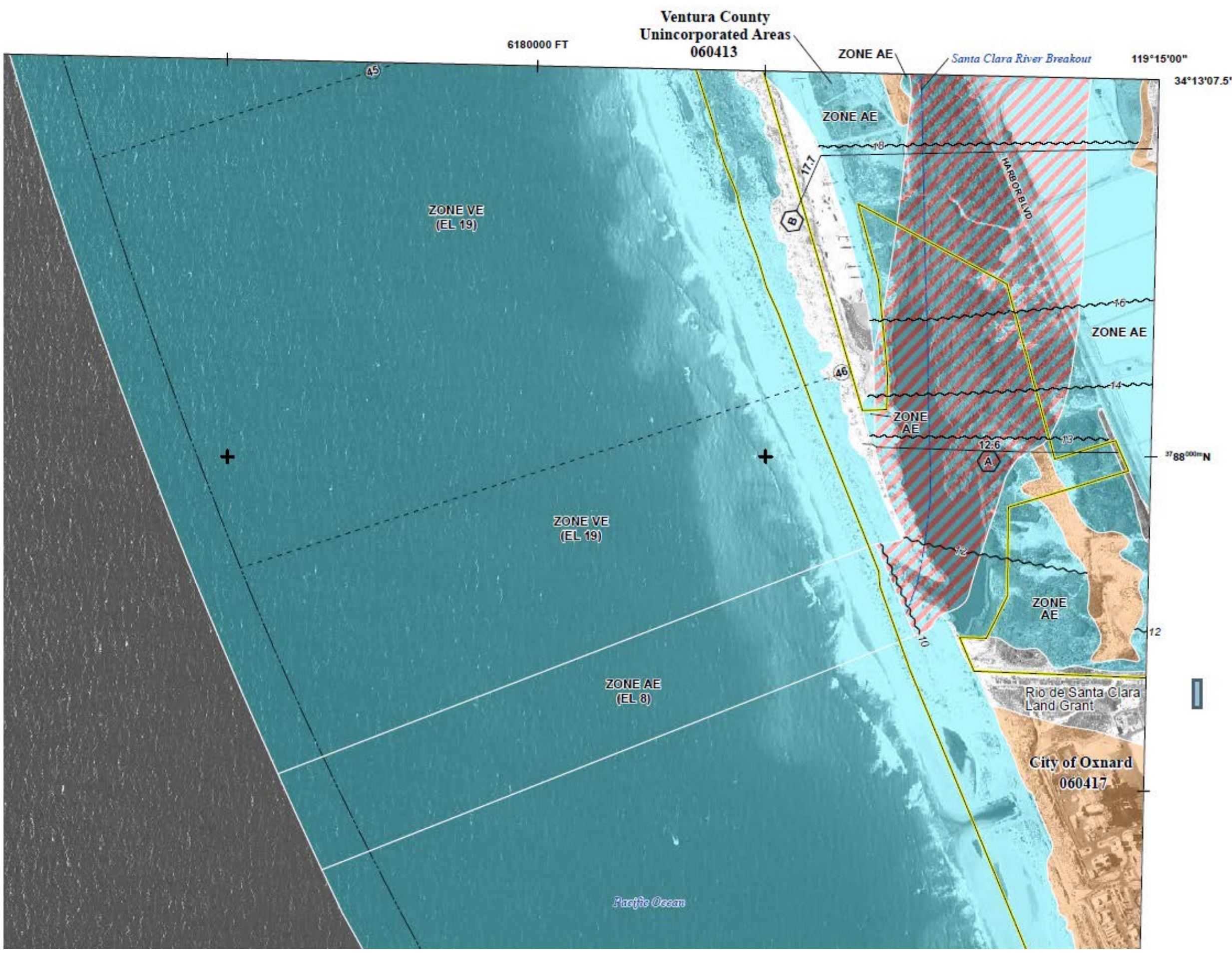

Figure 4-2: Excerpt of FEMA PFIRM Panel 06111C0884F

Transects begin at the -40 m NAVD bathymetry contour offshore, which is too deep as some two-dimensional (2-D) wave phenomena, such as refraction, captured in the 2-D modeling is lost in

1-D transect analysis. It is recommended to begin at a shallower depth around the -15 to -20 m contours.

The transect numbering provided in the IDS reflects the analysis number, not the mapping number shown in the PFIRM. The numbering scheme in the IDS should correspond to the PFIRM transect number, allowing reviewers to understand the technical approach and results applied at each location. The current numbering scheme in the IDS report presents a major barrier to review of technical methods, assumptions, and results by independent parties. This will result in major confusion when trying to explain results of the study to local floodplain managers and members of the public.

General Review Comments:

4. *Correct the AE zone mapping errors for coast between transects 44 and 45, and between 46 and 47. There are some odd discrepancies around the Rio de Santa Clara Land Grant where no coastal flood mapping has been identified despite the fact this area was flooded during the 1969 riverine flood event and is exposed to both riverine and coastal flood hazards (VE and AE zones shown in Figure 4-2).*
5. *Add transects to support the VE zone designations for coast between transects 88 and 89, and south of transect 90.*
6. *It is recommended that transects begin at a shallower depth around -15 to -20 m bathymetry contours instead of -40 m. Using wave parameters at the 40-m depth from the nearshore wave model as input parameters for the wave runup analysis is a poor choice for reaches with oblique wave approach angles and wave refraction. As some of the 2-D wave phenomena captured in the 2-D model cannot be captured in 1-D transect based analysis. These may lead to overestimate of the BFE. Please update the analysis.*
7. *The transect numbering scheme in the IDS shall correspond to the PFIRM transect numbers, allowing reviewers to understand the technical approach and results applied at each location.*
8. *Limit the difference in BFE between neighboring transects. PFIRMs for the Ventura County show that the difference in BFEs between neighboring transects is more than 10 feet around the following transects: 1-2, 4-5, 6-7, 10-11, 11-12, 30-31, 79-80, 87-88, 88-89. If the difference in BFE between neighboring transects exceeds a certain threshold regardless of the shore feature similarities, additional transect(s) should be added between those neighboring transects. If an isolated feature resulted in large BFE variations, a minimum of two transects should be used to bracket the BFE around the feature, and a transitional reach be provided to transit the BFE from one to another. Otherwise, it is very difficult for floodplain managers to interpret and implement the map results. This is particularly true for transacts separating neighboring residential properties. This practice is also not consistent with Pacific Guidelines (Section D.4.9.6) which states: Transition zones may be necessary between areas with high runup elevations to avoid big differences between BFEs and to smooth the changes in flood boundaries.*

4.3 Backshore Analysis

Transects 1 through 28 are predominantly steep bluff backed shorelines with small ephemeral beaches that vary in width and location seasonally and annually. Most of these beaches comprise of a mixture of sand and cobble. The backshore along this stretch is largely armored.

Transects 29 to 33 are cobble beaches with seasonal veneers of sand. This is largely a result of the cobble delta deposited from the Ventura River and being carried alongshore through Surfers Point and the Ventura Promenade.

Transects 34 to 42 are predominantly sandy beaches with seasonal cobble exposure during the winter. These transects east of the Ventura pier have a semi-natural section, which is managed by California State Parks and the residential neighborhood of Pierpont Bay. There are a series of 7 cross shore groins that serve as sand retention structures and have retained a wide sandy beach since they were constructed in the late 1940s.

Transects 43 to 68 are predominantly sandy shorelines with some armoring around the harbors (transects 43, 58, 59, and 60). The backshore here is a combination of relatively natural dunes managed as open space, industrial energy development, and residential development.

General Review Comments: *None*

4.4 Primary Frontal Dune (PFD)

The PFD is a FEMA designation that is one of the five qualifying definitions for a high velocity VE zone in the Pacific Guidelines. According to the guidelines, the PFD designation results in the BFE being mapped to the inland extent of the dunes (dune heel) regardless of the calculated erosion and flood extents.

As defined in 44 CFR Section 59.1 of the National Flood Insurance Program (NFIP) regulations, PFD means a continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms. The inland limit of the PFD occurs at the point where there is a distinct change from a relatively steep slope to a relatively mild slope.

While the definition is rather broad, the dunes along Pierpont Bay and Oxnard Shores fall within this broad definition. The preliminary FIRM mapping effort failed to identify any PFD outside of Transect 68, nor does the documentation provided clarify why Transect 68 was the only sandy beach and dune transect that received this level of mapping detail. This shortcoming has reduced the areas mapped as VE hazard zones.

General Review Comments:

9. *Please identify the Primary Frontal Dunes (PFD) or explain why the preliminary FIRM mapping effort failed to identify any PFD outside of transect 68.*

4.5 Most Likely Winter Profile (MLWP)

To account for seasonal changes in beaches, the FEMA guidelines require to estimate the MLWP as the initial beach profile before determining beach profile changes for a particular storm event. This method applies an annual storm recurrence event with the modified Komar et al. (2002) geometric model of dune erosion. Based on the average storm duration of the 50 maximum TWL events, the model was applied using this time duration to limit the annual profile erosion. This step adjusts the existing topography to an estimate of the MLWP. Section 4.5.1 of IDS3 (FEMA 2016b) has a good methodological write up on the MLWP approach. However, it was only considered on a single transect (Transect 68) in the dune backed areas, and none of the bluff backed, armoring backed or cobble beaches. This is a rather major shortcoming in applying FEMA methodology. The impact of this is likely an underestimation of the mapped flood extents.

Mapping and geomorphic data used in the PFIRM analysis to identify slope and other geomorphic input parameters is based on Fall 2009 LIDAR data. This data shows the beaches of Ventura in a relatively wide condition that may not be representative of conditions that occur during winter and spring seasons when beaches reach a minimum in response to seasonally elevated wave energy.

In addition to the seasonal changes to the shape of the beaches in Ventura, the changes in sediment composition have not been included in the mapping, as shown in Figure 4-3. The beaches in Ventura, particularly north of the Ventura Harbor, are composed of mixed sand and cobble grain sizes. As part of the seasonal cycle shifting into winter, much of the sand is moved offshore, leaving the cobbles exposed. The exposed cobbles form berms that reduce wave runup elevations due to the increased friction of coarser cobbles.

Figure 4-3: Seasonal Changes in Beach Composition along the Ventura Promenade: Sandy (left) and Cobble (right). Photos: Courtesy of BEACON.

General Review Comments:

10. *Please justify the use of a single topographic data set without performing the Most Likely Winter Profile (MLWP) analysis. The BFE analysis was based on a single 2009 LiDAR dataset with wide beaches and high dunes in many areas. The topographic profiles can vary greatly between seasons and years (such as pre- and post-El Niño winters). In some cases, beach widths can change up to 200 feet over a few years. Therefore, it is important to consider a range of potential morphologies when determining flood elevations and extents. The study contractor should follow the Pacific Guidelines, determine the Most Likely Winter Profile (MLWP) before performing wave runup analysis. Skipping the step of determining the MLWP would lead to underestimates of both flood hazard extent and BFE.*

4.6 Event-Based Erosion

Event-based erosion is an important process to consider in the mapping of coastal flood hazards, particularly in unarmored dune backed shoreline segments. Event-based erosion considers the effects a storm could have on a natural shoreline. Storms can erode away beaches and dunes, diminishing their ability to provide a protective buffer. Applying an event-based erosion analysis adjusts transects with beaches and dunes to reflect eroded conditions. The MLWP is the eroded beach profile that could be expected after winter storms. There was limited application of event-based erosion in the Study to a single transect (Transect 68). Figure 4-4 was reproduced from IDS3 (FEMA 2016b) and depicts the determination of the MLWP and final eroded profile. The dune erosion parameters are shown in Table 4-1.

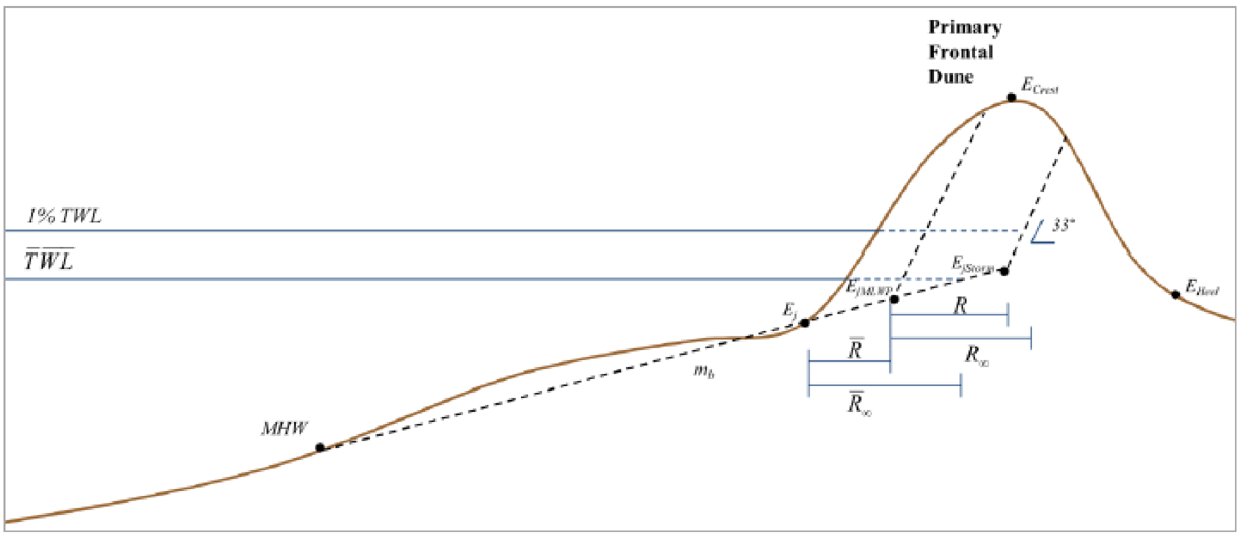

Figure 4-4: Determination of the MLWP and Final Eroded Profile (FEMA 2016b)

While the preliminary FIRM methodology states that unarmored dune backed shores are anticipated to retreat in response to extreme storm conditions, such as the 1% annual chance flood event, event-based erosion has only been applied to one of the 90 analysis transects (Transect 68). This is also the one site in Ventura County classified in the backshore analysis as a PFD. The location of this is on Naval Base Ventura County and outside any of the priority areas for the Ventura County jurisdictions. The dune event based erosion methodology applied to Transect 68 included adjustments for the MLWP, then applied the specific 1% annual chance storm parameters and TWLs to the MLWP to calculate the final eroded profile. This eroded profile section was then used to map the 1% coastal flood extents, the entire methodology is consistent with the FEMA guidelines for Transect 68.

All the sandy beach areas, particularly on the Oxnard plain (Transects 35 to 64), should include this event-based erosion analysis as well as further examination of the qualifying characteristics of a PFD (see Section 1.1). Storm wave conditions that cause erosion should be considered to best evaluate the potential magnitude of the erosion, the hydraulic connections across the landscape, as well as the context of the MLWP (see Section 4.4)

Geomorphic analysis of event-based erosion completed for detailed technical review sites are included in Section 5. This section focused on erosion observations and beach profile changes bracketing the large historic storm season during the 1997-98 El Niño, providing a general sense of the potential range of dune erosion. However, dune erosion calculations consistent with the FEMA guidelines, as outlined in the IDS3 (2016b) were not part of this scope and have not been completed.

Table 4-1: Summary of Dune Erosion Calculation Parameters (FEMA 2016b)

Variable	Description
A	Profile shape parameter
E_j	Initial dune toe elevation
MLWP (average annual storm)	
$\overline{TWL}$	Average annual maximum TWL
$\overline{R_\infty}$	Potential equilibrium dune retreat due to average annual storm
$\overline{T_S}$	Erosion response time scale for profile
$\overline{T_D}$	Average annual storm duration
$\bar{\alpha}$	Scaling parameter for MLWP
$\bar{R}$	Scaled retreat distance for MLWP
E_{jMLWP}	Dune toe elevation for MLWP
Final Eroded Profile (base flood event)	
TWL	1-percent-annual-chance (i.e., base flood) TWL
R_∞	Potential equilibrium dune retreat due to base flood event
$\overline{T_S}$	Erosion response time scale for profile
T_D	Base flood storm duration
α	Scaling parameter for base flood event
R	Scaled retreat distance for base flood event
E_{jStorm}	Final eroded dune toe for base flood event

General Review Comments:

11. *Please perform Event-Based Erosion analysis or explain why the preliminary FIRM mapping effort failed to perform Event-Based Erosion analysis outside of transect 68.*

4.7 Coastal structures

As stated in IDS3 (FEMA 2016b), the Pacific Guidelines direct the study contractor to model coastal structures for a range of performance scenarios (intact, failed, and partially failed) in an effort to bracket the worst-case flood scenario. In the study for the Ventura County, transects with coastal structures were modeled twice: once assuming that the structure will remain intact and again assuming that the structure will fail, and the results with a higher TWL are mapped.

The coast in Ventura County is characterized by an assortment of coastal structures including rock revetments, seawalls, groins, jetties, and breakwaters. The way that coastal structures were modeled at the analysis transects had profound impacts on determining the BFE. Not surprisingly, the assumptions for a failed structure resulted in significantly higher BFEs. The assumptions for "failed" geometry were to assume the rock structure or seawall is removed entirely without any roughness of rocks and the slope becomes very steep (between 1H:1V to 1.5H:1V), which increased the BFE by over 10 feet in some locations such as Transect 11. Nearly all transects with shoreline protection except seawalls were assumed to be "failed" structures in the PFIRM BFE determination. Groins, breakwaters, jetties near the harbors and a few seawalls were assumed to remain intact and did not factor into the 1-D transect based analyses.

Rock revetments for the failed scenario were removed from the transect geometry and replaced with a steep slope (1.5H:1V) with a roughness coefficient of sand. The roughness treatment was not consistent with Section D.4.7.3.2 of the Pacific Guidelines, which states: *the Mapping Partner shall select an appropriate roughness factor when conducting runup and overtopping analyses on the failed structure*. Many of the rock revetments in Ventura County are engineered, continuous revetments, meaning they have been designed to withstand storm waves with multiple layers of rock sized to resist wave forces, crest height and toe depth to provide adequate protection, and stable slopes. However, these structures have to be either certified by FEMA or able to survive the 1% annual chance flood to be credited in the FIS study.

These rock revetments are actively maintained and protect private homes, infrastructure, and government assets. If the revetment is left intact, BFE values are less and would reduce bore overtopping scenarios. Engineered revetments in good condition are unlikely to fail catastrophically and would continue to provide protection even in a degraded state. A more representative scenario might model an engineered revetment as partially failed and assume an appropriate roughness. Although they may be permeated, shifted, and overtopped during a storm event, the rocks will generally remain along the shoreline; therefore, some roughness of a runup slope with partial rocks in place should be assumed.

Seawalls were largely modeled as intact, which may be a poor assumption due to the uncertainty in design, condition, and maintenance practices of these structures. Some of these seawalls are privately owned and non-continuous, leaving them vulnerable to failure from design flaws and deferred maintenance. However, compared to the failure condition, leaving them intact likely results in a higher BFE, which is consistent with the Pacific Guidelines.

4.7.1 Coastal Structure Failed Condition

During a storm event, coastal structures like rock revetments and seawalls may be damaged and ultimately fail. When failure occurs, these structures no longer provide the same level of protection and considerations must be made for these conditions. In the Study, failed revetments were removed from transect geometry and seawalls were left intact. Figure 4-5 and Figure 4-6 were reproduced from IDS3 (FEMA 2016b), and illustrate how failed revetments were modeled. Figure 4-7 and Figure 4-8 illustrate the partial failure case that may be warranted for consideration at some transects. A partial failure analysis may be warranted for Transects (4, 6, 9, 11, 14, 21, 22, 25, 56, 59, 60, 67, 71, 72, 73, 76, 82 and 88) protected with revetment that survived 1% annual chance flood. The seawall failure method is shown in Figure 4-9.

General Review Comments:

12. *Treatment of shore protection structures has a significant impact on BFEs. Many rock revetments (at Transects 4, 6, 9, 11, 14, 21, 22 ,25, 56, 59, 60, 67, 71, 72, 73, 76, 82 and 88 along the County coastline) were engineered with multiple layers of rock sized to resist extreme wave forces and survived equivalent to and larger than the 1% annual chance storm event. Per the Pacific Guidelines (Section D4.7.3), these structures may be recognized on flood hazard maps.*

However, no structures were recognized in the study as they are not certified. For these structures, a more representative failure mode for analysis is partial failure mode. Please apply the partial failure mode and appropriate roughness coefficient in the analyses of these transects.

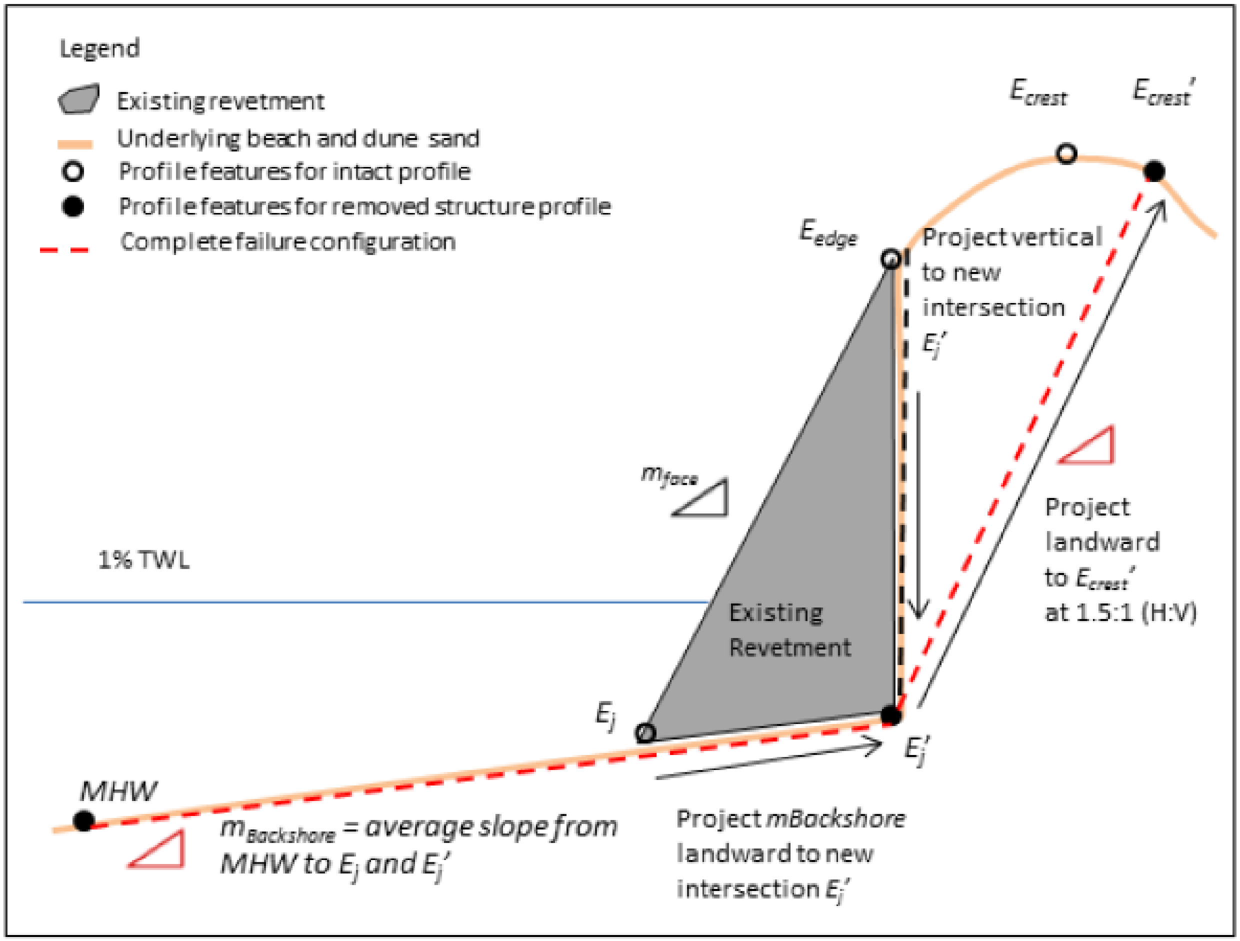

Figure 4-5: Revetment Removal Method for Dune-Backed Profiles (FEMA 2016b)

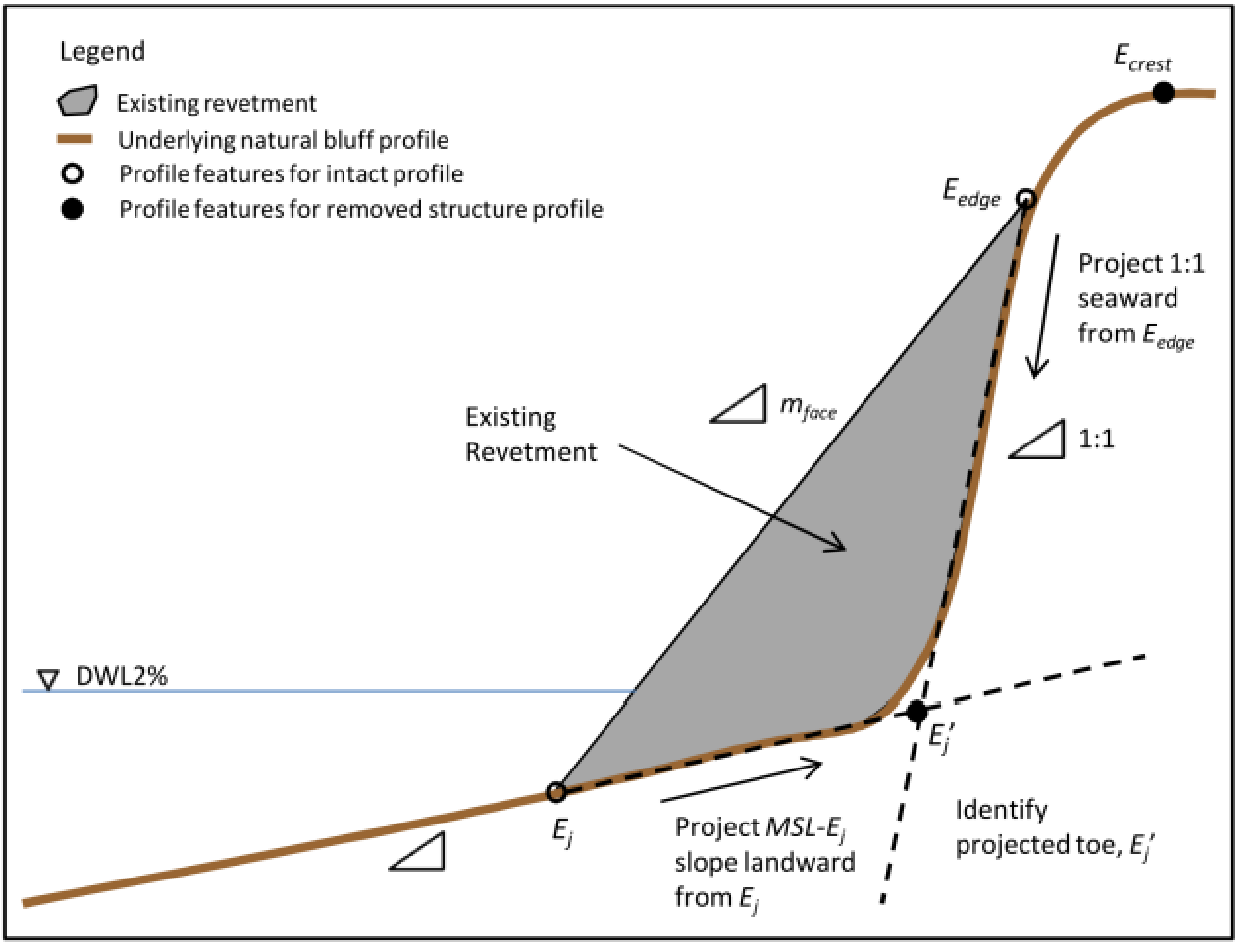

Figure 4-6: Revetment Removal Method for Bluff-Backed Profiles (FEMA 2016b)

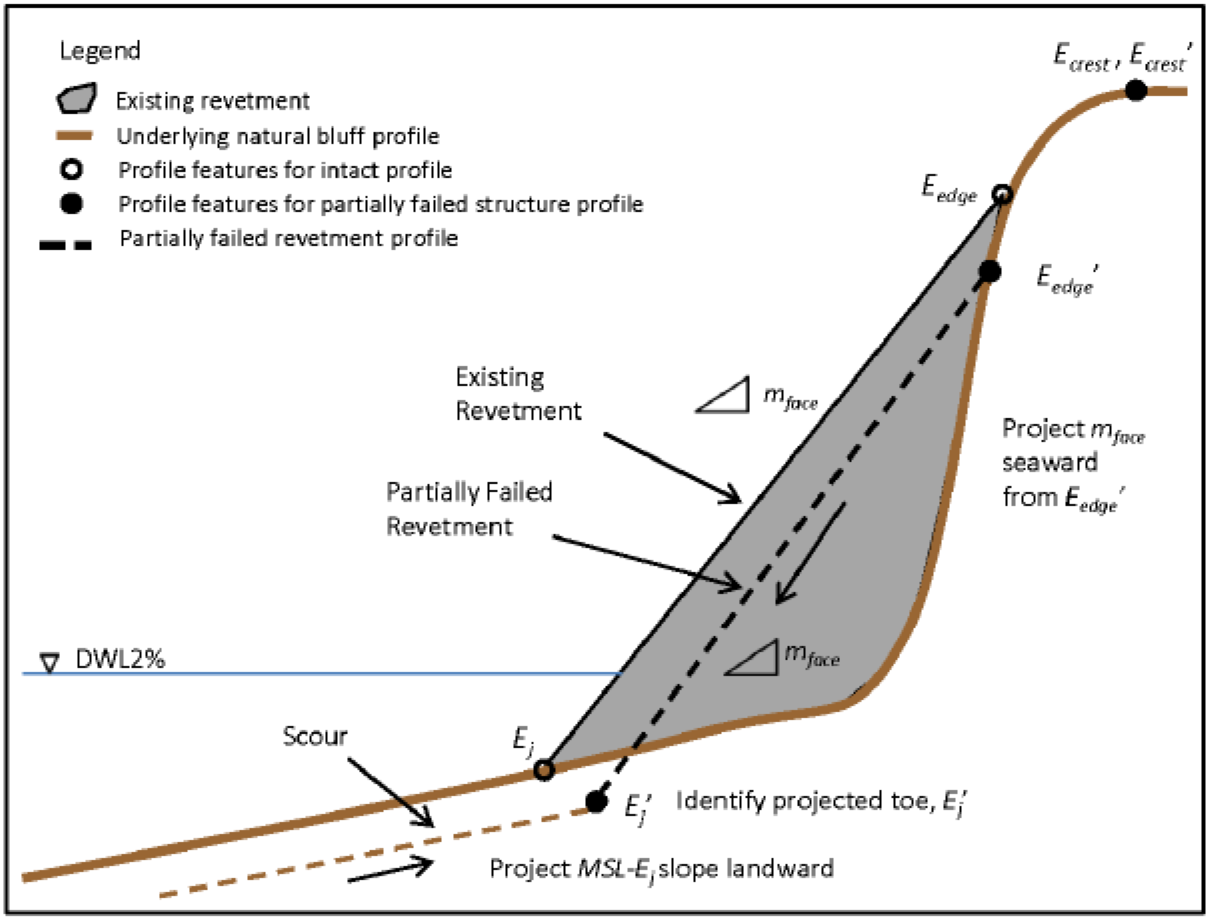

Figure 4-7: Revetment Partial Failure Method for Bluff-backed Profiles (FEMA 2016b)

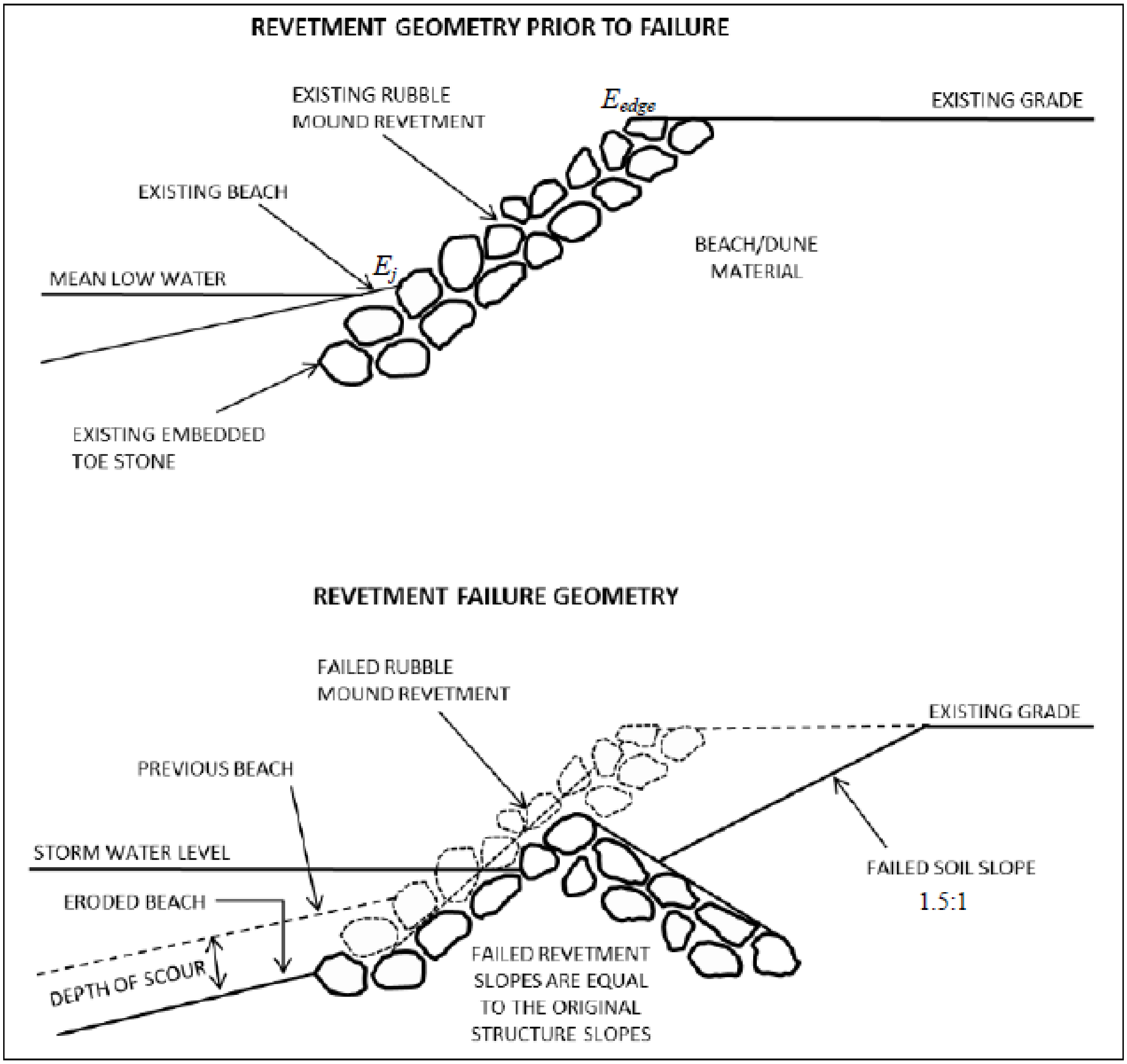

Figure 4-8: Revetment Partial Failure Method for Dune-backed Profiles (FEMA 2016b)

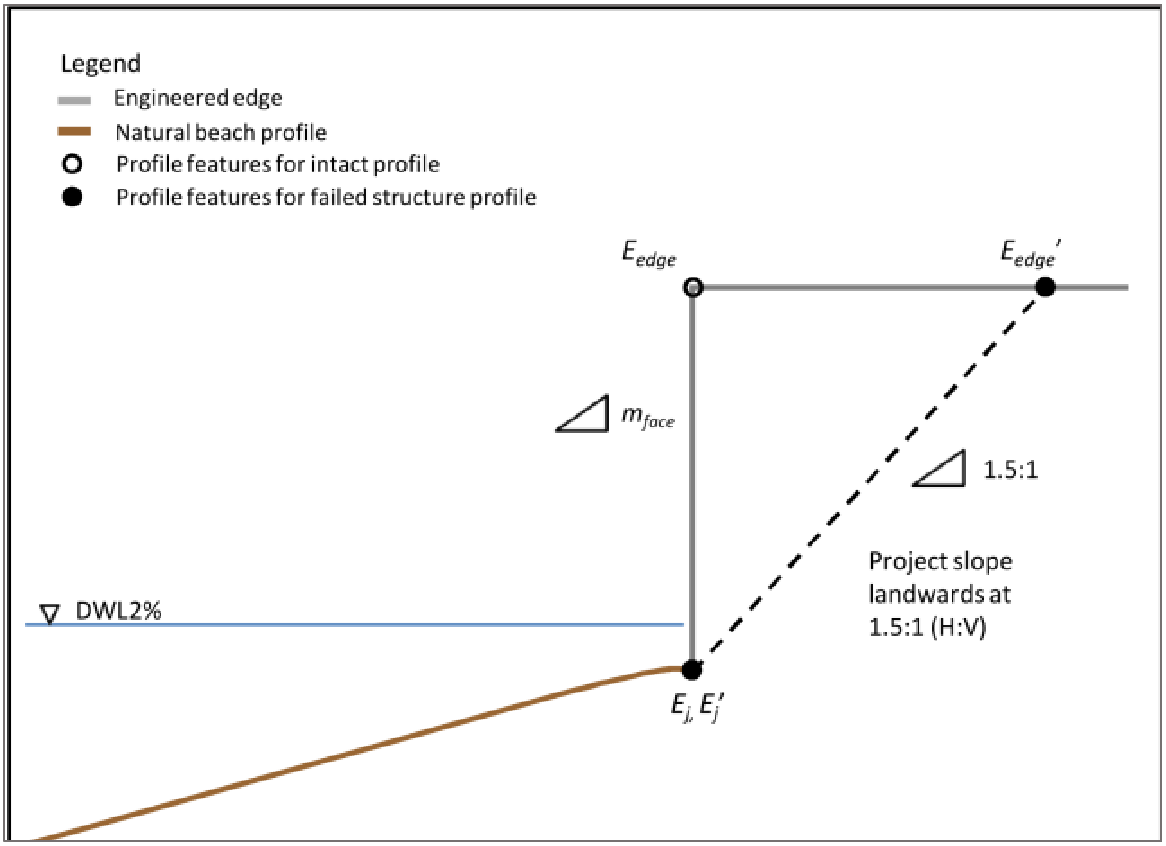

Figure 4-9: Seawall Failure Method for Uncertified Seawalls (FEMA 2016b)

General Review Comments: *None*

4.8 Wave Runup TWL Calculations

In the primary VE zone, TWLs were based on calculated wave runup elevations. The three runup methods used in the Study are referred to as Stockdon Method, DIM, and TAW Method. The specific method used for final TWL calculations was based on criteria comprising transect geometry parameters and wave parameters at each transect as described in IDS3 (FEMA 2016b). Generally,

- Stockdon Method: Sandy beaches (m_f<0.11, or m_f>0.11 and 0.3<ξ<3.5)
- DIM: Sandy beaches (m_f>0.11) or armored beaches (DWL2% < E_j)
- TAW Method: Armored beaches and bluff backed beaches

in which

- m_f – Slope
- ξ – Surf similarity parameter
- DWL – Dynamic Water Level
- E_j – Slope toe

The criteria for selecting a runup method for bluff backed shorelines is outlined in Figure 4-10, reproduced from IDS3 (FEMA 2016b).

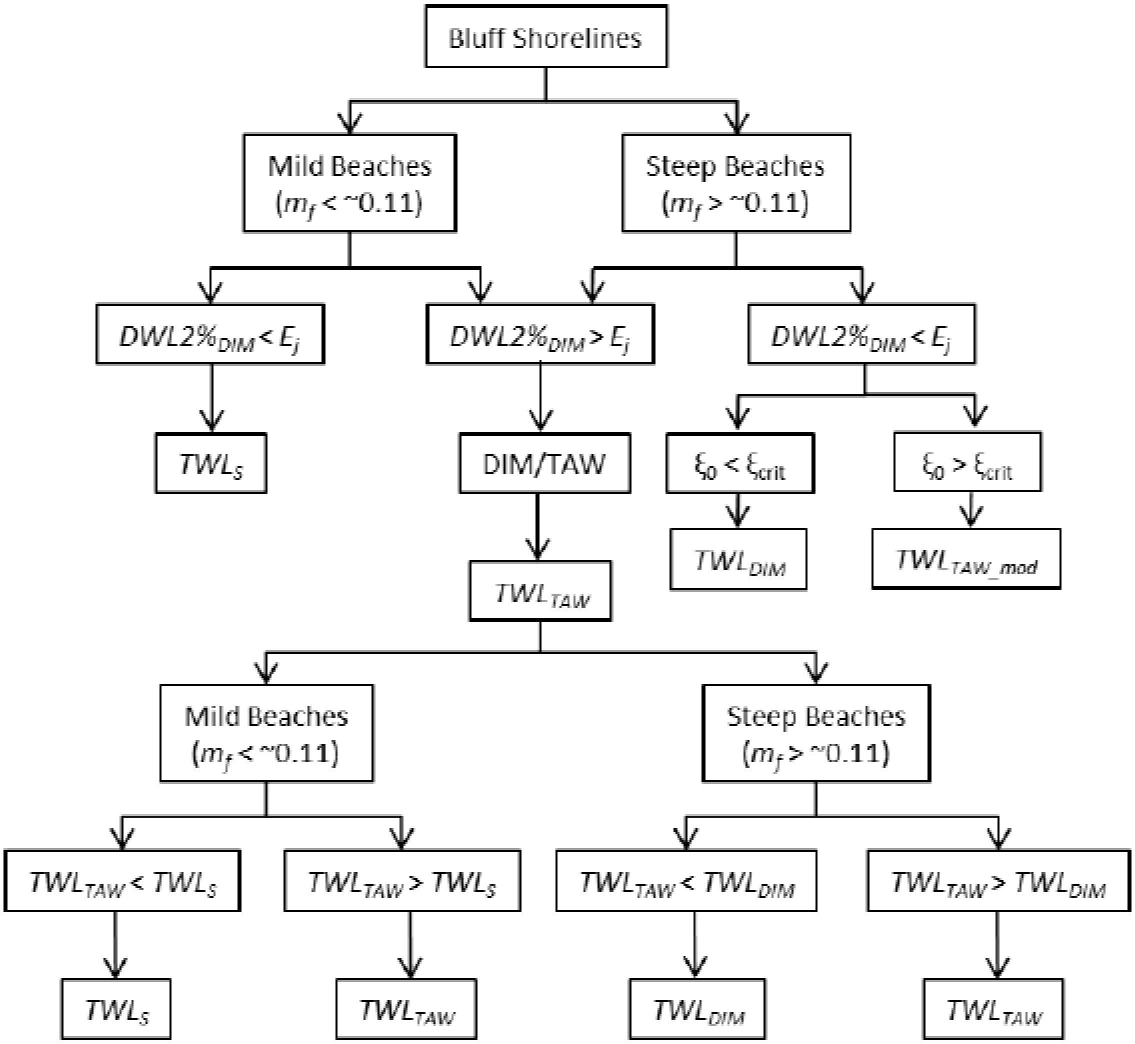

Figure 4-10: TWL Computation Flowchart for Bluff-Backed Shorelines (FEMA 2016b)

General Review Comments: *None*

4.9 Analysis of Total Water Levels

The BFEs relate to the coastal high hazard areas mapped as the VE zones reported on the PFIRMs. These elevations reflect a variety of actual physical processes that are defined by the FEMA guidelines. It is not clear which of these elevations is being mapped at each transect, which promotes confusion about the causative hazard. The FEMA guidelines define the VE as one of the following:

- Wave runup elevation is 3' higher than ground surface
- Wave overtopping/splash is 3' or more above barrier/structure elevation

- High velocity flow landward of splash zone (the product of flow depth and velocity squared is greater than 200 $ft^3/second^2$)
- Breaking wave height is greater than 3' (odd because this is surf zone/nearshore)
- PFD zone

The typical expectation is that the BFE represents the 1 % annual chance TWL based on a runup calculation. The wave overtopping/splash definition is a theoretical parameter associated with a coastal structure or bluff backshore and is defined by the limit of wave uprush on an infinite slope. The differences between the TWL and wave splash elevations can be dramatic and the wave splash tends to be extremely high compared to base flood elevations; wet and splashed is not necessarily flooded and damaged, and should not be used to characterize the BFE. In reality, the coastal topography along Ventura County is often lower than the calculated runup and the resulting flooding is largely dependent on the amount of overtopping, local topography and drainage patterns. In any case where runup exceeds the existing crest elevation, the BFE should be defined by existing topography plus an estimated depth of flooding due to overtopping, not the depth at the crest shown in Figure 4-11 since the overtopping volume is limited. This would result in significantly lower (and more realistic) BFEs throughout the County.

The northern coast of Ventura County (Rincon to Emma Wood State Beach) consists of narrow to non-existent beaches backed by steep bluffs. Almost all development along this coast have some form of shoreline protection in place. The TWL calculations are based on the TAW method for runup against structures or bluff backed shorelines. This method includes many key assumptions that can significantly affect the results. Some general comments related to this methodology are described below:

- The TAW calculations have applied a uniform relationship for breaking wave height at the toe of the runup feature. The relationship of $Hb = 0.78d_{toe}$ is only applicable to very flat slopes and likely underestimates the breaking wave height at most locations. Despite language in the IDS stating an alternate method for this ratio, most appear to be equal or close to the 0.78 ratio. The ratio of wave height to depth can be much higher with longer wave periods and steeper offshore slopes, both of which are typical along the Ventura County coast.
- The TAW depth at toe assumptions are a key parameter influencing the runup estimates on steep slopes and structures. This parameter is dynamic and depends on the amount of sand fronting the structure, the depth of scour/erosion during a storm event or the presence of hard substrate fronting the bluff or structure. The method used to define d_{toe} is not provided in the IDS and seems to be influencing the runup (TWL) calculations. The Pacific Guidelines require determination of MLWP before performing scour analysis, but it was not in this study. No MLWP determination likely leads to underestimating of BFE.
- Very limited roughness coefficient treatments were considered (Table 15 in IDS3 [FEMA 2016b]). Application of TAW does not include any dissipative processes from the cobbles and instead only uses roughness on the face of the structure.

General Review Comments:

13. *Please consider the beach slope effect on the wave breaking criterion (ratio of wave height to water depth) and use an appropriate ratio of wave height to water depth in the analysis. Without considering the slope effect would lead to underestimate of wave height.*
14. *Please provide the method used to define dtoe in the IDS. Please also include a discussion of the dheel and incorporate those into the hazard mapping.*
15. *Roughness factor due to presence of cobbles, offshore reefs, and rock from failed revetment structures were not considered, which would lead to overestimate of BFE. A composite roughness factor should be used instead of using roughness factor of sandy or earthen materials. Rock revetments were completely removed from the transect geometry and the roughness factor was replaced with that of sand for the analysis of the structure failure scenario. The roughness treatment was not consistent with Section D.4.7.3.2 of the Pacific Guidelines, which states: the Mapping Partner shall select an appropriate roughness factor when conducting runup and overtopping analyses on the failed structure. Please correct.*

4.10 Wave Overtopping and Overland Wave Propagation

Wave overtopping occurs when water from waves travels up a shoreline slope and washes over the top of the beach/dune or coastal structure. Overtopping of the profile should be evaluated after profiles were adjusted to reflect event-based erosion or failure/removal of coastal structures. No event-base erosion was performed in the study for Ventura County for structure backed profiles, which could lead to underestimate of BFE. This water can either be in the form of a wave splash when the wave breaks seaward of the shoreline crest, or a wave bore, where a wave breaks over the top of the shoreline crest. Bore overtopping would generally contribute a larger amount of water and result in deeper and further reaching inland flooding. The wave and transect criteria used to determine the overtopping regime is described below. An illustration of the wave overtopping regimes and the associated flood zones is shown in Figure 4-11, reproduced from IDS3 (FEMA 2016b).

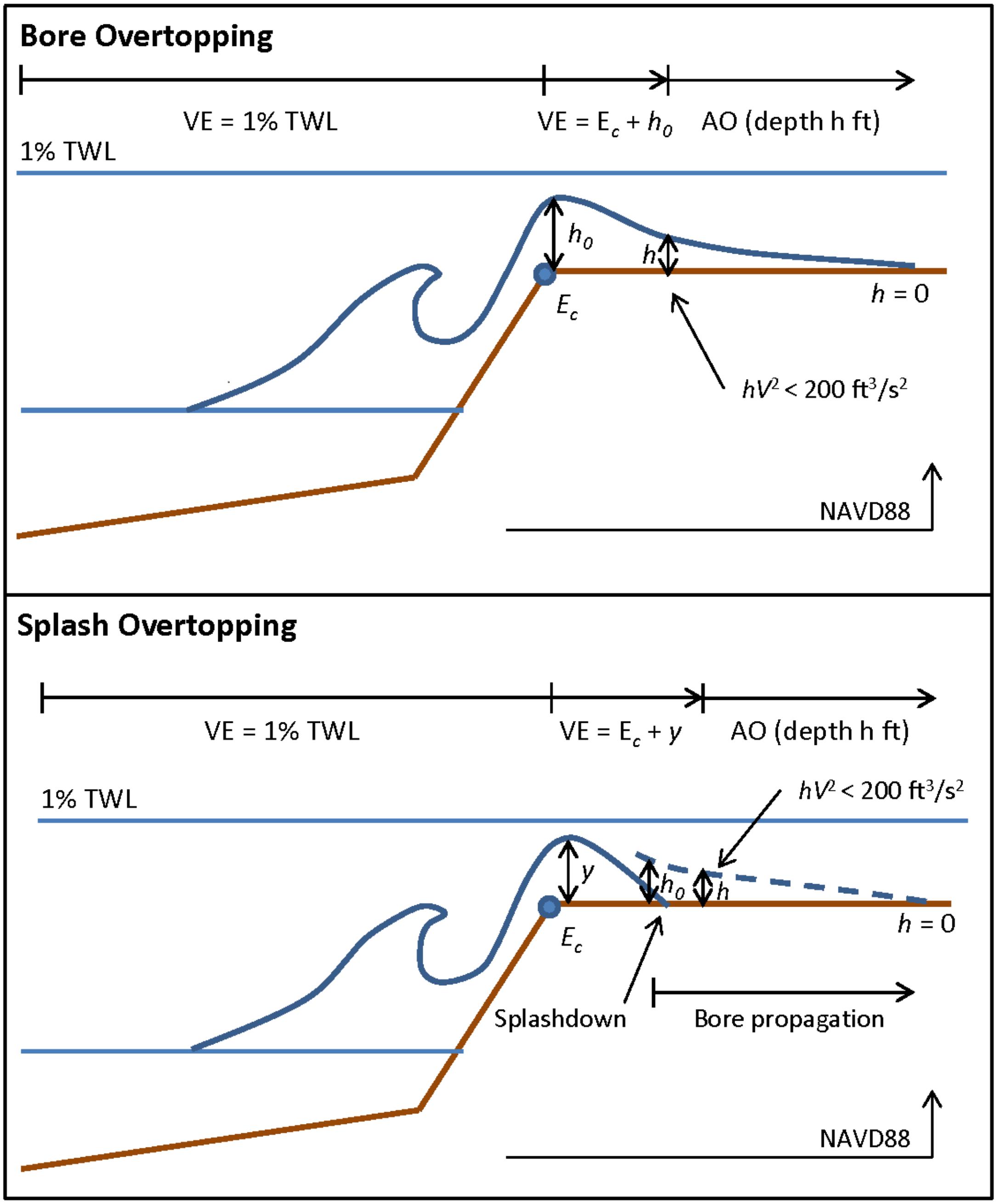

Figure 4-11: Special Flood Hazard Areas Mapping Approach for Overtopped Transects (FEMA 2016b)

Wave overtopping was determined based on a ratio of the 1% TWL over crest elevation of the analysis transect. Overland wave propagation was not modeled at any transects in Ventura County.

Overtopping was calculated in two ways:

1) Bore Propagation

   - Waves break onto or over the crest and a bore of water propagates inland

- o Used when (1%TWL/Crest Elevation) ≥ 2 or DWL2% > Crest Elevation1[4]
- o Inland propagation and depth are a function of excess runup relative to crest elevation

2) Splash Overtopping

- o Waves break seaward of the crest and a jet of water splashes over
- o Used when 1< (1%TWL/Crest Elevation) <2
- o Inland propagation and depth of splashdown jet are a function of cross shore position, runup slope, velocity, and time

The adjustment for wave angle is neglected in TAW analysis in the study for Ventura County. Although this adjustment is relatively small, less than 10%, it should be considered in transects with an oblique angle more than 20 degrees which occurs inside several of the headlands particularly along the north county.

General Review Comments: *None*

4.11 Sheltered Waters and Harbors

A transect-specific approach does not account for sediment budget especially those associated with the harbor dredging. In particular, it does not account for the hazards caused by lack of dredging, which changes the beach morphology leading to upcoast accretion from the harbors and downcoast erosion.

Harbor dredging, while supposedly routine, is an ongoing fiscal issue with federal dredge contracts responsible for most of the sediment bypassing. As has been seen frequently in recent years, delays or funding shortfalls result in delayed, substantially reduced volumes, or canceled dredge operations. This can rapidly lead to downcoast erosion such as that observed in Port Hueneme in 2013/14 or substantive geomorphic changes that may negate the application of the Stockdon method as the runup may change from occurring on a sandy beach to on a structure. This is again due to the fact of not determining the MLWP in the study.

General Review Comments: *None*

[4] All elevations referenced to DWL2%

5 DETAILED REVIEW OF FLOOD HAZARD MAPPING AT AREAS OF INTEREST

Based on results of technical review discussed in Section 4, five sites were selected for detailed review, and review findings and recommendations were summarized in the following sections site by site from north to south. The detailed review evaluated the general site condition, historical aerial photos, wave patterns, historical profiles for sandy beaches, as well as the parameters and methodology used in the transect analysis.

5.1 Site 1: Mussel Shoals Beach (Transect # 4/637 and # 5/633)

This site is located at Mussel Shoals Beach known locally as Little Rincon; the two primary VE zones of interest are separated by the point where the Richfield Pier extends seaward, as shown in Figure 5-1. Waves approach in an oblique angle and the typical wave patterns are shown in Figure 5-2. The primary VE zone represents a maximum wave runup elevation from wave splash, which is not necessarily a flood damage elevation. The BFEs vary greatly between these adjacent zones due to the differences in shore orientation and characteristics.

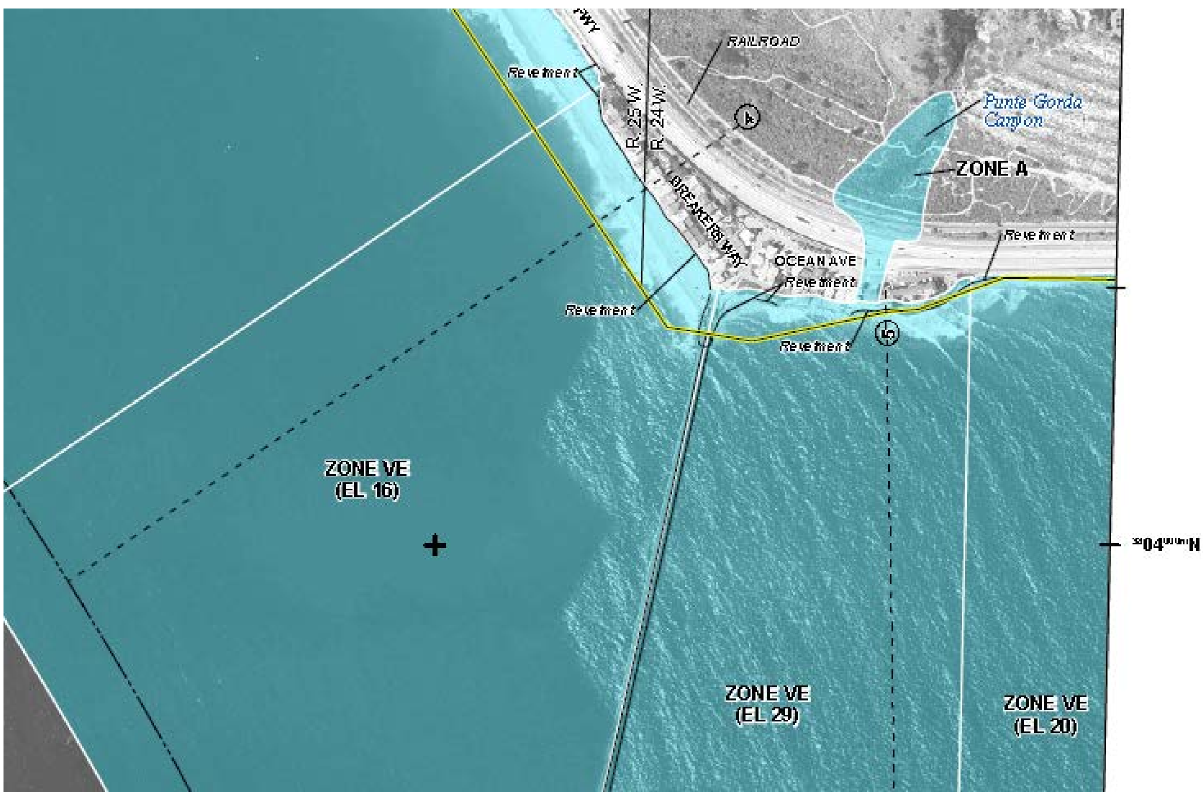

Figure 5-1: Site 1 PFIRM Panel 702F Excerpt (FEMA 2016)

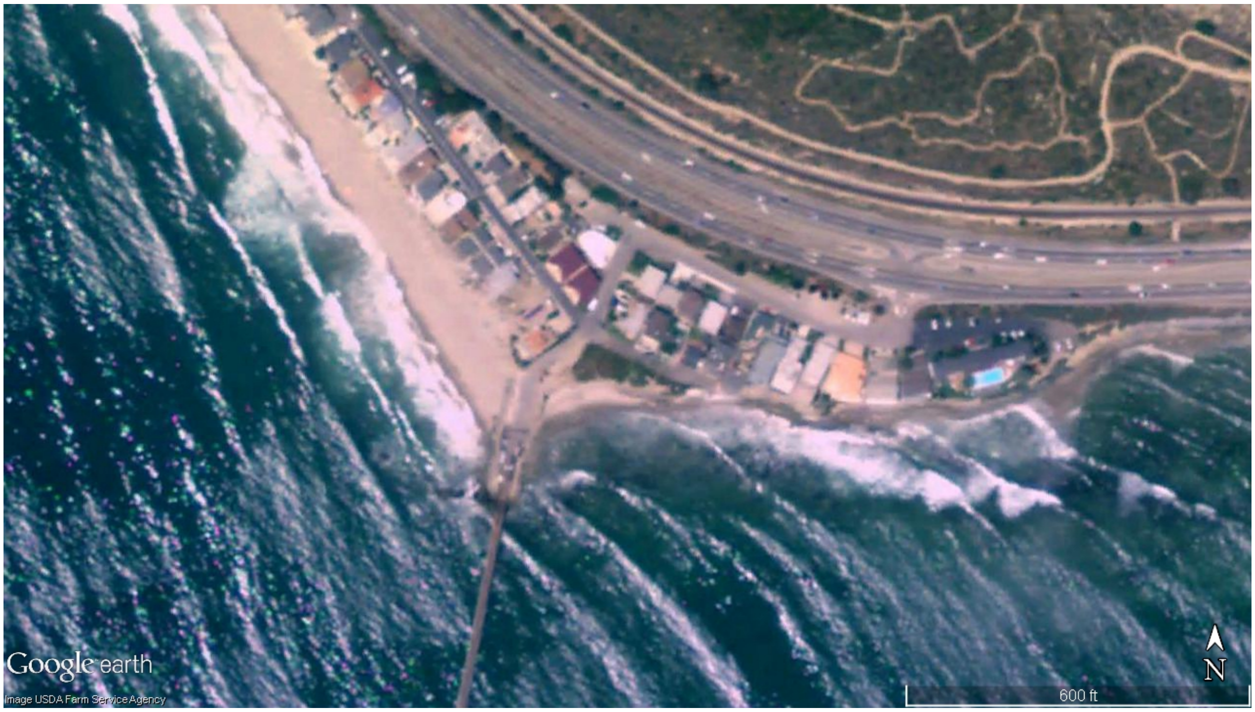

Figure 5-2: Aerial View of Site 1 – Typical Wave Patterns (Google 2009)

Transect 4 is located along a mild sloped dry sandy beach, which helps dissipate wave energy and reduce runup elevations, as shown in Figure 5-3. At this transect, it is assumed that waves will break on the sandy beach and the revetment/bluff crest at the back of the beach is not overtopped. If an eroded beach condition was assumed or the Most Likely Winter Profile was calculated, at this transect, waves would likely break on the back beach at the revetment (intact condition) or sandy bluff (failed condition) and wave runup would be greater and the BFE would increase. Runup parameters are shown on the transect profile in Figure 5-4 and further discussed in the following section.

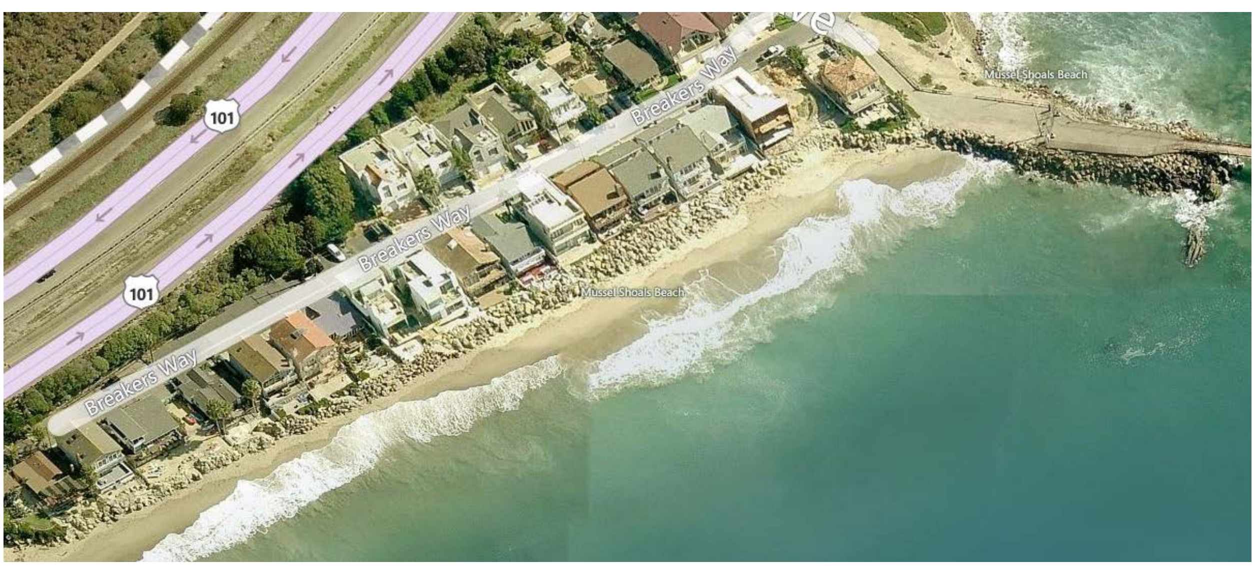

Figure 5-3: Oblique Image at Transect 4 (Bing 2017)

Transect 5 is located along a wet beach with reef, cobble, sand and rock, as shown in Figure 5-5. Although the modeled wave heights are reduced by the refraction around the point, waves break on the revetment (intact condition) or sandy bluff (failed condition) resulting in greater runup values and a higher BFE. Waves approach the beach at an oblique angle, as seen in Figure 5-5. Runup parameters are shown on the transect profile in Figure 5-6 and further discussed in the following section.

5.1.1 Analysis

Transect 4 /637 – BFE Acceptable

- BFE (16 ft NAVD88) is close to TWL of the event of record (16.2 ft NAVD88 on 1/18/88).
- Event of record SWL (5.6 ft NAVD88) is inconsistent with SWL of neighboring transects (6.8 ft NAVD88). The time when this record wave event (on January 18, 1988) occurred between these two neighboring transects were 2-hours apart, which resulted in different SWL and wave period. The wave period is 15.9 seconds at Transect 4 vs 14.4 seconds at Transect 5. No detailed information is available for further analysis.
- Wave angle of attack is reasonable.
- Stockdon runup method is appropriate only if dry sandy beach is present; however, there is not always a beach present based on historical imagery. In the condition of no dry sandy beach, TAW should be used, which would result in higher BFE.
- The runup slope used seems reasonable.
- Calculated TWL results were the same for both intact and failed conditions.

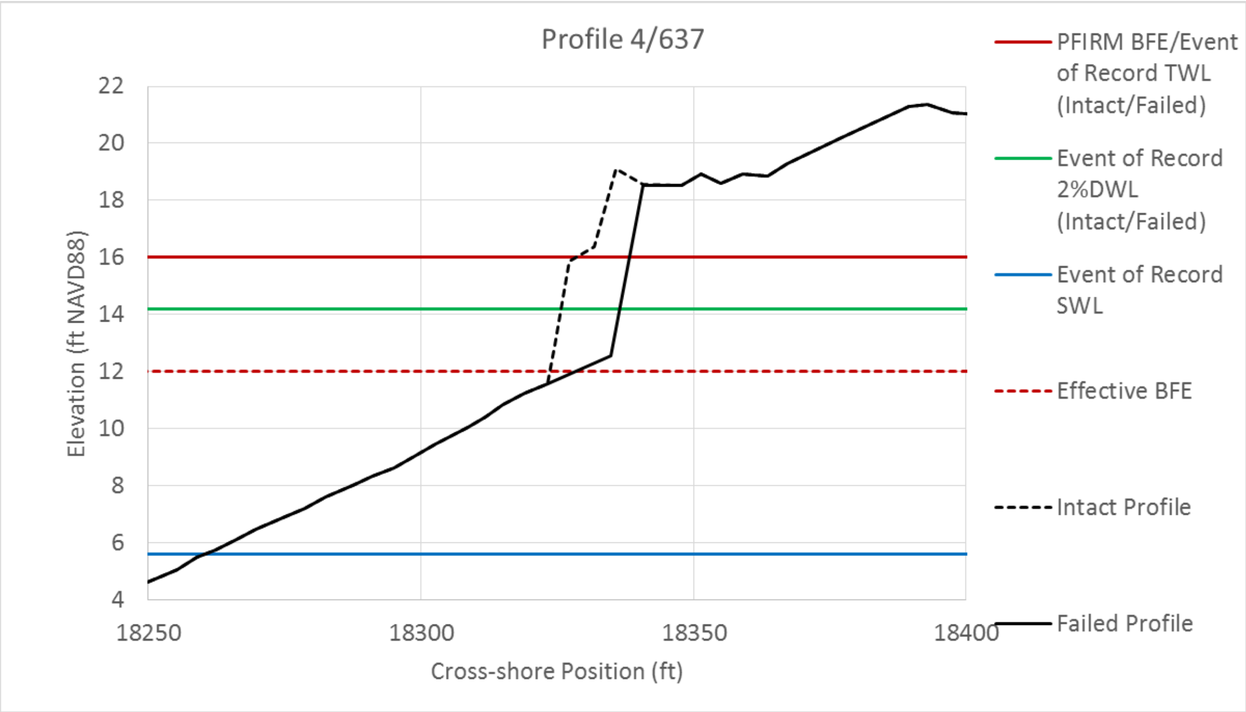

Figure 5-4: Transect 4/637 Profile and Runup Parameters

Transect 5/633 – Potential Overestimation

- BFE (29 ft NAVD 88) exceeds event of record TWL (28.1 ft NAVD88 on 1/18/88).
- Event of record SWL (6.8 ft NAVD88) is inconsistent with Transect 4 (5.6 ft NAVD88), as discussed in Transect 4.
- H_o of 9.7 ft is 32% less than Transect 4, and T_p of 14.4 seconds is 9% less than Transect 4. It is strange that the record wave event occurred 2-hours apart between two neighboring transects and the wave period changed so much in two hours. No detailed information or rationale is available for further analysis.
- Wave approach angle is oblique along an offshore shale reef, which may warrant an additional TWL reduction.
- SWL is above toe; therefore, TAW runup method used is appropriate. The same slope was used for both the structure intact and failed conditions.
- Coastal structure treatment has significant effect on TWL between intact and failed conditions due to roughness of the slope. Complete removal of structure assuming a roughness coefficient of earthen slope without considering the presence of dislodged rock is a poor assumption. Especially since this structure survived the event of record on January 18, 1988.
- TWLs could be reduced if a higher roughness factor was considered for the failed condition as portions of the failed revetment would remain and contribute to a rougher runup slope. Historical aerial imagery shows the revetment in place in 1972 and current aerial imagery shows reef, cobble, sand, rock, and the rock revetment along this reach.
- Bore overtopping was calculated and mapped in the primary VE zone at this transect since inland propagation was less than 35 ft. If TWLs are reduced, overtopping would be recalculated, and as a result, inland propagation may be reduced.

Figure 5-5: Oblique Image at Transect 5 (Bing 2017)

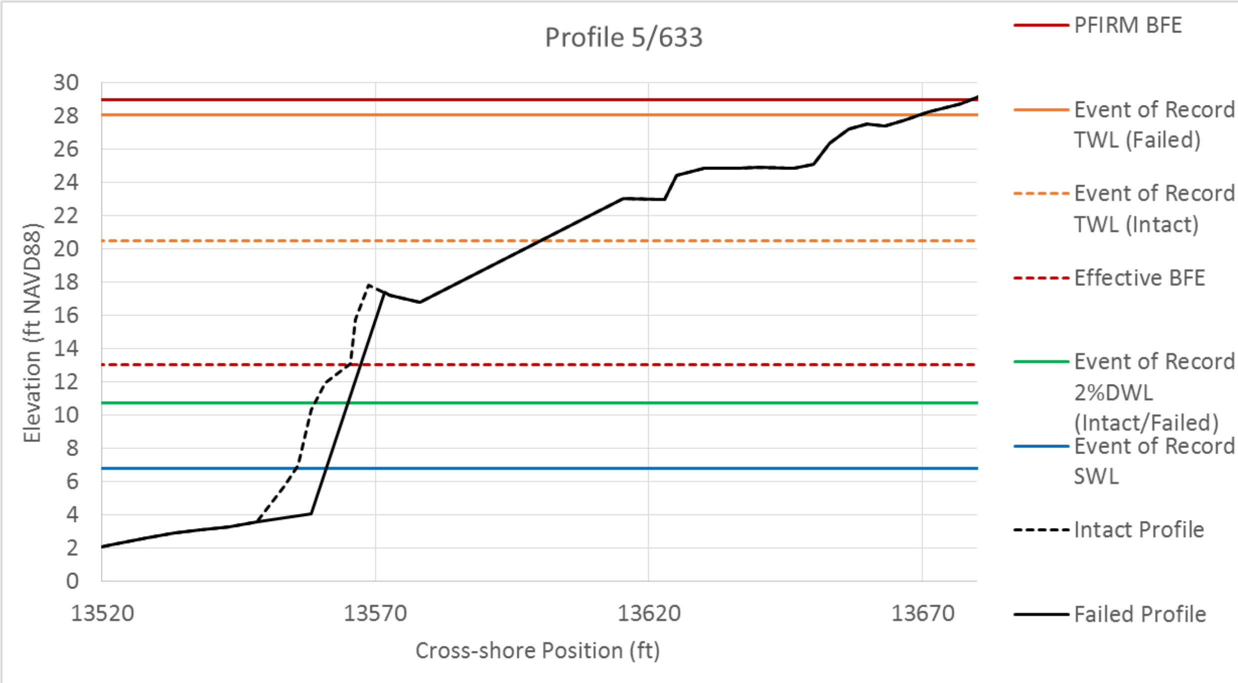

Figure 5-6: Transect 5/633 Profile and Runup Parameters

5.1.2 Recommendation

As stated in IDS3 (FEMA 2016b), the TAW adjustment for wave angle of attack is relatively small and only represents a 10-percent reduction in TWL for wave angles up to as much as 45 degrees oblique. In addition, a reduction of similar magnitude may be applicable to account for roughness along this transect. If one or both of these reduction factors were applied, the BFE could be reduced by 10%-30% (2.9 to 8.7 feet) at this transect. Overtopping may be recalculated depending on the level of reduction in TWLs for the splashdown jet regime, which would reduce the inland extent of the VE zone. Modeling the revetment as intact would provide an additional reduction in the BFE; however, regulations are stringent and as-built drawings, maintenance records, maintenance plans and other documentation would be required by FEMA. Study and calculations will be required for the appeal process.

5.2 Site 2: Seacliff Community and Hobson Park (Transect #8/601)

This site includes the Seacliff community and Hobson Park. The transect at this site includes a primary VE zone (34 ft NAVD88) and a secondary VE zone (20 ft NAVD88) as shown in Figure 5-7. The primary VE zone represents a wave runup elevation associated with wave splash and is not necessarily a flood damage elevation. The secondary VE zone maps the extent of inland propagation resulting from bore overtopping since this distance is greater than 35 ft. However, the extent of the secondary VE zone shown in the PFIRM panel combines the secondary VE zone with the AO zone due to the narrowness of the landward flood analysis.

Transect 8 is located along a wet beach with an offshore reef and sand, backed by a rock revetment as shown in Figure 5-9. Waves break on the reef, before reforming as smaller waves and breaking again on the revetment (intact condition) or sandy bluff (failed condition). Waves approach normal to the shoreline as seen in Figure 5-8. Runup parameters are shown on the transect profile in Figure 5-10 and discussed in the following section.

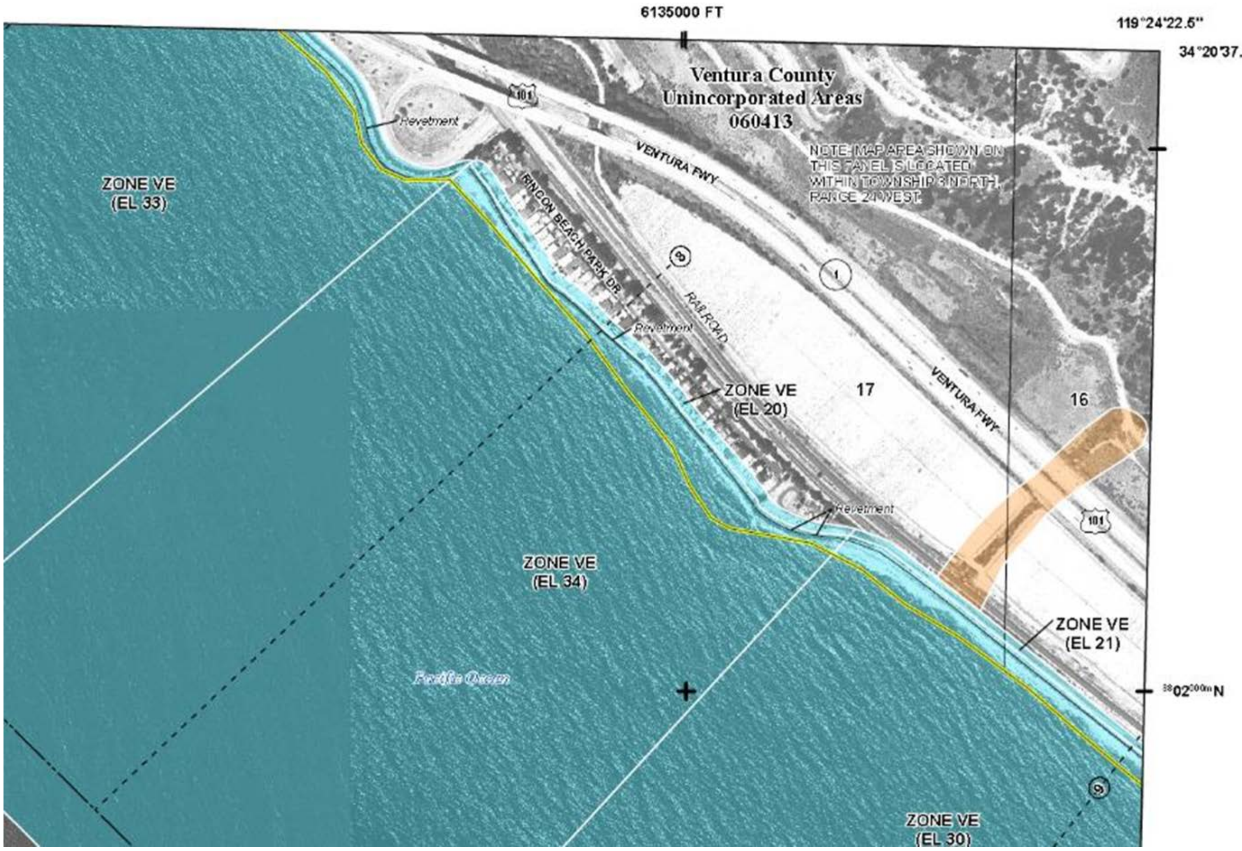

Figure 5-7: Site 2 PFIRM Panel 708F Excerpt (FEMA 2016)

Figure 5-8: Aerial View of Site 2 – Typical Wave Patterns (Google 2017)

5.2.1 Analysis

Transect 8/601 – Potential Overestimation

- BFE (34 ft NAVD 88) exceeds event of record TWL (32 ft NAVD88 on 1/18/88).
- SWL of 6.8 ft NAVD88, H_o of 13.7 ft, T_p of 15.9 seconds for the record event, consistent with neighboring transects.
- Wave angle of attack used is reasonable.
- SWL is above toe; therefore, TAW runup method is appropriate. Same slope was used for both the intact and failed conditions.
- Coastal structure treatment between intact and failed conditions has significant effect on TWL due to difference in roughness coefficient.
- Complete removal of structure and assuming smooth earthen slope is a poor assumption.
- This structure has survived the event of record on January 18, 1988 and maintenance recently completed in 2016.
- TWLs could be reduced if a higher roughness factor was considered for the failed condition as portions of the failed revetment would remain and contribute to a rougher runup slope. Historical aerial imagery shows the revetment in place in 1972 and current aerial imagery shows an offshore reef, sand, cobble, and the rock revetment along this reach.
- Bore overtopping was calculated and mapped in a secondary VE zone at this transect since inland propagation exceeded 35 ft. If TWLs are reduced, overtopping would be recalculated and as a result, inland propagation and flood depths may be reduced.

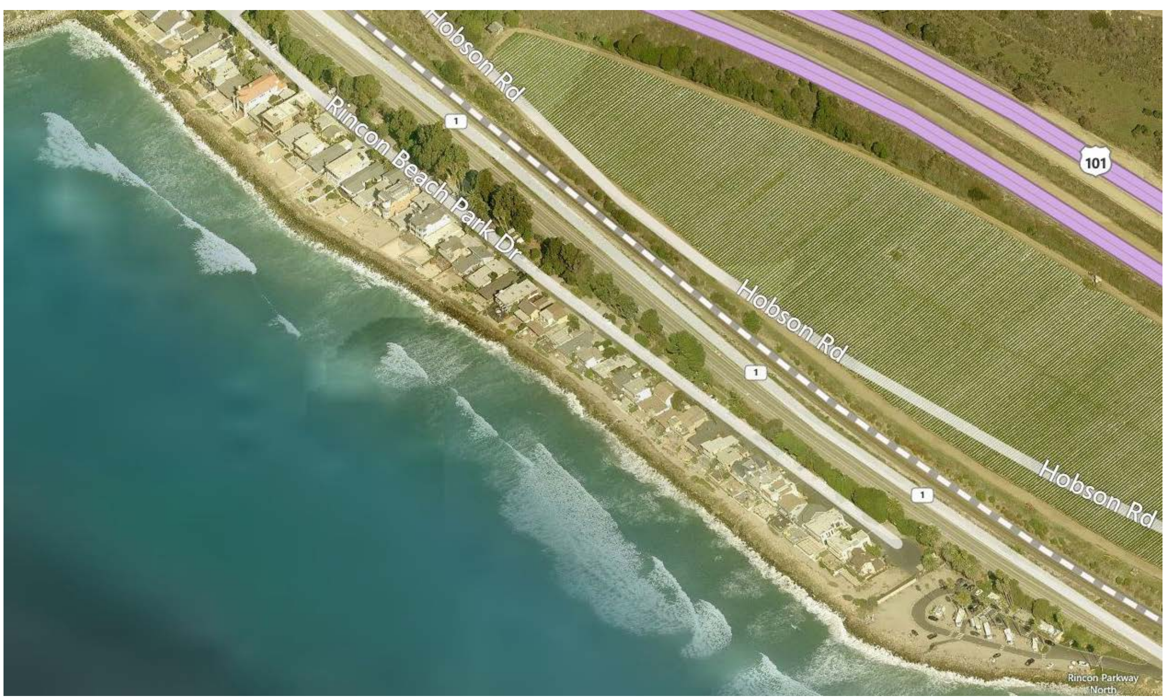

Figure 5-9: Oblique Image at Transect 8 (Bing 2017)

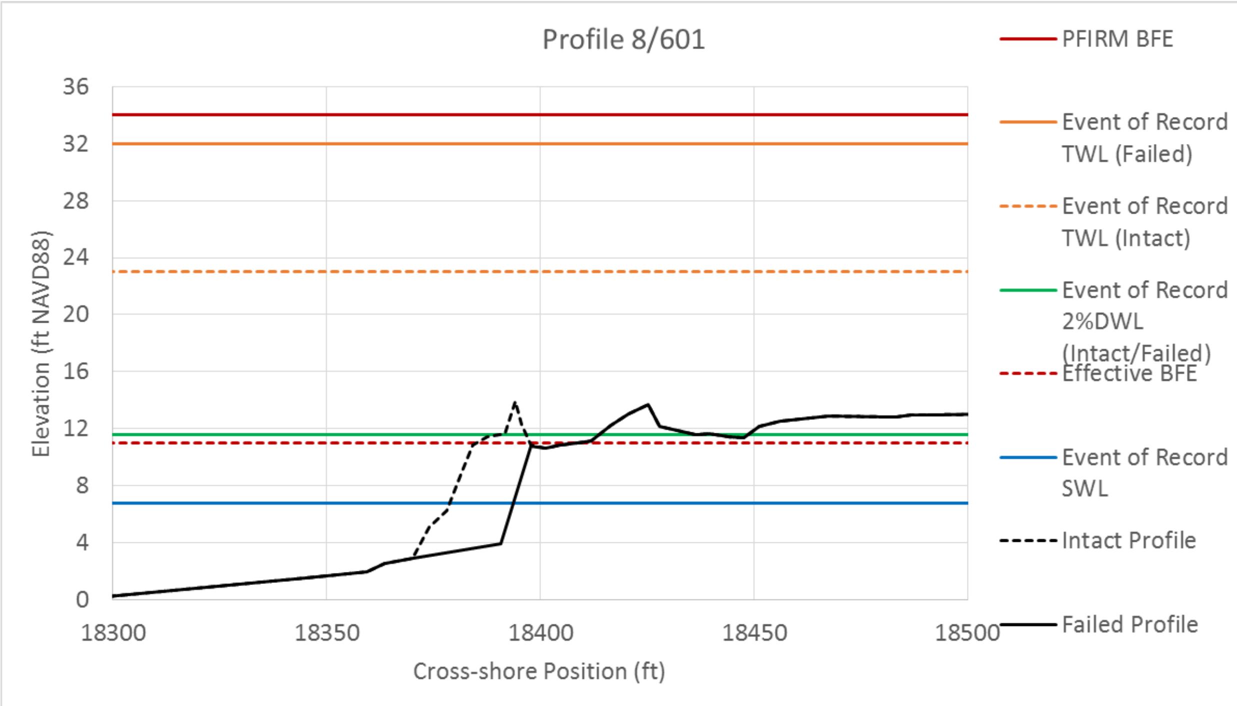

Figure 5-10: Transect 8/601 Profile and Runup Parameters

5.2.2 Recommendation

An appeal may be warranted at Site 2 if the community wishes to challenge the BFE at Transect 8, on the basis of roughness reductions. Due to the longstanding existence of the rock revetment at this site a roughness factor should be applied to the failed revetment condition along this transect. If a reduction factor was applied the BFE could be lowered by 10%-20% at this transect. Overtopping would be recalculated with the reduced TWLs, which would reduce the inland extent and depth of the secondary VE zone. Modeling the revetment as intact, would provide an additional reduction in the BFE; however, regulations are stringent and as-built drawings, recent maintenance records, maintenance plans and other documentation would be required by FEMA. Additional study and calculations will be required for the appeal process.

5.3 Site 3: Pitas Point (Faria Beach) to Solimar (Transect #11/568 - #20/533)

This site extends from Pitas Point downcoast to the Solimar Beach community. In total, this site contains 10 primary VE zones (one at each transect), which represent wave runup elevations, and a secondary VE zone at six of transects. Secondary VE zones are mapped when calculations indicate that seawater resulting from wave runup will propagate 35 ft or more inland. If this distance is less than 35 ft, the extent of inland propagation is mapped in the primary VE zone. BFEs range from 21 to 29 ft NAVD88 at this site due to the differences in shore characteristics and orientation. All these transects, due to topographic constraints and mapping limitations, have mapped as the VE zone without the AO zone due to mapping resolution requirements. An aerial view of the site and typical wave patterns is shown in Figure 5-11.

Figure 5-11: Aerial View of Site 3 – Typical Wave Patterns (Google 2014)

Transects 11-15 are located along a wet beach with sand, cobble, and rock; an offshore reef is apparent in aerial imagery and is popular among surfers. The beach is backed by a combination of non-continuous revetments and seawalls protecting a park and homes. At these transects it is assumed that waves will break on the coastal structures along the back beach (intact condition) or sandy bluff (failed condition). Waves approach these transects at an oblique angle. An excerpt from the PFIRM is shown in Figure 5-12 and an oblique view of the site is shown in Figure 5-13. Runup parameters are shown on the transect profiles in Figure 5-19 through Figure Figure 5-23 and further discussed in the following section.

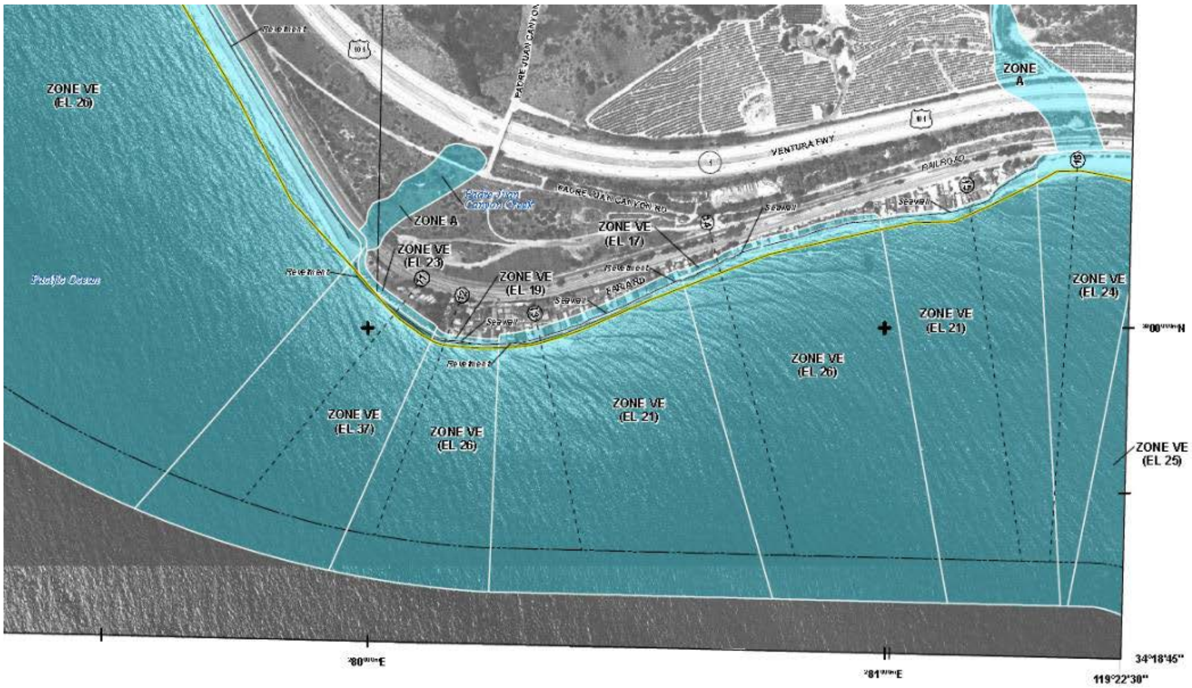

Figure 5-12: Site 3 PFIRM Panel 709F Excerpt (FEMA 2016)

Figure 5-13: Oblique Image at Transect 11-14 (Bing 2017)

Transects 16-18 are located along a cobble and small boulder beach. An offshore reef is apparent in aerial imagery. The beach at Transect 16 is backed by a rock revetment. A dry beach exists periodically at Transect 16 and may extend partially into the VE zone of Transect 17. Transects 16 and 17 have an offshore reef utilized by surfers. The VE zone for Transect 17 encompasses an isolated housing tract with a wet beach and a combination of non-continuous rock revetments and seawalls fronting homes. The beach at Transect 18 is a wet sandy beach backed by a rock revetment. At these transects it is assumed that waves will break on the coastal structures along the back beach (intact condition) or sandy bluff (failed condition). An excerpt from the PFIRM is shown in Figure 5-14 and an oblique view of the site is shown in Figure 5-15 and Figure 5-16. Runup parameters are shown on the transect profiles in Figure 5-24 through Figure 5-26 and further discussed in the following section.

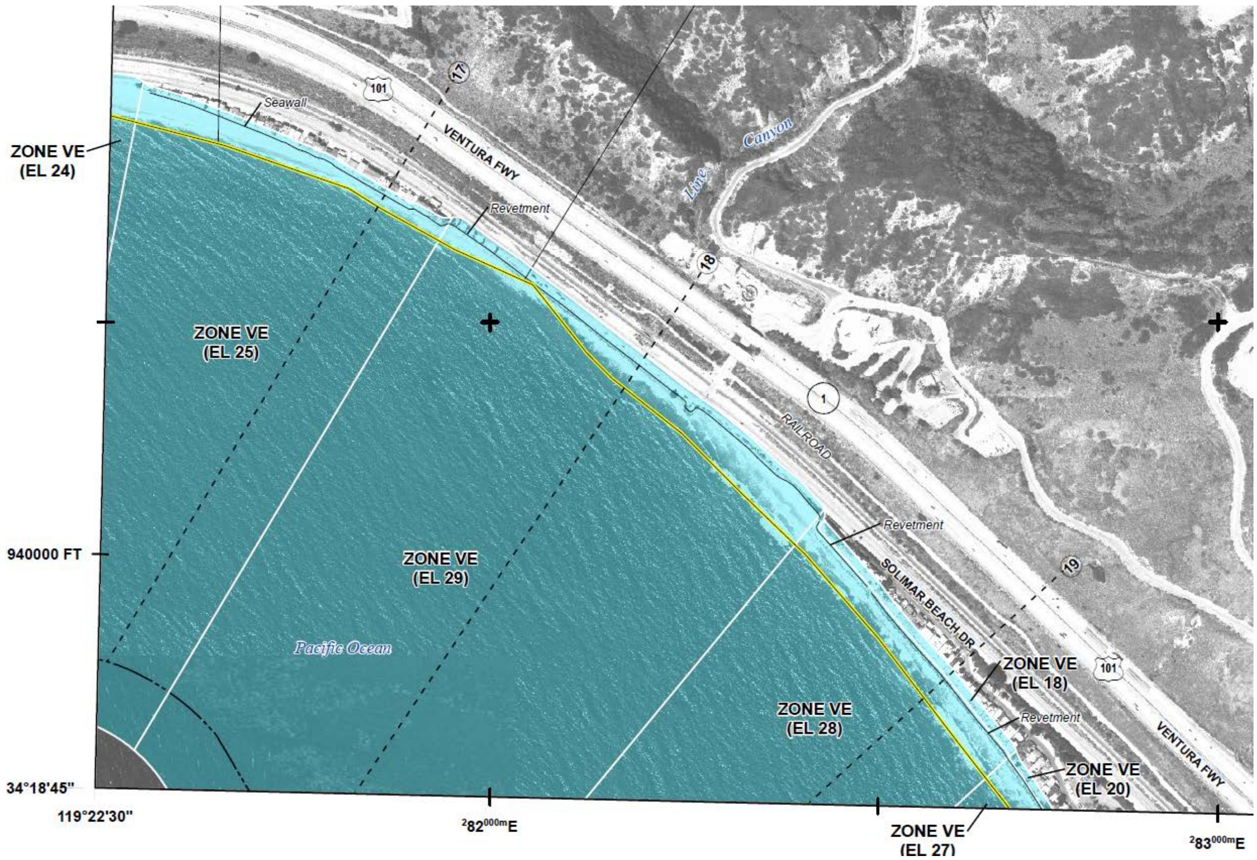

Figure 5-14: Site 3 PFIRM Panel 728F Excerpt (FEMA 2016)

Figure 5-15: Oblique Image at Transect 15-16 (Bing 2017)

Figure 5-16: Oblique Image at Transect 17-18 (Bing 2017)

Transects 19-20 are located along a wet sand and cobble beach; an offshore reef is apparent in aerial imagery. The beach is backed by a continuous rock revetment fronting homes. At these transects it is assumed that waves will break on the revetment along the back beach (intact condition) or sandy bluff (failed condition). An excerpt from the PFIRM is shown in and an oblique view of the site is shown in Figure 5-17. Runup parameters are shown on the transect profiles in Figure 5-27 and Figure 5-28 with further discussion in the following section.

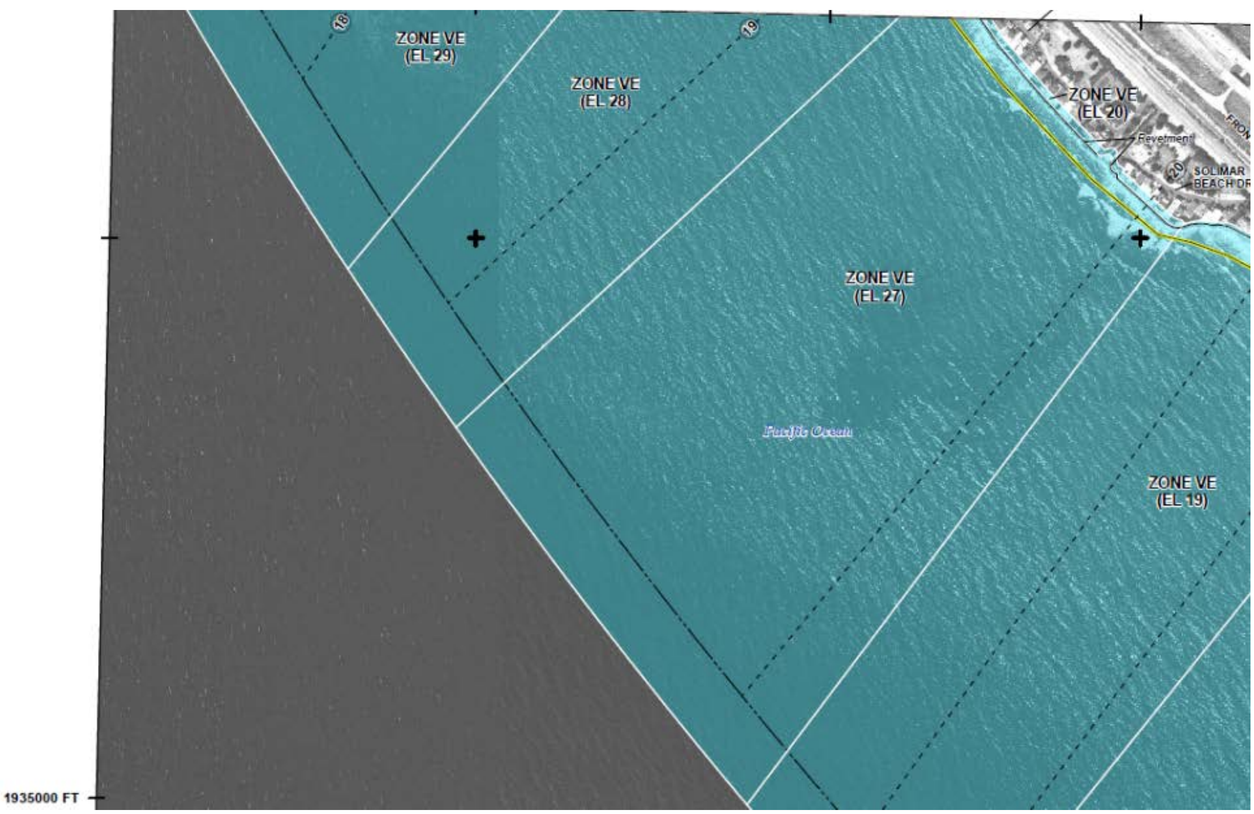

Figure 5-17: Site 3 PFIRM Panel 736F Excerpt (FEMA 2016)

Figure 5-18: Oblique Image at Transect 19-20 (Bing 2017)

5.3.1 Analysis

Transect 11/568 – Potential Overestimate

- BFE approximately equals the event of record TWL (37 ft NAVD88 on 1/18/88).
- SWL of 6.8 ft NAVD88, H_o of 16.6 ft, T_p of 15.9 seconds; these parameters are consistent with neighboring transects.
- Wave angle of attack used is acceptable.
- SWL is above structure toe; therefore, TAW runup method used is appropriate.
- Failed slope value assumed is steeper than intact condition; followed the Pacific Guidelines for the revetment removal method for bluff backed structure failure.
- Coastal structure treatment has significant effect on TWL for intact vs. failed conditions due to roughness assumptions.
- Complete removal of structure, steepening, and smoothing of slope is a poor assumption.
- This structure has survived the event of record on January 18, 1988.
- TWLs could be reduced if a roughness factor was considered for the failed condition as portions of the failed revetment would remain and contribute to a rougher runup slope. Historical aerial imagery shows the revetment in place in 1972 and current aerial imagery shows an offshore reef, sand, and the rock revetment along this reach.
- Bore overtopping was calculated and mapped in a secondary VE zone at this transect since inland propagation exceeded 35 ft. If TWLs are reduced, overtopping would be recalculated and as a result, inland propagation and flood depths may be reduced.

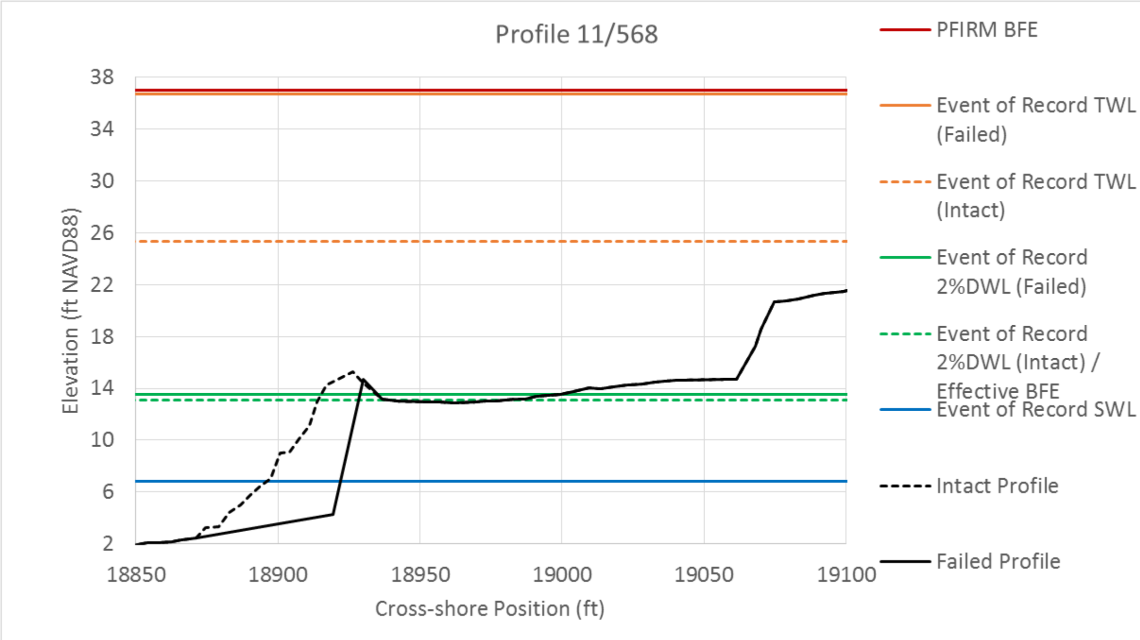

Figure 5-19: Transect 11/568 Profile and Runup Parameters

Transect 12/567 – Potential Overestimation

- BFE (26 ft NAVD88) exceeds the event of record TWL (20.8 ft NAVD88 1/18/88).
- SWL of 6.8 ft NAVD88 is the same as Transect 11, H_o of 14.6 ft is 12% less than Transect 11, and T_p of 15.9 seconds is the same as Transect 11.
- Wave approach angle is oblique and may warrant a small TWL reduction.
- SWL is above toe; therefore, TAW runup method is appropriate.
- Transect geometry includes a vertical face of a seawall. The condition and maintenance of this structure is unknown, and it may not be representative of the entire zone where some seawalls have a recurved face.
- Aerial imagery shows the presence of cobble, rock, and sand at the base of seawalls. There may be potential for a small TWL reduction if a revised roughness factor is

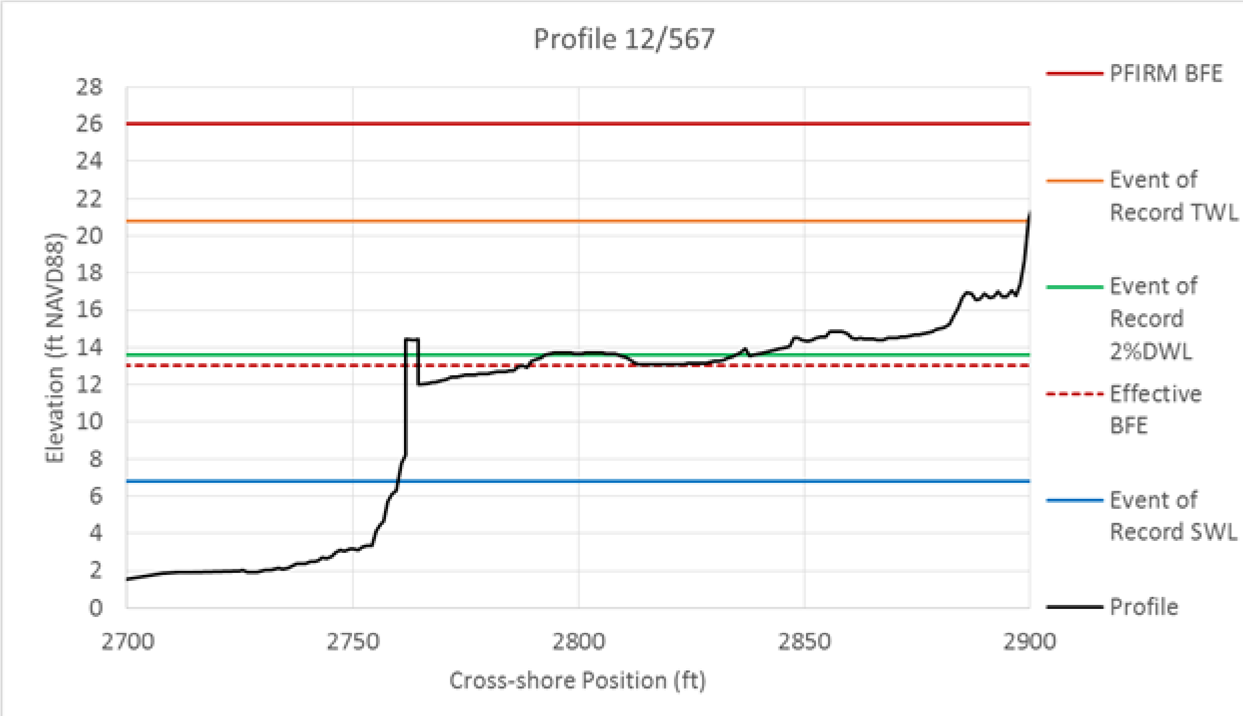

Figure 5-20: Transect 12/567 Profile and Runup Parameters

Transect 13/565 – Acceptable

- BFE (21 ft NAVD88) is less than the event of record TWL (21.7 ft NAVD88 on 1/27/83).
- The event of record at this transect is different compared to Transect 12.
- Comparison of the event of record between two transects indicate: SWL of 7.3 ft NAVD88 is a 7% increase from Transect 12; H_o of 6.4 ft is 56% decrease from Transect 12; and T_p of 19.2 seconds is a 21% increase from Transect 12.
- Wave approach angle is oblique, but not considered in FEMA analysis, which may warrant a small TWL reduction.
- Stockdon runup was used and may be a poor choice since the beach slope is very steep and outside of the Stockdon method application range. Also, there were 20 events in which SWL is above toe, and historic imagery as far back as 1972 consistently showed a wet beach at this location. Therefore, TAW runup should be used, which may result in a decrease in BFE.
- Transect geometry includes a vertical or recurved face of a seawall. However, the condition and maintenance of this structure is unknown and may not be representative of entire zone where some seawalls have a recurved face.
- Aerial imagery shows the presence of cobble, rock, and sand at this transect. A composite roughness factor should be considered if TAW method is used.
- Bore overtopping was calculated and mapped in a secondary VE zone at this transect since inland propagation exceeded 35 ft. If TWLs are reduced, overtopping would be

recalculated and as a result, inland propagation and flood depths may be reduced.

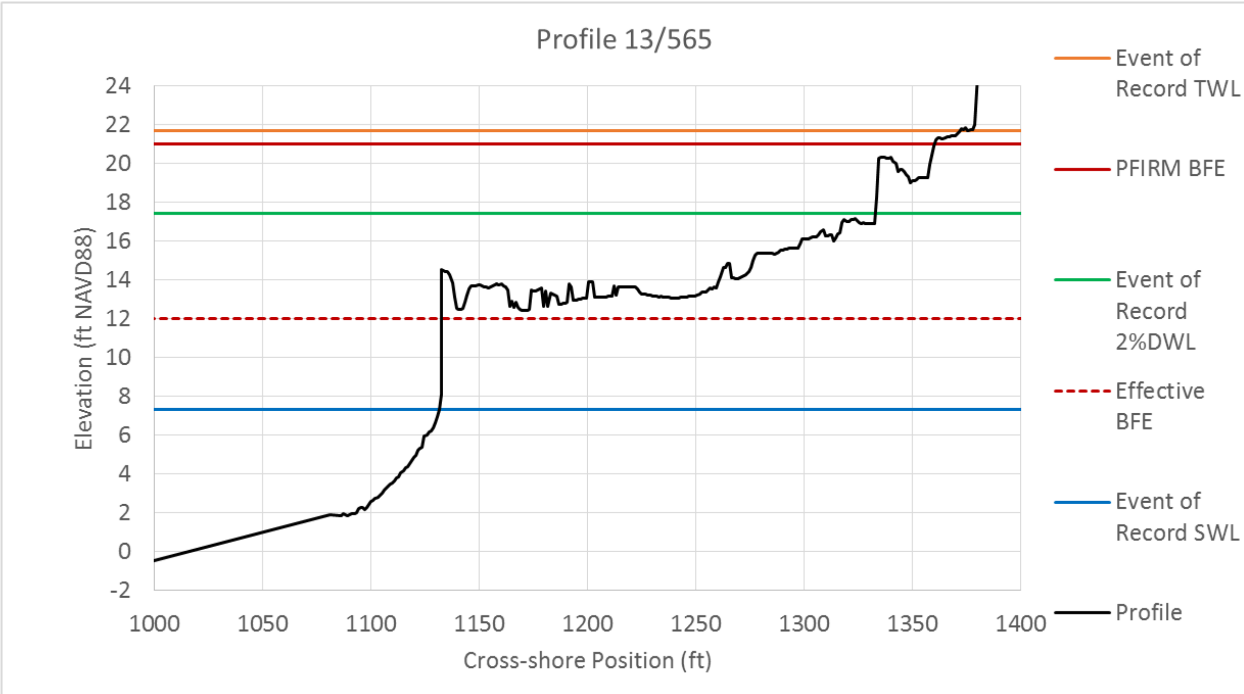

Figure 5-21: Transect 13/565 Profile and Runup Parameters

Transect 14/561 – Potential Overestimation

- BFE (26 ft NAVD88) is less than the event of record TWL (27.1 ft NAVD88 on 1/27/83).
- SWL of 7.3 ft NAVD88 is the same as Transect 13, H_o of 5.4 ft is a 16% decrease from Transect 13, and T_p of 19.2 seconds is the same as Transect 13. The trend seems reasonable.
- Wave approach angle is oblique and not considered in the analysis, which may warrant a small TWL reduction.
- SWL is above toe; therefore, TAW runup method used is appropriate. Same slope value is used for both the intact and failed conditions.
- Aerial imagery shows the presence of rock, cobble, and sand at this transect. There may be potential for a small TWL reduction if a revised composite roughness reduction factor is considered for the failed condition.
- Coastal structure treatment has significant effect on TWL due to roughness coefficient differences for intact and failed conditions.
- Roughness reduction factor assumed for intact condition with full revetment condition may be too high as rock protections are sporadic in this section. A composite roughness reduction factor should be considered, which may raise intact TWLs.
- Bore overtopping was calculated and mapped in a secondary VE zone at this transect since inland propagation exceeded 35 ft. If TWLs are reduced, overtopping would be

recalculated and as a result, inland propagation and flood depths may be reduced.

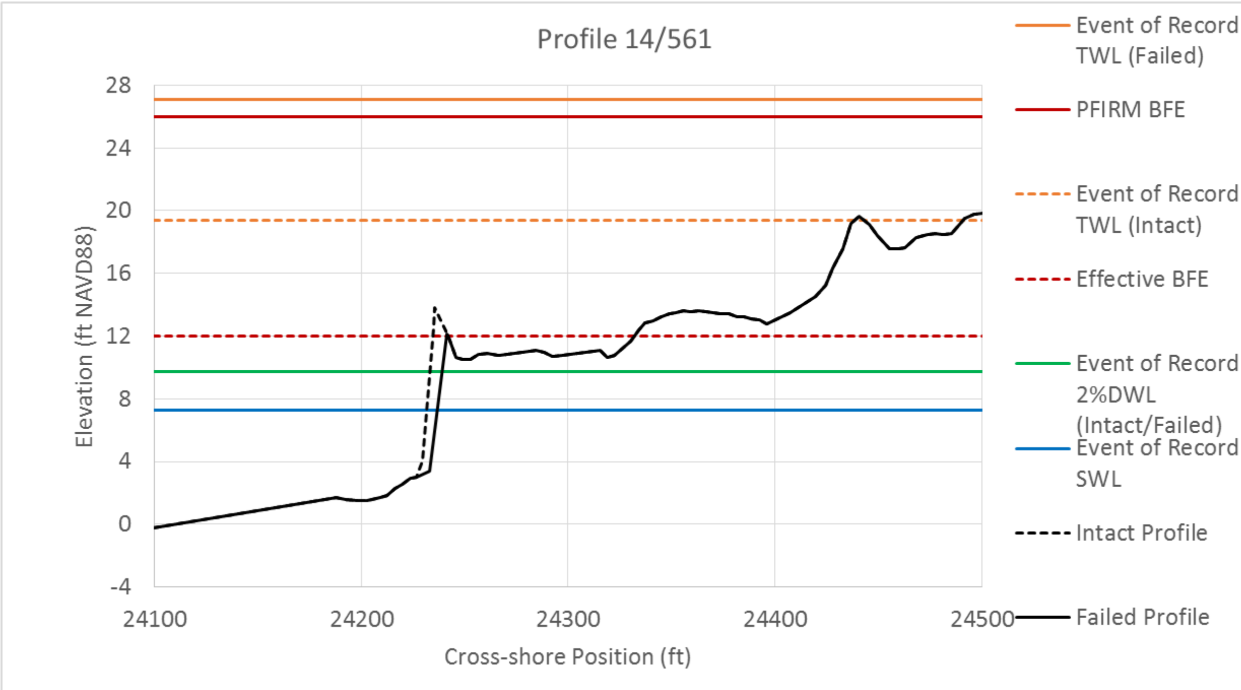

Figure 5-22: Transect 14/561 Profile and Runup Parameters

Transect 15/556 – Acceptable

- BFE (21 ft NAVD88) is less than event of record TWL (21.8 ft NAVD88 on 1/27/83).
- SWL of 7.3 ft NAVD88 is the same as Transect 14, Ho of 6.7 ft is a 24% increase from Transect 14, Tp of 19.2 seconds is the same as Transect 14. The wave height trend seems reasonable.
- Wave approach angle is oblique and not considered in the analysis, which may warrant a small TWL reduction.
- SWL is above toe; therefore, TAW runup method is appropriate.
- Transect geometry includes a vertical face of a seawall. However, the condition and maintenance of this structure is unknown and may not be representative of the entire zone as some seawalls in this area have a recurved face.
- Bore overtopping was calculated and mapped in the primary VE zone at this transect since inland propagation was less than 35 ft. If TWLs are reduced, overtopping would be recalculated and as a result, inland propagation may be reduced.

Figure 5-23: Transect 15/556 Profile and Runup Parameters

Transect 16/554 – Potential Overestimation

- BFE (24 ft NAVD88) is greater than the event of record TWL (22.4 ft NAVD88 on 1/27/83).
- SWL of 7.3 ft NAVD88 is the same as Transect 15, H_o of 8.6 ft is a 28% increase from Transect 15, T_p of 19.2 seconds is the same as Transect 15. The wave height trend should probably be similar to a small reduction.
- Wave angle of attack used is acceptable. Offshore reef may dissipate wave energy before it reaches the beach and may warrant a small reduction in the TWL.
- Beach conditions fluctuate at this transect between dry sandy beach and wet sandy beach.
- During the wet sandy beach condition modeled, SWL is above toe. Therefore, TAW runup method appropriate.
- The runup slope consists of a sandy foreshore and rock placed along back of beach, a composite roughness factor should be assumed, which may lower TWLs. The revetment would contribute to a rougher runup slope. Historical aerial imagery shows the revetment in place in 1972 and current aerial imagery shows an offshore reef, sand, and the rock revetment along this reach.
- Splash overtopping was calculated and mapped in the primary VE zone at this transect since inland propagation was less than 35 ft. If TWLs are reduced, overtopping would be recalculated and as a result, inland propagation may be reduced.

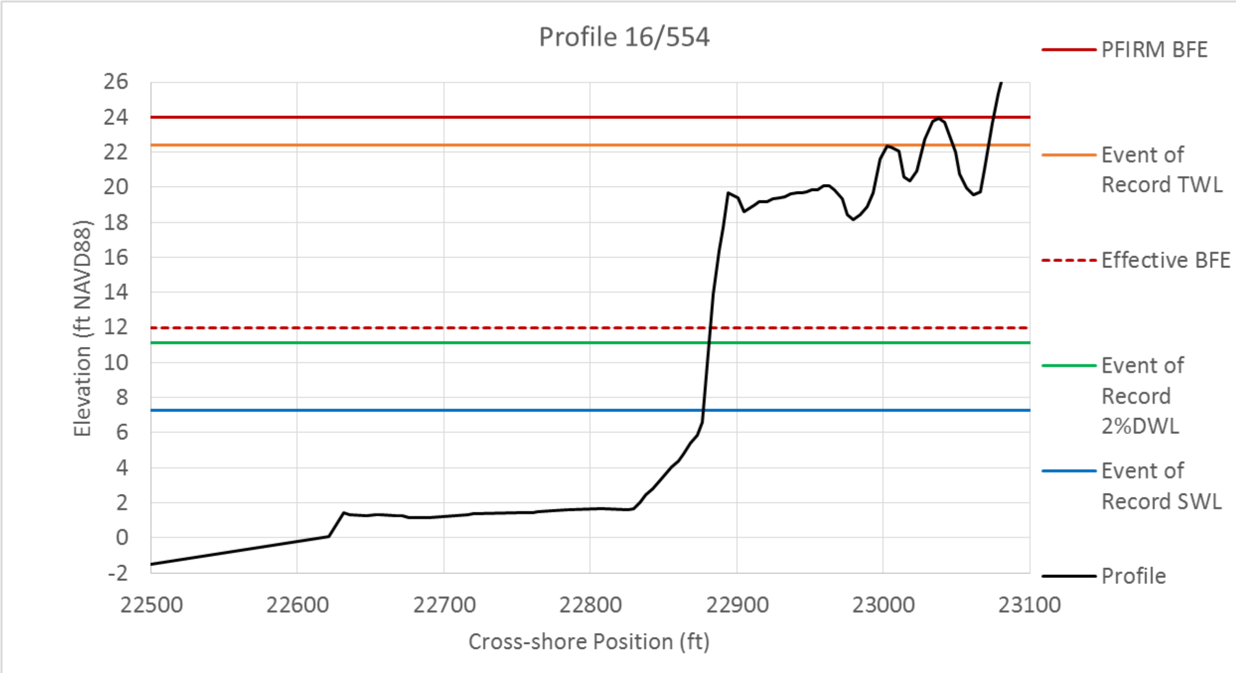

Figure 5-24: Transect 16/554 Profile and Runup Parameters

Transect 17/549 – Acceptable

- BFE (25 ft NAVD88) is greater than the event of record TWL (23 ft NAVD88 on 1/18/88).
- The event of record at this transect is different compared to Transect 16.
- SWL of 6.8 ft NAVD88 is a 7% decrease from Transect 16, H_o of 15.4 ft is a 79% increase from Transect 16, T_p of 15.9 seconds is a 17% decrease from Transect 16. The wave height trend should probably be similar to Transect 16.
- Wave angle of attack used is acceptable. Offshore reef may dissipate wave energy before it reaches the beach and may warrant a small reduction in the TWL.
- Beach conditions fluctuate at this transect between dry sandy beach and wet sandy beach.
- During the wet sandy beach condition modeled, SWL is above toe. Therefore, TAW runup method used is appropriate.
- Transect geometry includes a vertical face of a seawall. However, the condition and maintenance of this structure is unknown and may not be representative of entire zone where some recurved seawalls exist.
- Historical imagery shows a rock revetment exposed at the toe of the seawall in some locations. The revetment would contribute to a rougher runup slope and hence a reduced TWL.
- Bore overtopping was calculated and mapped in the primary VE zone at this transect since inland propagation was less than 35 ft. If TWLs are reduced, overtopping would be

recalculated and as a result, inland propagation may be reduced.

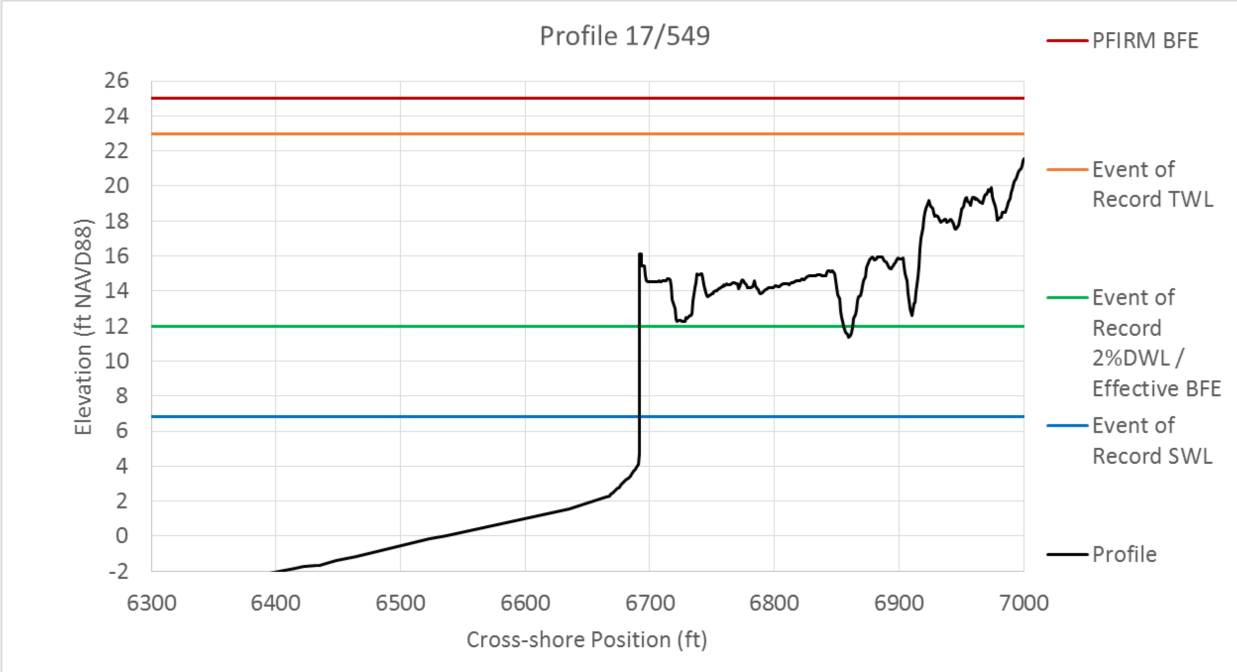

Figure 5-25: Transect 17/549 Profile and Runup Parameters

Transect 18/546 – Potential Overestimation

- BFE (29 ft NAVD88) is greater than the event of record TWL (27.2 ft NAVD88 on 1/18/88).
- SWL of 6.8 ft NAVD88 is the same as Transect 17, H_o of 16.0 ft is a 4% increase from Transect 17, T_p of 15.9 seconds is the same as Transect 17.
- Wave angle of attack used is acceptable. Offshore reef may dissipate wave energy before it reaches the beach and may warrant a small reduction in the TWL.
- Wet sandy beach is backed by a rock revetment. SWL is above toe; therefore, TAW runup method used is appropriate.
- The runup slope consists of a wet sandy foreshore with cobble, and rock placed along back of beach; hence, a composite roughness factor should be used, which may lower TWLs. Also, portions of the failed revetment would remain and contribute to a rougher runup slope. Historical aerial imagery shows the revetment in place in 1972 and current aerial imagery shows an offshore reef, sand, and the rock revetment along this reach.
- Same slope value is used for both intact and failed conditions.
- Coastal structure treatment between intact and failed conditions has significant effect on TWL due to roughness assumptions.
- Complete removal of structure and assuming smooth earthen slope is a poor assumption.

- Bore overtopping was calculated and mapped in the primary VE zone at this transect since inland propagation was less than 35 ft. If TWLs are reduced, overtopping would be recalculated and as a result, inland propagation may be reduced.

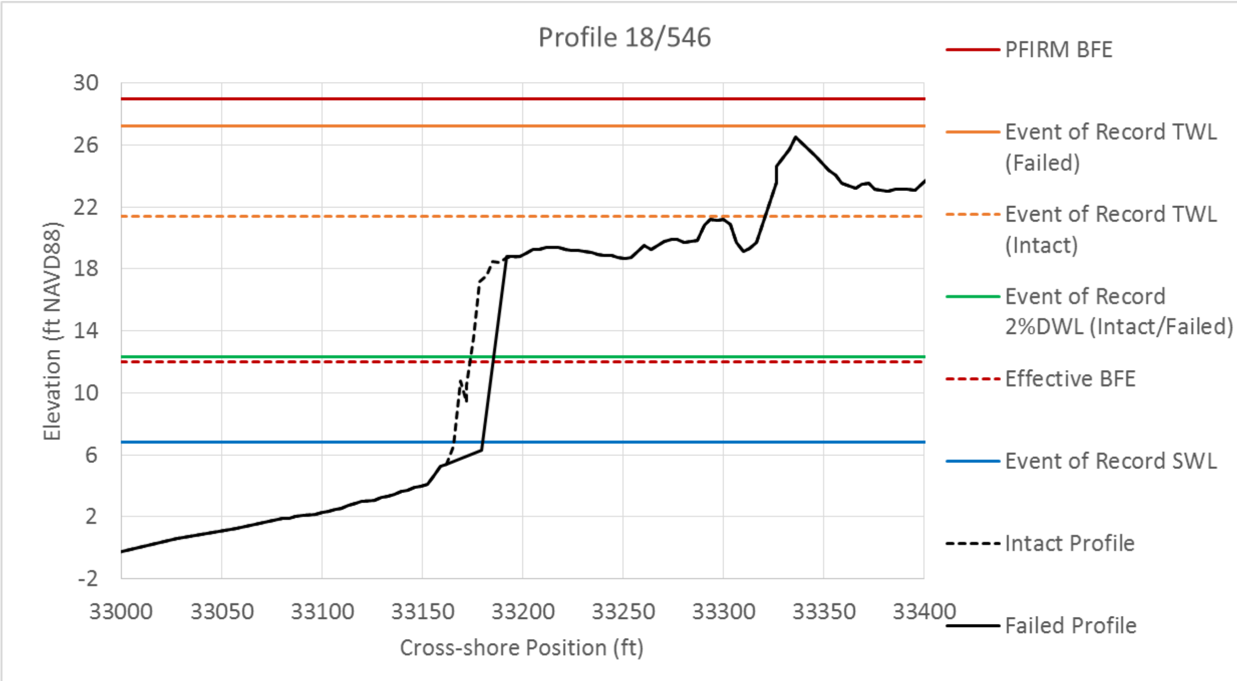

Figure 5-26: Transect 18/546 Profile and Runup Parameters

Transect 19/539 – Potential Overestimation

- BFE (28 ft NAVD88) is greater than the event of record TWL (26.5 ft NAVD88 on 1/18/88).
- SWL of 6.8 ft NAVD88 is the same as Transect 18, H_o of 15.9 ft is very close to Transect 18, and T_p of 15.9 seconds is also the same as Transect 18.
- Wave angle of attack used is acceptable.
- Wet sandy beach backed by a rock revetment, and SWL is above toe; therefore, TAW runup method used is appropriate. Same slope value is used for both structure intact and failed conditions.
- The runup slope consists of a wet sandy foreshore and rock revetment, a composite roughness factor should be assumed which may lower TWLs.
- Coastal structure treatment for the failed condition has significant effect on TWL due to roughness assumptions.
- Complete removal of structure and assuming smooth earthen slope is a poor assumption.
- TWLs could be reduced if a roughness factor was considered for the failed condition. Portions of the failed revetment would remain and contribute to a rougher runup slope. Historical aerial imagery shows the revetment in place in 1972 and current aerial imagery

shows an offshore reef, sand, and the rock revetment along this reach.

- Bore overtopping was calculated and mapped in a secondary VE zone at this transect since inland propagation exceeded 35 ft. If TWLs are reduced, overtopping would be recalculated and as a result, inland propagation and flood depths may be reduced.

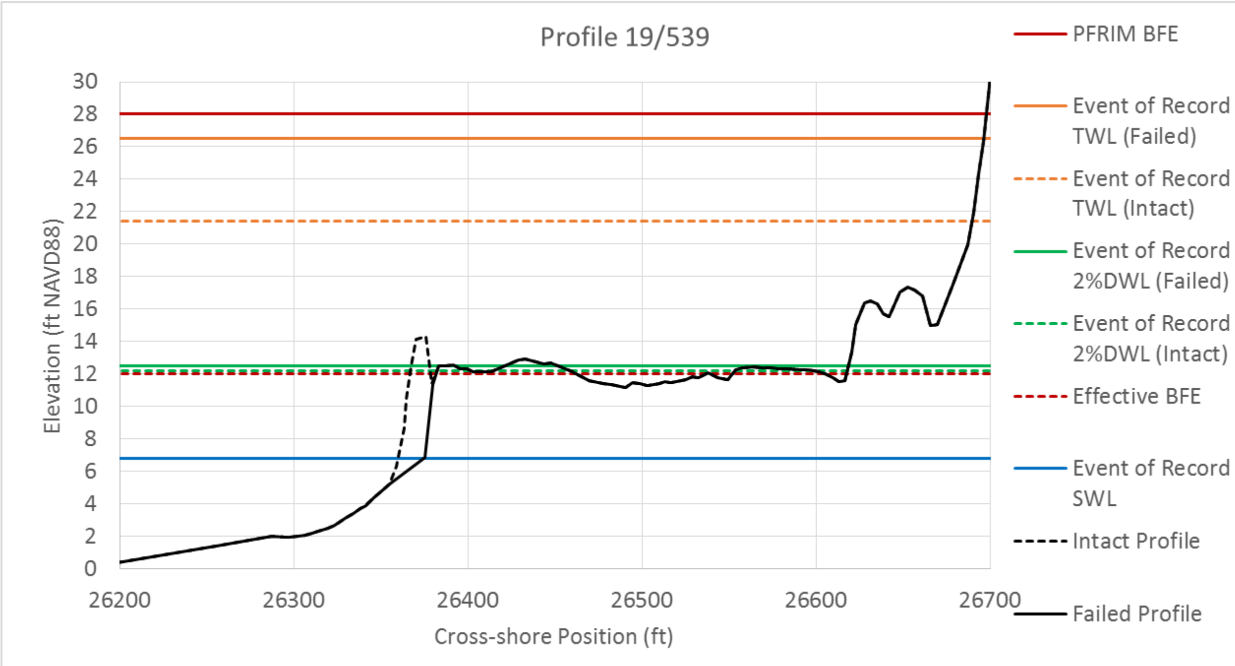

Figure 5-27: Transect 19/539 Profile and Runup Parameters

Transect 20/533 – Potential Overestimation

- BFE (27 ft NAVD88) is greater than the event of record TWL (26.1 ft NAVD88 on 1/18/88).
- Intact and failed structure conditions have different event of record.
- For failed condition analysis, SWL of 6.8 ft is the same as Transect 19, H_o of 16.3 ft is a 3% increase from Transect 19, and T_p of 15.9 seconds is the same as Transect 19.
- Wave angle of attack used is acceptable.
- Wet sandy beach backed by a rock revetment, and SWL is at or above toe. Therefore, TAW runup method used is appropriate. Same slope value is used for both structure intact and failed conditions.
- Coastal structure treatment has significant effect on TWL for the failed condition due to roughness assumptions.
- Complete removal of structure and assuming smooth earthen slope is a poor assumption.
- The structure has survived the event of record.
- TWLs could be reduced if a composite roughness factor was considered for the failed

condition as portions of the failed revetment would remain and contribute to a rougher runup slope. Historical aerial imagery shows the revetment in place in 1972 and current aerial imagery shows an offshore reef, sand, and the rock revetment along this reach.

- Bore overtopping was calculated and mapped in a secondary VE zone at this transect since inland propagation exceeded 35 ft. If TWLs are reduced, overtopping would be recalculated and as a result, inland propagation and flood depths may be reduced.

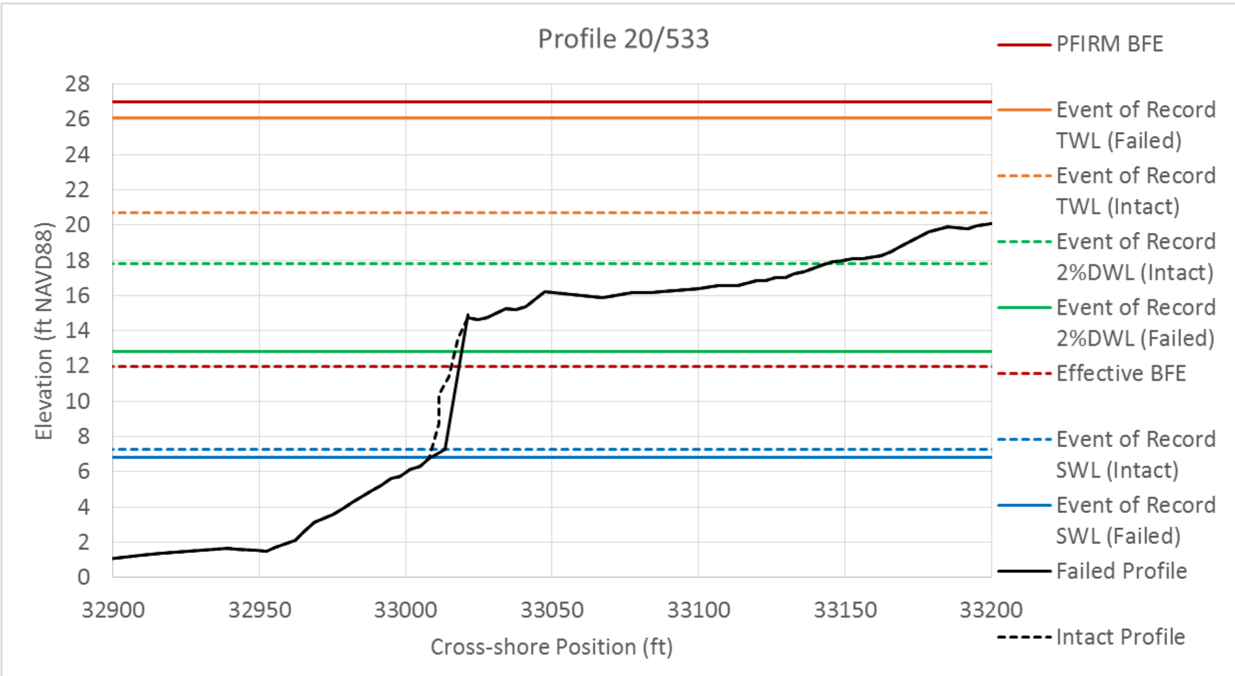

Figure 5-28: Transect 20/533 Profile and Runup Parameters

5.3.2 Recommendations

An appeal may be warranted at Site 3 if the community wishes to challenge the BFEs on the following basis:

Transect 11/568

- A continuous engineered revetment exists at this transect and has survived the event of record as evident by historic aerial imagery. A roughness reduction should be applied to the TWLs for the failed condition.

Considering roughness could reduce the BFE by 10-20% at Transect 11. A lowered BFE would require overtopping to be recalculated and may reduce the depth and extent of the secondary VE zone. Modeling the revetment as intact would provide an additional reduction in the BFE; however, FEMA regulations are stringent and as-built drawings, maintenance records, maintenance plans and other documentation would be required.

Transect 12/567-15/556

- Waves approach these transects at an oblique angle and an appropriate TWL reduction should be considered.

- A non-continuous revetment, offshore reef, and cobble exist along these transects and a composite roughness reduction may be warranted.
- Inconsistent modeling of coastal structures resulted in variable BFEs between these transects, a more uniform approach may alter the BFEs.

Considering these factors could reduce the BFE by 10-30% at Transect 12-15. An appeal could lead to a revised modeling approach of coastal structures along this reach, which may lower some BFEs and increase others. Lowered BFEs would require overtopping to be recalculated and may reduce the depth and extent of the secondary VE zone.

Transect 16/554 & 18/546

- A composite roughness factor should be considered as the beach is backed by a rock revetment.
- Inconsistent modeling of similar beaches (revetment removed in Transect 18 but not Transect 17).

Using a composite roughness factor could reduce the BFE by 10-20% at Transects 16 & 18. An appeal could lead to a revised modeling approach of the revetment along this reach, which may raise the BFE.

Transect 19/539 & 20/533

- A continuous engineered revetment exists at this transect and has survived the event of record as evident by historic aerial imagery. A roughness reduction should be applied to the TWLs for the failed condition.

Using a composite roughness factor could reduce the BFE by 10-20% at Transect 19 & 20. A lowered BFE would require overtopping to be recalculated and may reduce the depth and extent of the secondary VE zone. Modeling the revetment as intact would provide an additional reduction in the BFE; however, FEMA regulations are stringent and as-built drawings, maintenance records, maintenance plans and other documentation would be required.

5.4 Site 4: Pierpont

This site generally shows an increase in BFE by 4 to 7 feet compared to those shown in the effective FIRMs. The change in BFE shown in the preliminary FIRMs (Figure 5-29) do not show the typical increase in wave height observed as one moves from north to south toward Ventura Harbor. The wave runup calculations used elevations and foreshore beach slopes from 2009 LIDAR data that fall within the range of measured geomorphic parameters. The pattern of increasing wave heights used by FEMA at each transect from north to south are consistent with thoseobserved wave patterns; however, the BFE differences are contributed to the use of a single beach slope at each transect extracted from the 2009 LIDAR topography. Typical wave patterns at the site are shown in Figure 5-30, an oblique view of the site is shown in Figure 5-31.

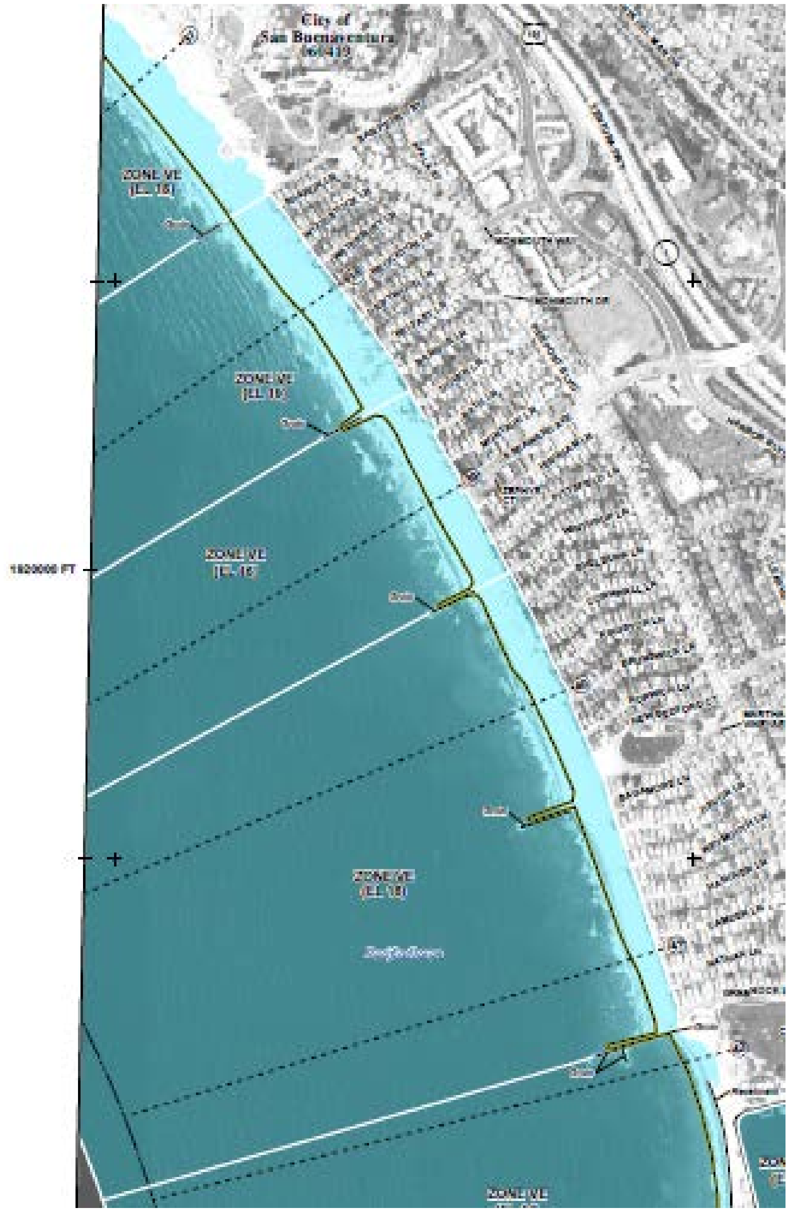

Figure 5-29: Site 4 PFIRM Panel 744F Excerpt (FEMA 2016)

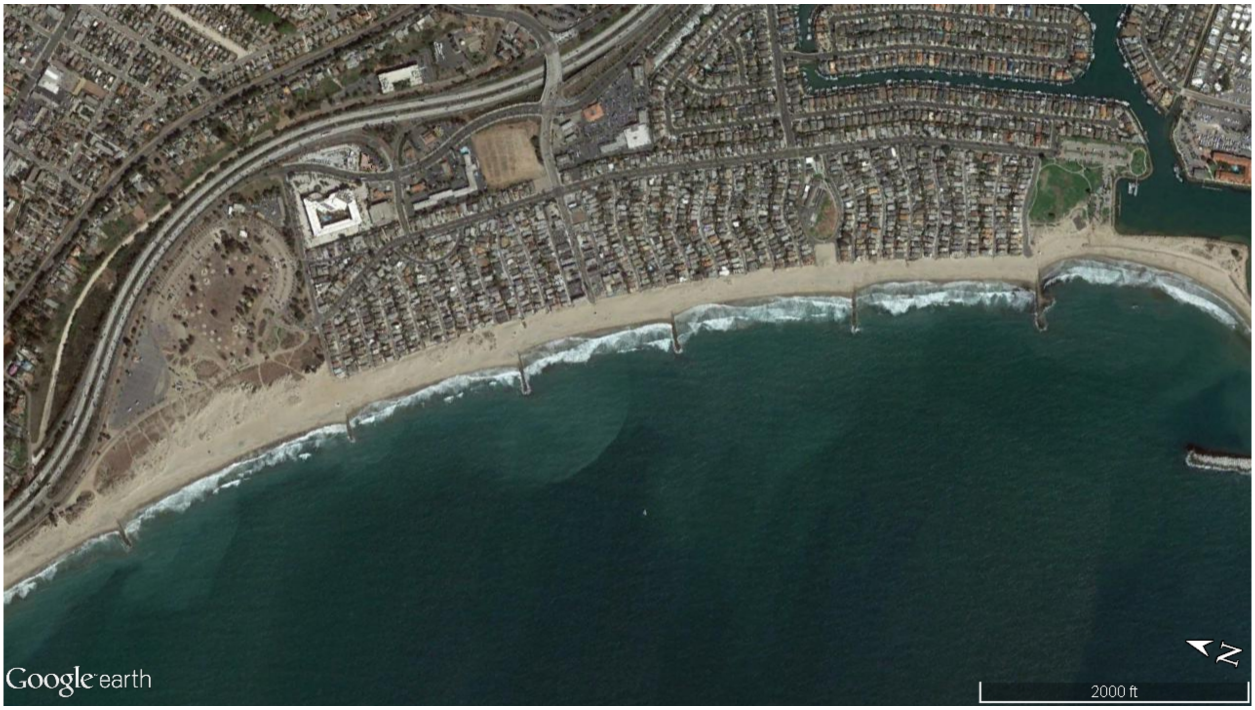

Figure 5-30: Aerial View of Site 4 – Typical Wave Patterns (Google 2016)

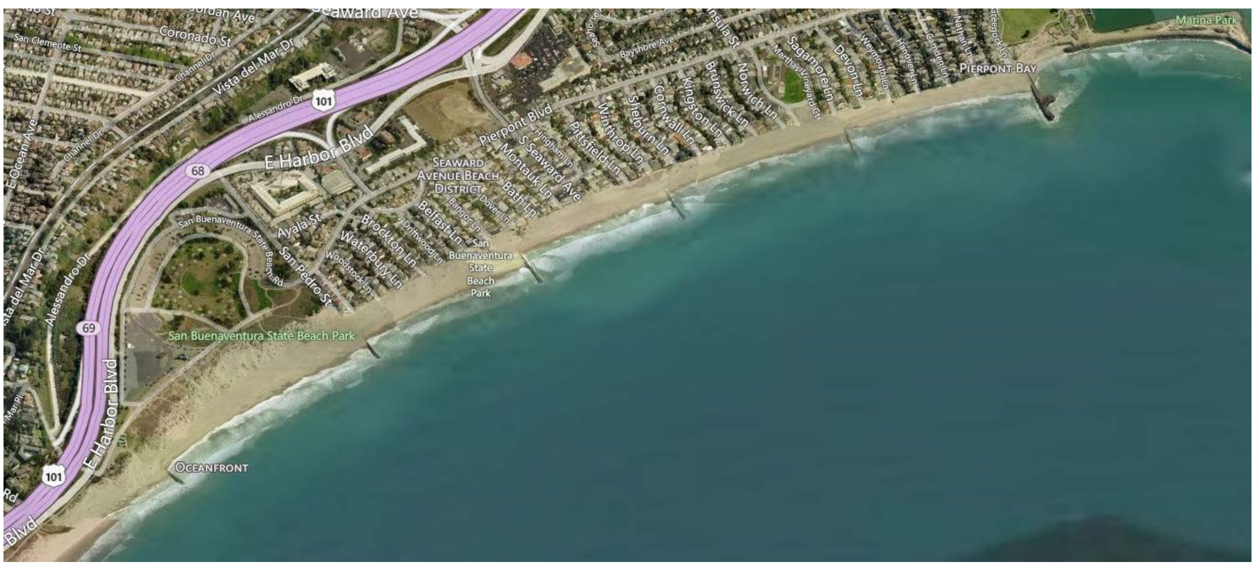

Figure 5-31: Oblique Image at Site 4 (Bing 2017)

5.4.1 Analysis

Geomorphically, the site shows much beach stability due largely to the presence of cross shore groins serving to impound sand in the longshore and stabilize the beach width. These groins are not directly considered in the FEMA transect analysis, but rather indirectly as a result of the overall effect on topography. The topography alone does not capture the beach and geomorphic variability along this site, which is made up of a mixed sand and cobble beach that includes substantial cobbles primarily carried downcoast by waves and nearshore currents from the nearby Ventura River. Cobbles change the behavior of a sandy beach dramatically and can serve to increase friction on bore propagation up the beach and thus decrease wave runup elevations. Any evaluation of MLWP should identify that this beach changes from a sandy beach to a largely cobble beach during the seasonal transition. This seasonal change in roughness would likely reduce the wave runup elevations.

In most of the available topographic LIDAR, the 1997 topography is the widest. The beach widths throughout the 19-year period from 1997 to 2016 with topographic data are all relatively wide and stable (> than 100 feet). Calculations of the MLWP (see Section 4.4) or event-based erosion (see Section 3) that were not completed in accordance with the FEMA Pacific Guidelines, would likely show erosion of these existing dunes and expand the coastal flood extents. In most cases, the 2009 topographic data are higher than the other data sets so dunes at the back of the beach are higher than the preliminary BFEs, which likely limit the landward extent of VE zone.

Specific analysis of each profile is provided in more detail below and summarized in Table 5-1 and a schematic representation of dune features (toe, crest, heel, etc.) is displayed in Figure 5-32.

Table 5-1: Site 4 Runup Parameters Summary Table

Transect No.	Foreshore Beach Slope				Crest Elevation (ft)			Dune Heel Elevation (ft)			
	FEMA Slopes	Avg	Min	Max	Avg	Min	Max	FEMA Elevations	Avg	Min	Max
38	0.096	0.087	0.059	0.117	21.9	20.5	23.0	14.9	13.7	12.3	14.7
39	0.064	0.081	0.062	0.110	15.7	14.7	16.8	14.2	14.8	14.1	15.5
40	0.081	0.081	0.071	0.092	16.7	16.0	18.7	15.4	15.9	15.0	16.5
41	0.078	0.085	0.070	0.102	17.4	16.0	19.0	18.8	16.3	15.9	17.0

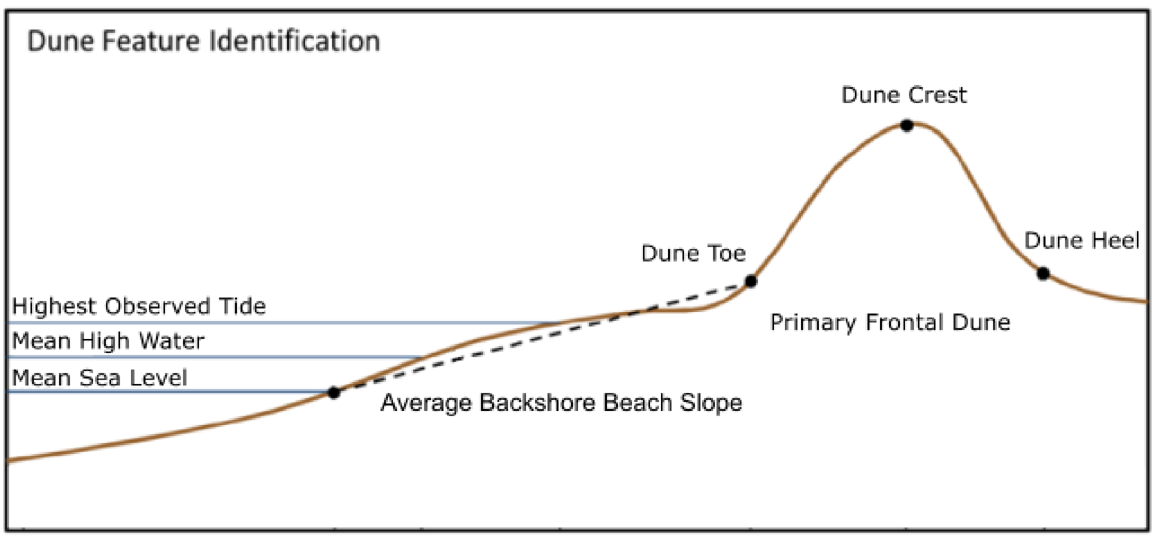

Figure 5-32: Schematic Cross Shore Dune Backed Beach Profile (Modified from FEMA 2016b)

Transect 38/438

Beach and dunes are relatively stable yet variable with dune crests typically at least 3 feet above the preliminary BFE elevation. It is unknown what the potential impact from legally mandated sand management activities are on the long-term stability of the dunes, but vegetative plantings and reduction in sand removal may further reduce the flood extents. If the City-surveyed block wall elevation was included in the bore propagation calculations, then there would likely be a decrease in the landward extent of the VE zone. Cross shore beach profiles at Transect 38 are shown in Figure 5-33.

- PFIRM BFE of 19.3 feet (effective FIRM 12 feet) does not exceed event of record TWL (19.7 feet from 1/18/88).
- Event of record SWL of 6.8 feet, H_o of 15.9 feet, and T_p of 15.9 seconds are the same as adjacent transect 39.
- Beach slope used by FEMA is 0.096. Geomorphic analysis on available topography showed an average beach slope of 0.087 with a range between 0.059 and 0.117.
- Implications of using foreshore beach slopes in the Stockdon runup equation for the storm of record are as follows: TWL is 18.8 feet with average beach slope with a potential BFE ranging from 16.2 to 21.8 feet.
- Bore calculations were completed using a DWL2% over the crest (dune heel) elevation. FEMA used a DWL2% of 16.8 feet and a crest elevation of 14.9. Geomorphic analysis on available topography showed an average crest of 13.7 feet and a range of 12.3 - 14.7 feet. The City of Ventura surveyed Transect 38, which shows a dune heel elevation of 12.8 feet and a block wall crest elevation of 18.7 feet.
- Storm caused changes during the 1997-98 El Niño (October to April):
    - Beach width narrowed by 17 feet
    - Dune erosion of 20 feet measured at the toe and 5 feet at the crest
- Long term changes between 1997 and 2016 included:
    - Beach width (MHW to crest) narrowed by 7 feet
    - MHWs shoreline change eroded by 25 feet
    - Dune increased in elevation by 1.4 feet and migrated landward by 18 feet

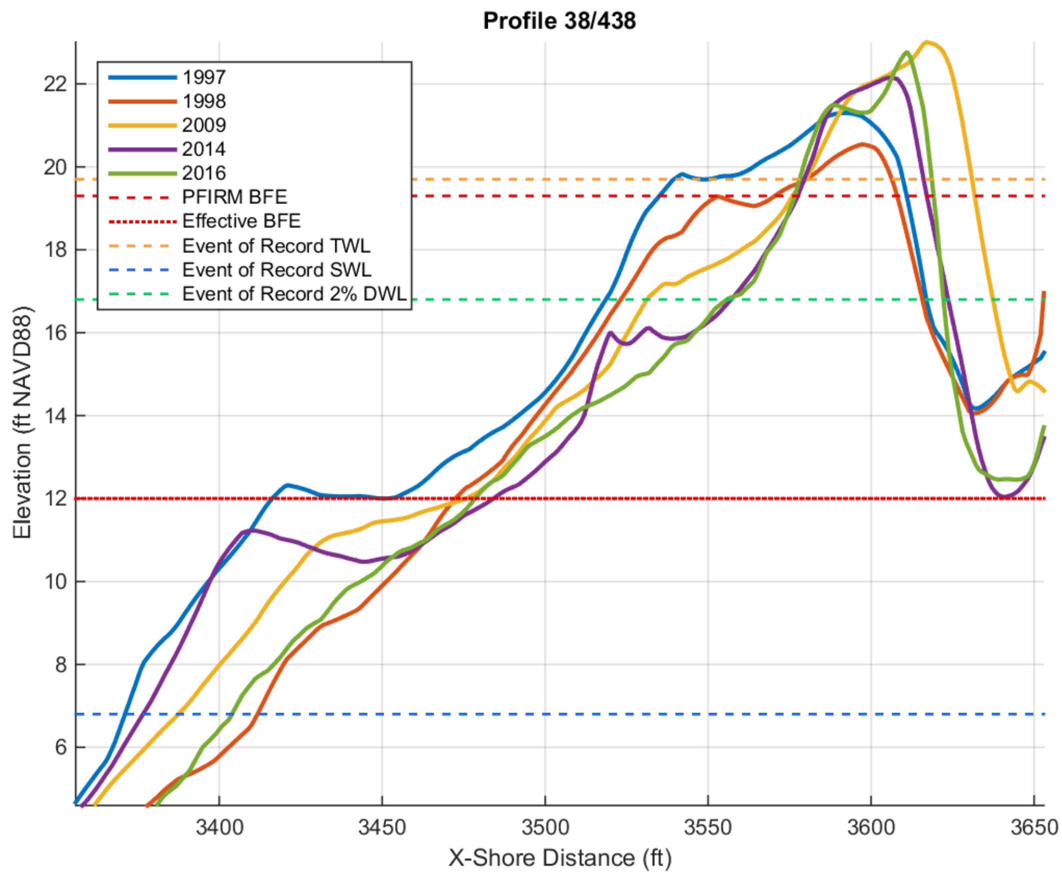

Figure 5-33: Cross Shore Beach Profiles at Transect 38

Transect 39/434

The use of the 2009 LIDAR data is the only topographic data set that captures dune crest elevations in excess of the preliminary BFE as well as the least steep beach slope. Therefore, this 2009 data set may be considered a bit of an outlier. If the 2009 dune crest and foreshore beach slope was not used, then the flood extents shown on the PFIRMs would likely extend farther inland. If the City-surveyed block wall elevation was included in the bore propagation calculations, then there would likely be a substantial decrease in the landward extent of the VE zone. Cross shore beach profiles at Transect 39 are shown in Figure 5-34.

- PFIRM BFE of 16 feet (effective FIRM 12 feet) does not exceed the event of record TWL (16.6 feet from 1/18/88).
- Event of record SWL of 6.8 feet, H_o of 15.9 feet, and T_p of 15.9 seconds are the same as Transect 38, but with a slightly lower wave height than transect 40 with a wave height of 17.2 feet.
- Beach slope used by FEMA was 0.064. Geomorphic analysis on available topography showed an average beach slope of 0.081 with a range between 0.062 and 0.110.
- Implications of using foreshore beach slopes in the Stockdon runup equation for the storm

of record are: TWL is 18.2 feet with the average beach slope with a potential BFE ranges between 16.4 and 21.1 feet.

- Bore calculations were completed using a DWL2% over the crest (dune heel) elevation. FEMA used a DWL2% of 15.0 feet and a crest elevation of 14.2 feet. Geomorphic analysis on available topography showed an average crest of 14.8 feet and a range of 14.1 to 15.5 feet. The City of Ventura surveyed Transect 39 and showed a dune heel elevation of 13.5 feet and a block wall crest elevation of 17.59 feet.
- Storm caused changes during the 1997-98 El Niño (October to April):
  - Beach width narrowed by 43 feet
  - Dune erosion of 41 feet measured at the toe and 4 feet at the crest
- Between 1997 and 2016, the long-term changes were:
  - Beach width (MHW to crest) narrowed by 45 feet
  - MHWs shoreline change eroded by 32 feet
  - Dune eroded in elevation by 0.74 feet and migrated seaward by 13 feet

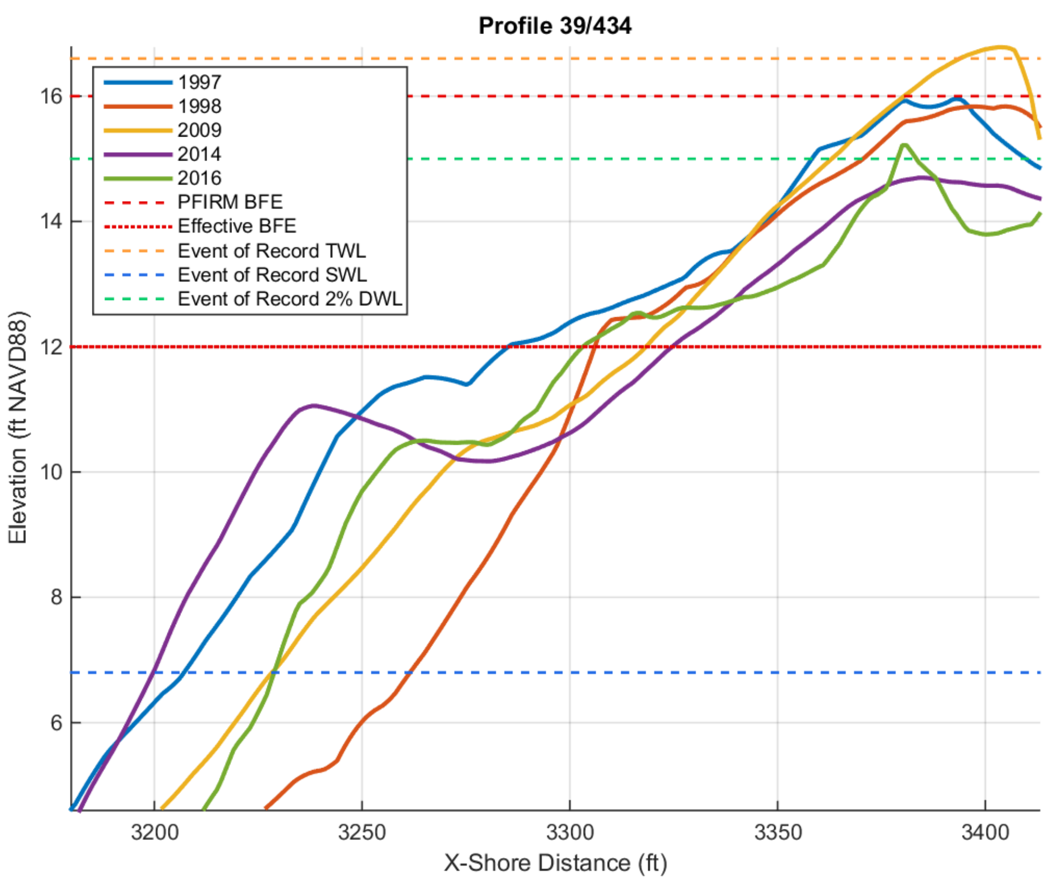

Figure 5-34: Cross Shore Beach Profiles at Transect 39

Transect 40/430

Preliminary FIRM base flood elevation exceeds all dune crests in the historic record except for the 2009 LIDAR data. Cross shore beach profiles at Transect 40 are shown in Figure 5-35.

- PFIRM BFE of 18.4 feet (effective FIRM 12 feet) does not exceed the event of record TWL (18.6 feet from 1/18/88).
- Event of record SWL of 6.8 feet and T_p of 15.9 seconds are the same as the neighboring transects, However, H_o of 17.2 feet is higher than transect 39 and similar to Transect 41.
- Beach slope used by FEMA was 0.081. Geomorphic analysis on available topography showed an average beach slope of 0.082 ranging from 0.071 to 0.092.
- Using foreshore beach slopes in the Stockdon runup equation for the storm of record results a TWL of 18.8 feet with the average beach slope and a potential BFE range between 17.7 and 19.8 feet.
- Bore calculation was completed using a DWL2% over the crest (dune heel) elevation. FEMA used a DWL2% of 16.3 feet and a crest elevation of 15.4. Geomorphic analysis on available topography showed an average crest of 15.9 feet and a range of 15.0 - 16.5 feet. The City of Ventura surveyed Transect 40 and showed a dune heel elevation of 15.5 feet and a house backing the transect.
- Storm caused changes during the 1997-98 El Niño (October to April):
    - Beach width narrowed by 53 feet
    - Dune erosion of 2 feet measured at the toe and 11 feet of erosion of the crest
- Between 1997 and 2016, the long-term changes were:
    - Beach width (MHW to crest) narrowed by 23 feet
    - MHW shoreline change eroded by 50 feet
    - Dune increased in elevation by 0.7 feet and migrated landward by 27 feet

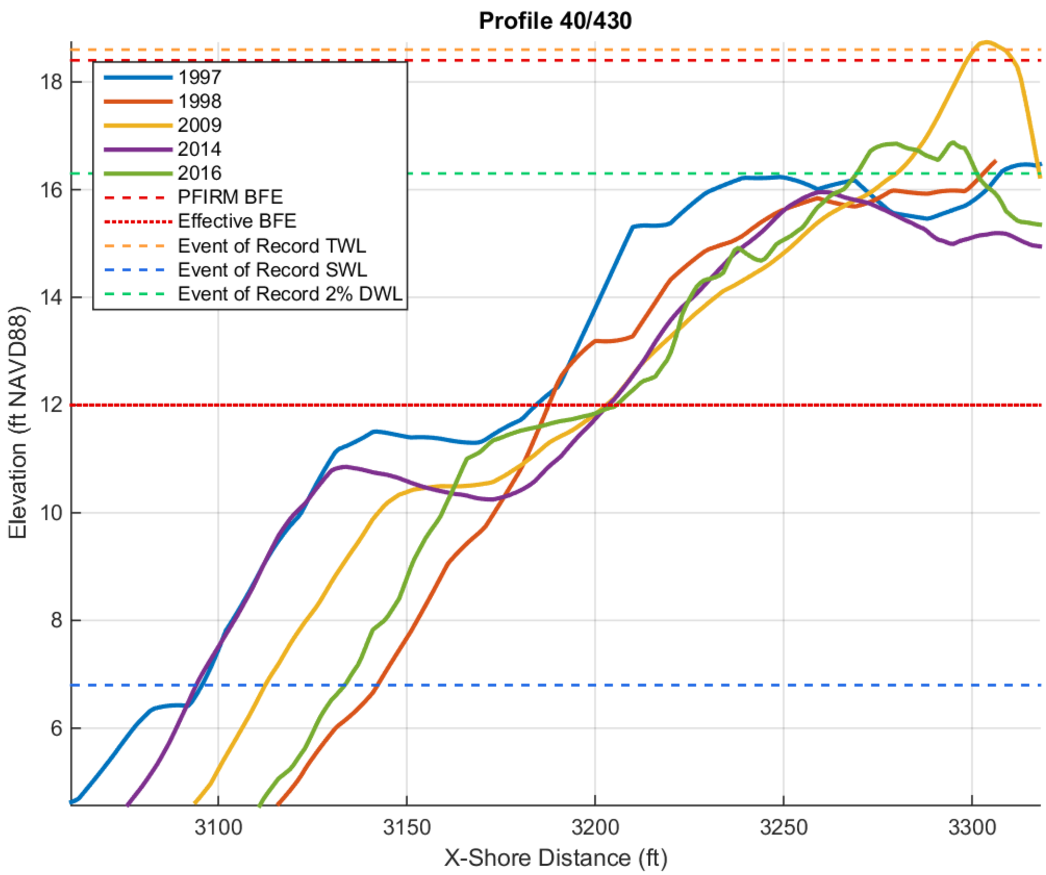

Figure 5-35 : Cross Shore Beach Profiles at Transect 40

Transect 41/426

The beach profile is relatively stable, but dune development is largely constrained inland by the first row of houses, so there is not much protection provided by any dunes. If the City-surveyed block wall elevation was included in the bore propagation calculations, then there would likely be a substantial decrease in the landward extent of the VE zone. Cross shore beach profiles at Transect 41 are shown in Figure 5-36.

- PFIRM BFE of 17.6 feet (effective FIRM 13 feet) does not exceed the event of record TWL (18.4 feet on 1/18/88).
- Event of record SWL of 6.8 feet, H_o of 17.5 feet and T_p of 15.9 seconds are about the same as transect 40, but with a slightly higher wave height.
- Beach slope used by FEMA was 0.078. Geomorphic analysis on available topography showed an average beach slope of 0.085 with a range between 0.070 and 0.102.
- Using foreshore beach slopes in the Stockdon runup equation for the storm of record results a TWL of 19.1 feet with the average beach slope with a potential BFE range between 17.7 and 20.9 feet.
- Bore calculation completed using a DWL2% over the crest elevation. FEMA used a

DWL2% of 16.2 feet and a crest elevation of 18.8. Geomorphic analysis on available topography showed an average crest of 16.3 feet and a range of 15.9 - 17.0 feet. The City of Ventura surveyed Transect 41 and showed a dune heel elevation of 17.3 feet and a block wall crest elevation of 20.21 feet.

- Storm caused changes during the 1997-98 El Niño (October to April):
  - Beach width narrowed by 30 feet.
  - Dune erosion of 19 feet was measured at the toe
- Between 1997 and 2016, the long-term changes were:
  - Beach width (MHW to crest) widened by 8 feet
  - MHWs shoreline change accreted by 9 feet

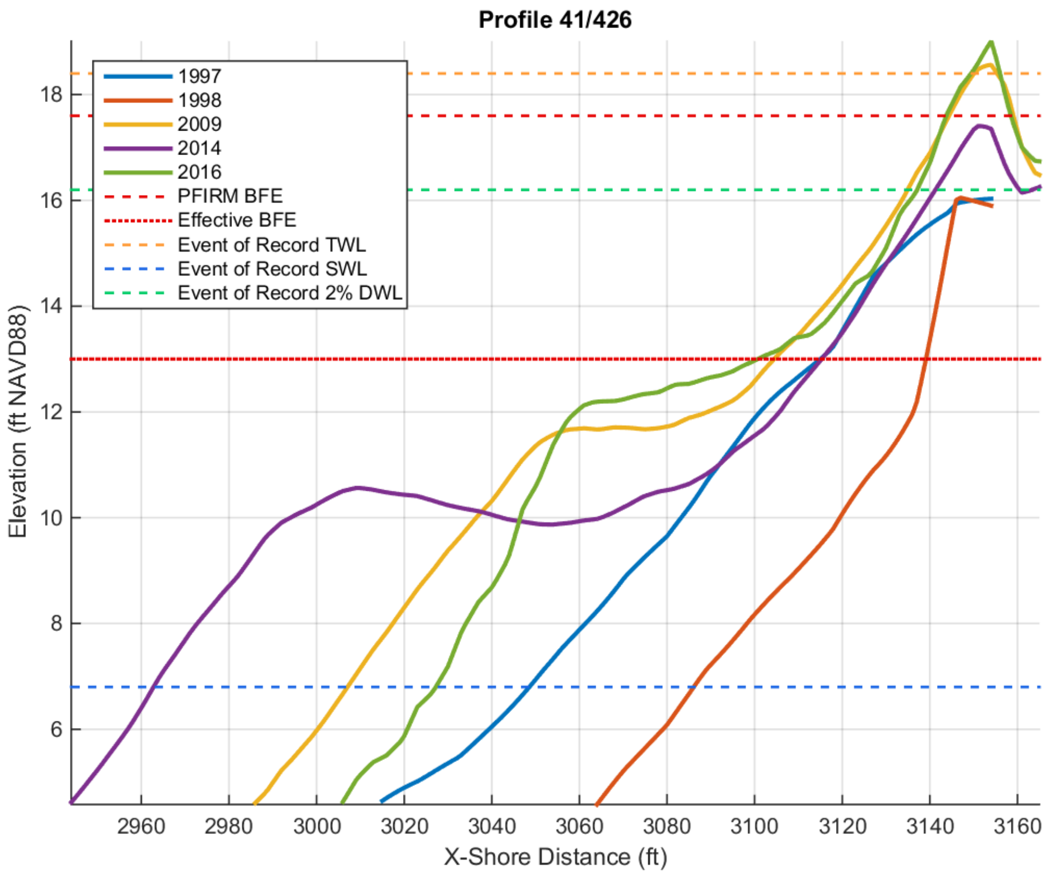

Figure 5-36: Cross Shore Beach Profiles at Transect 41

5.4.2 Recommendation

An appeal may be warranted at Site 4 if the community wishes to challenge the BFEs, on the basis that the analysis of the overland bore propagation may mischaracterize the elevation of the back of the beach wall, and thus the volume of water (DWL2% - back beach elevation), which would contribute to the bore propagation caused flooding. However, certification of wall regulations are stringent. As-built drawings, maintenance records, maintenance plans and other documentation would be required to initiate this process. In addition, the analysis of a MLWP should highlight that there is a substantial cobble component in the beach that would reduce wave runup if friction were properly considered in the wave runup analyses.

However, the FEMA methodology as applied failed to conduct any dune erosion calculations or identify any PFDs, which, if considered, would likely increase the extent of the flood extents and may serve to increase the BFE. The use of any topographic data other than the 2009 data set may also show beaches with lower elevations at the back of the beach and further escalate the landward extent of coastal flooding. Observations of the coastal flooding from the December 11, 2015 storm event exceed the PFIRM mapped VE extents. Additional study and calculations will be required for any appeal process.

5.5 Site 5: Oxnard Shores

The preliminary FIRMs (Figure 5-37 through Figure 5-39) show a substantial increase between 5 and 8 feet in BFE compared to effective FIRMs with a BFE of 13 feet. The increase varies alongshore with the largest increase at Transect 50 of 8.3 feet. Adjacent transects show substantial variability with a 3-foot difference between Transects 50 and 51. Across this site, there are differences in storm events, differences in the wave period and still water level used from the same storm event, as well as geomorphic variability in beach slopes through which subtle differences affect wave runup elevations. These differences are highlighted by individual transects below and explain the ranges in preliminary BFEs. In the residential development along Oxnard Shores, these distinct differences in the BFE make future planning and permitting decisions difficult.

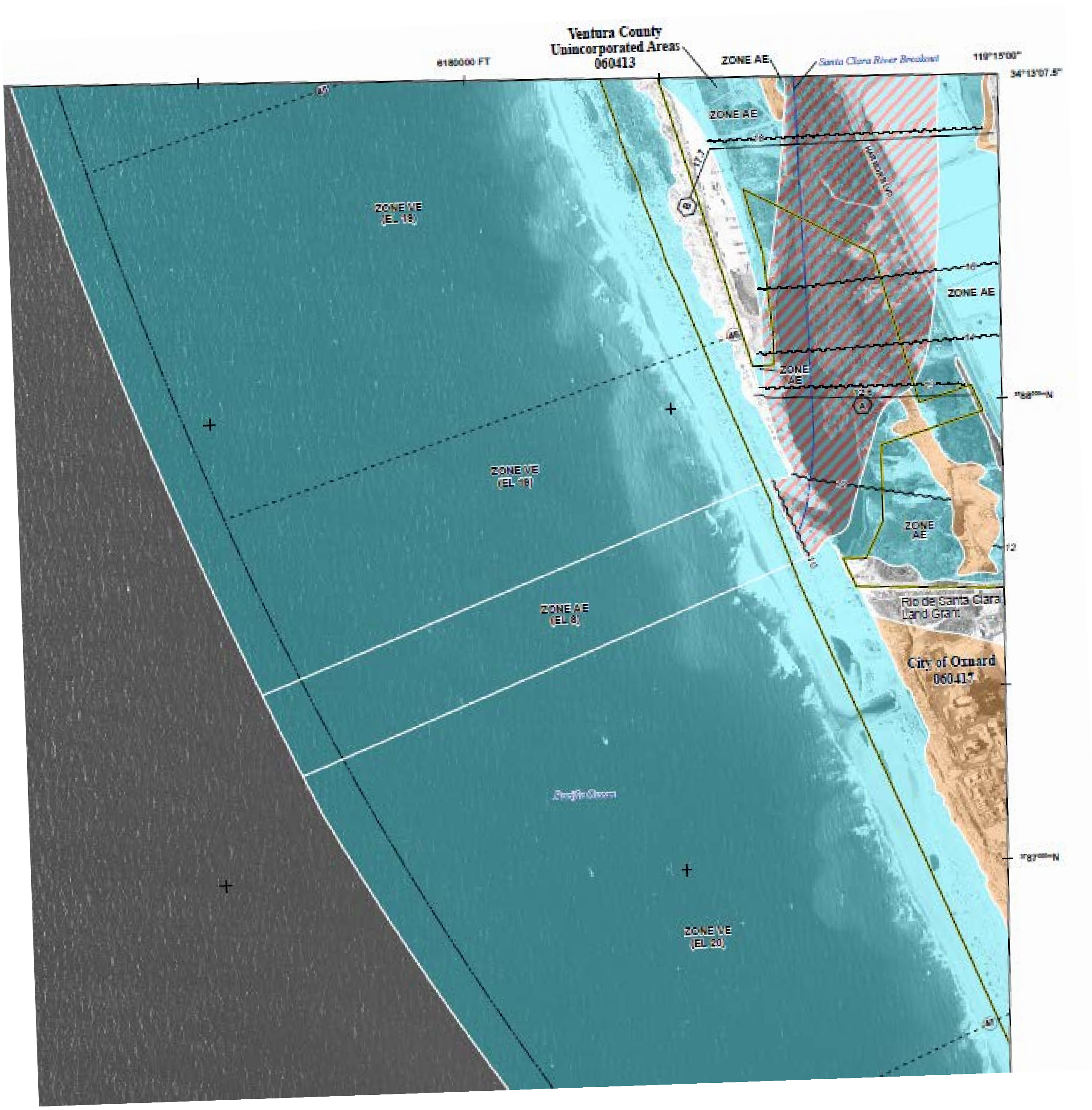

Figure 5-37: Site 5 PFIRM Panel 884F & 903F Excerpt (FEMA 2016)

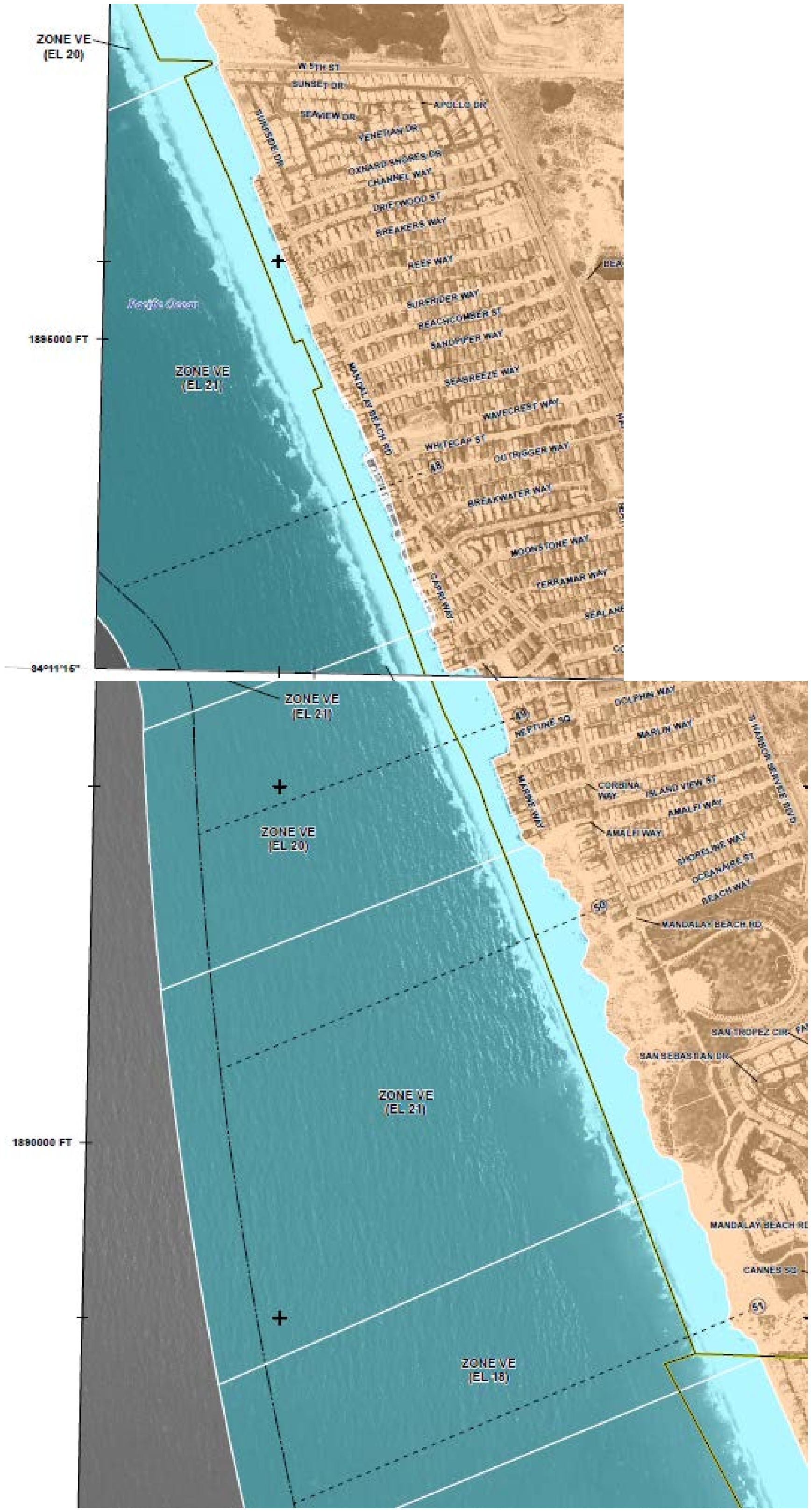

Figure 5-38: Site 5 PFIRM Panel 903F & 911F Excerpt (FEMA 2016)

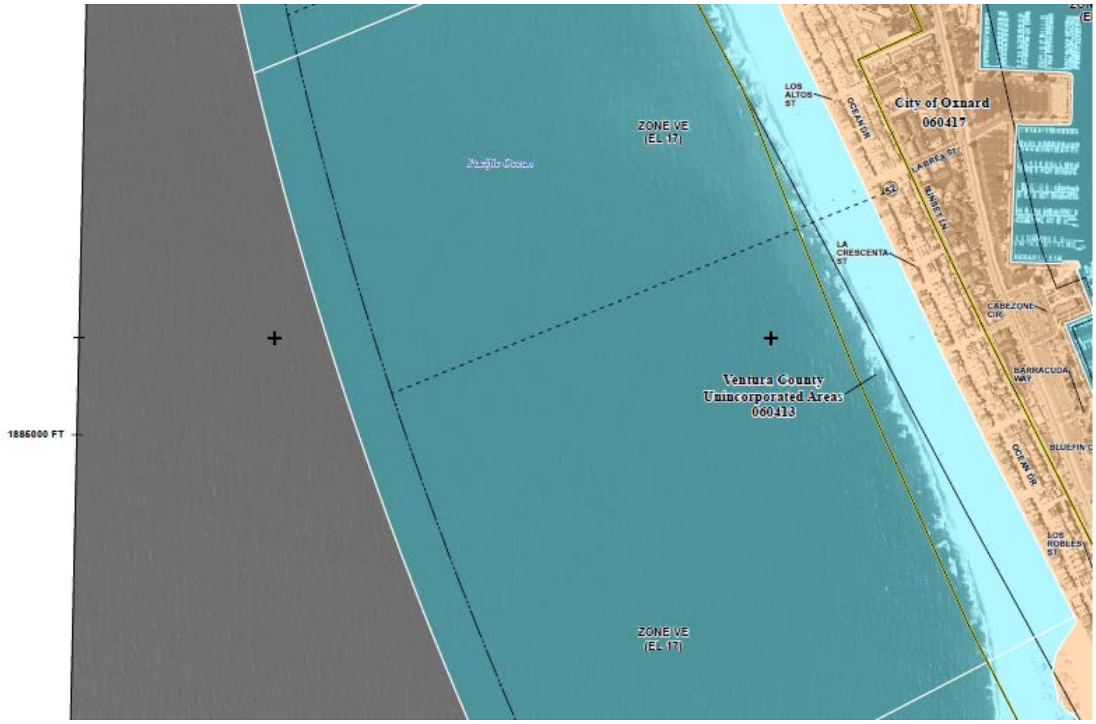

Figure 5-39: Site 5 PFIRM Panel 911F Excerpt (FEMA 2016)

The Oxnard shores study site has a similar shoreline orientation throughout between the Santa Clara River and the Channel Islands Harbor. Wave observations and wave model outputs have shown some gradients in wave heights with larger waves in the north near the Santa Clara River (Transects 46 and 47) decreasing to the south (Transect 52). Overall, this pattern of wave heights is not captured in the storm of record TWL data used in the FEMA analysis. The FEMA TWL data shows the highest waves at Transect 50. One storm of record from 1/18/1988 uses different wave periods and still water levels for the same event on the same day. Typical wave patterns at the site are shown in Figure 5-40, and an oblique view of the site is shown in Figure 5-41.

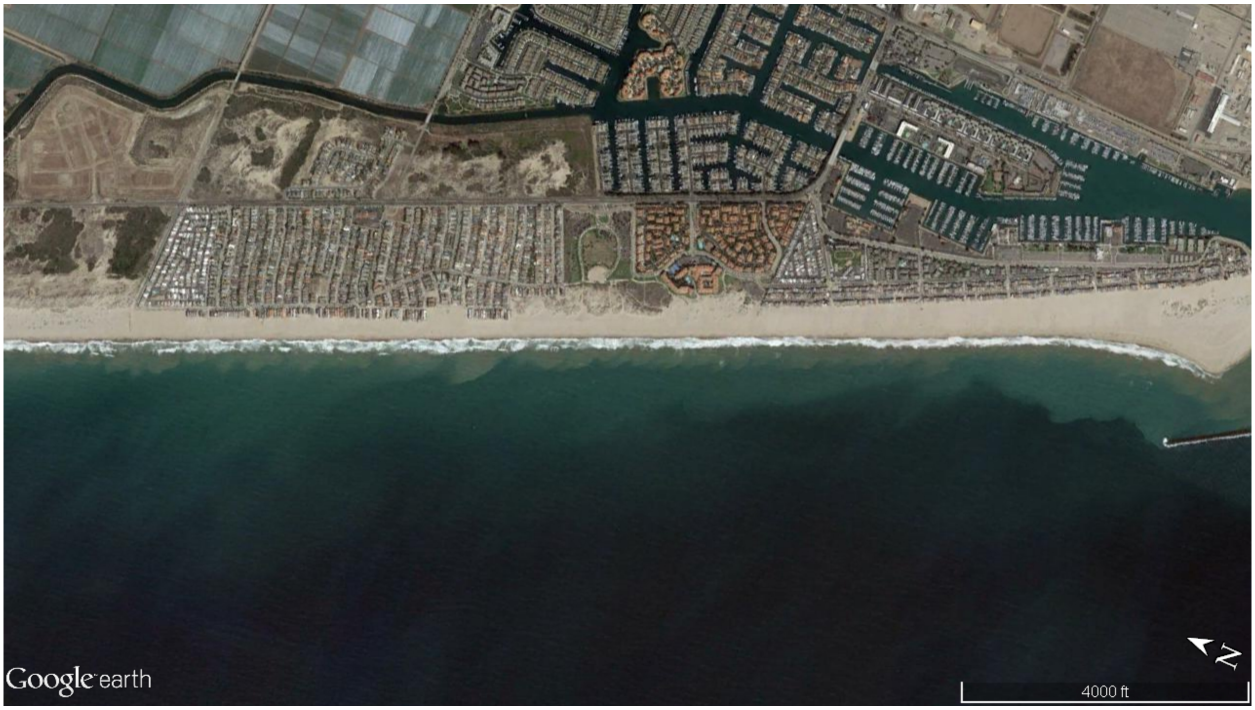

Figure 5-40: Aerial View of Site 5 – Typical Wave Patterns (Google 2015)

Figure 5-41: Oblique Image at Site 5 (Bing 2017)

Geomorphically, this site/shoreline segment is largely controlled by sediment impounded updrift to the north of the Channel Islands Harbor and augmented by episodic discharges from the Santa Clara River. The transect-based analysis used by FEMA does not consider the widening of the beach caused by the changes in dredge volumes and frequency, instead relying solely on a single topographic data set collected in November 2009. Most of the beaches have widened since that time, as evidenced by subsequent topographic data collection. Beach slopes are largely controlled by sediment grain size and are variable and similar throughout the site. The range in beach slopes is from 0.05 to 0.13. This variability alone and its effect on wave runup calculations can affect the wave runup elevations by 8 feet and may be the single most important variable to consider. All the slopes used by FEMA in this analysis however fall within the range of beach slopes observed for each transect.

This area also highlights the deficiencies in the methodology used to generate the PFIRMs that is outlined in the FEMA Pacific Guidelines. The calculation of the MLWP to adjust the slope followed by applying the event based erosion methodology to determine whether the dune may be breached and expose more of the low lying coastal areas to flooding was not implemented before running the wave runup analyses. The limitation of the method likely under predicts potential flood elevations and extents, particularly in areas where there are dunes fronting the developments.

Specific analysis of each profile is provided in more detail below and summarized in Table 5-2.

5.5.1 Analysis

Table 5-2: Site 5 Runup Parameters Summary Table

Transect No.	Foreshore Beach Slope				Crest Elevation (ft)			Dune Heel Elevation (ft)			
	FEMA Slopes	Avg	Min	Max	Avg	Min	Max	FEMA Elevations	Avg	Min	Max
47	0.100	0.072	0.048	0.102	32.5	32.1	32.8	23.0	13.9	13.7	14.2
48	0.102	0.072	0.046	0.105	18.2	16.7	20.9	16.7	16.3	15.7	17.0
49	0.096	0.096	0.077	0.131	17.4	16.6	18.5	15.0	16.1	15.0	17.8
50	0.106	0.084	0.060	0.106	27.2	23.7	31.0	27.5	19.1	18.6	19.5
51	0.094	0.067	0.041	0.096	24.1	23.5	25.1	26.0	21.4	20.3	22.5
52	0.081	0.096	0.084	0.107	16.8	15.8	18.0	13.8	13.6	13.4	14.0

Transect 47/359

This transect is dune backed and shows relatively natural conditions along the site. Dunes are well developed with high dune toe elevations and dune crests greater than the preliminary FIRM base flood elevation. While there are is a bore propagation calculation conducted, without application of the MLWP and dune erosion methodology, this bore calculation is not particularly useful at this site, and may under predict the extent of the hazards at the site. Cross shore beach profiles at Transect 47 are shown in Figure 5-42.

- PFIRM BFE of 20.1 feet (effective FIRM 13 feet) does not exceed the event of record TWL (20.4 feet from 1/18/88).
- Event of record SWL of 6.8 feet, H_o of 20.4 feet and T_p of 14.4 seconds are similar to adjacent Transect 46; however, the period drops compared to Transect 48 to the south and Transect 45 to the north for the same storm event. It is strange that the record wave event period changed between neighboring transects for the same event on a nearly uniform stretch of coast. No detailed information or rationale is available for further analysis.
- Beach slope used by FEMA was 0.10. Geomorphic analysis on available topography showed an average beach slope of 0.072 with a range between 0.048 and 0.102.

- Using foreshore beach slopes in the Stockdon runup equation for the storm of record resulted a TWL of 17.6 feet with the average beach slope and a potential BFE range of 15.4 to 20.6 feet. The implication on runup from the storm of record using Stockdon with the same wave period as adjacent transects and the average beach slope is a TLW of 18.8 feet with a potential range of 16.3 to 22.1 feet.
- Bore calculation completed using a DWL2% over the crest elevation. FEMA used a DWL2% of 17.3 feet and a crest elevation of 23.0 feet. Geomorphic analysis on available topography showed an average crest of 13.9 feet and a range of 13.7-14.2 feet. This is a large natural dune system and the heel of the dune extends farther inland than that shown by FEMA.
- Storm caused changes during the 1997-98 El Niño (October to April):
    - Beach width narrowed by 71 feet
    - Dune did not erode
- Between 1997 and 2016, the long-term changes were:
    - Beach width (MHW to crest) widened by 137 feet
    - MHW shoreline change accreted by 138 feet
    - Dune was stable

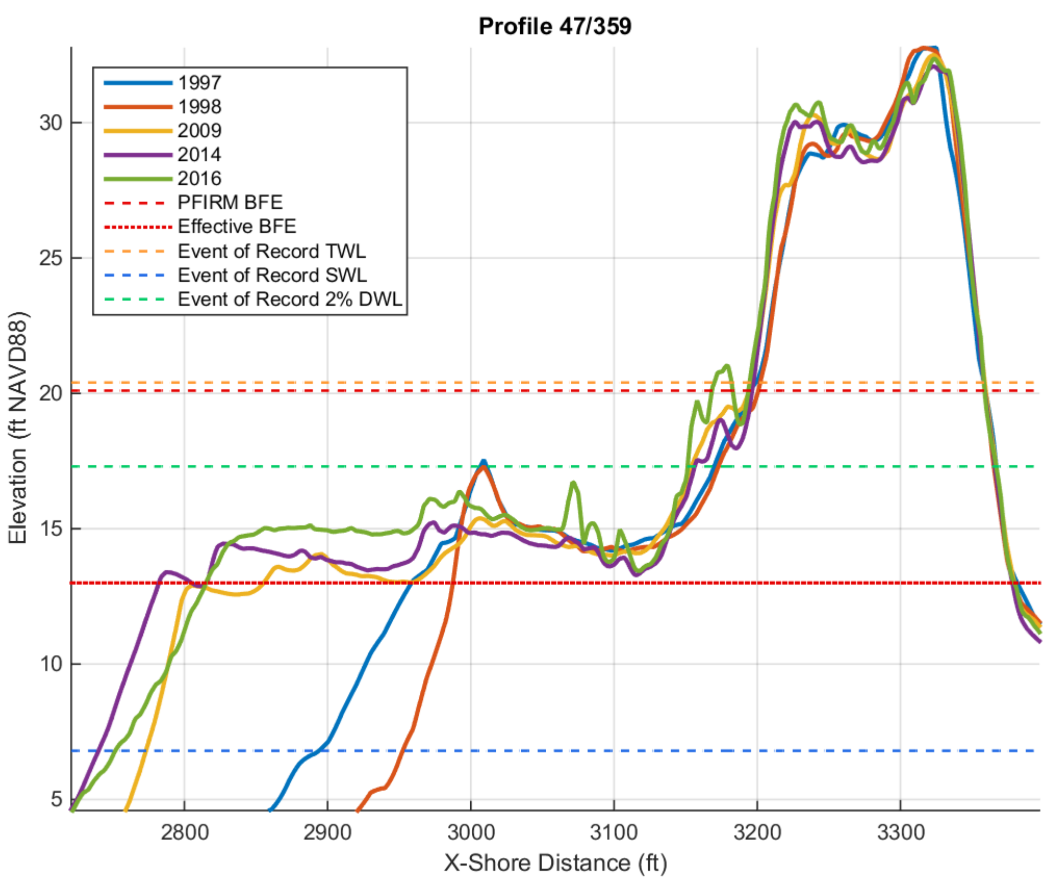

Figure 5-42: Cross Shore Beach Profiles at Transect 47

Transect 48/347

This location has had a relatively flat beach with low lying dune topography that was likely maintained by beach grooming. However, since 2009, the beach has widened, likely as a result in a decline in the dredging volumes and frequency at downcoast Channel Islands. A new dune measured in 2016 has grown to the approximate elevation of the PFIRM base flood elevation. Cross shore beach profiles at Transect 48 are shown in Figure 5-43.

- PFIRM BFE of 20.6 feet (effective FIRM 13 feet) does not exceed the event of record TWL (21.9 feet from 1/18/88).
- Event of record SWL of 6.8 feet, H_o of 20.2 feet, and T_p of 15.9 second are similar to adjacent transects with the wave period increasing to similar magnitude as the Pierpont transects. It is strange that the record wave event period changed between neighboring transects for the same event on a nearly uniform stretch of coast. No detailed information is available for further analysis.
- Beach slope used by FEMA was 0.102. Geomorphic analysis on available topography showed an average beach slope of 0.072 and a range between 0.046 - 0.105.
- Using foreshore beach slopes in the Stockdon runup equation for the storm of record showed a TWL of 18.6 feet with the average beach slope and a potential BFE range of 16.1 – 22.3 feet.
- Bore calculation completed using a DWL2% over the crest elevation. FEMA used a DWL2% of 18.5 feet and a crest elevation of 16.7. Geomorphic analysis on available topography showed an average crest of 16.3 feet and a range of 15.7 - 17.0 feet.
- Storm caused changes during the 1997-98 El Niño (October to April):
  - Beach width widened by 62 feet
  - Dune erosion of 21 feet measured at the toe
- Between 1997 and 2016, the long-term changes were:
  - Beach width (MHW to crest) narrowed by 33 feet
  - MHWs shoreline change accreted by 142 feet
  - New dune grew in elevation by 6.5 feet and was located seaward of previous dune by 175 feet

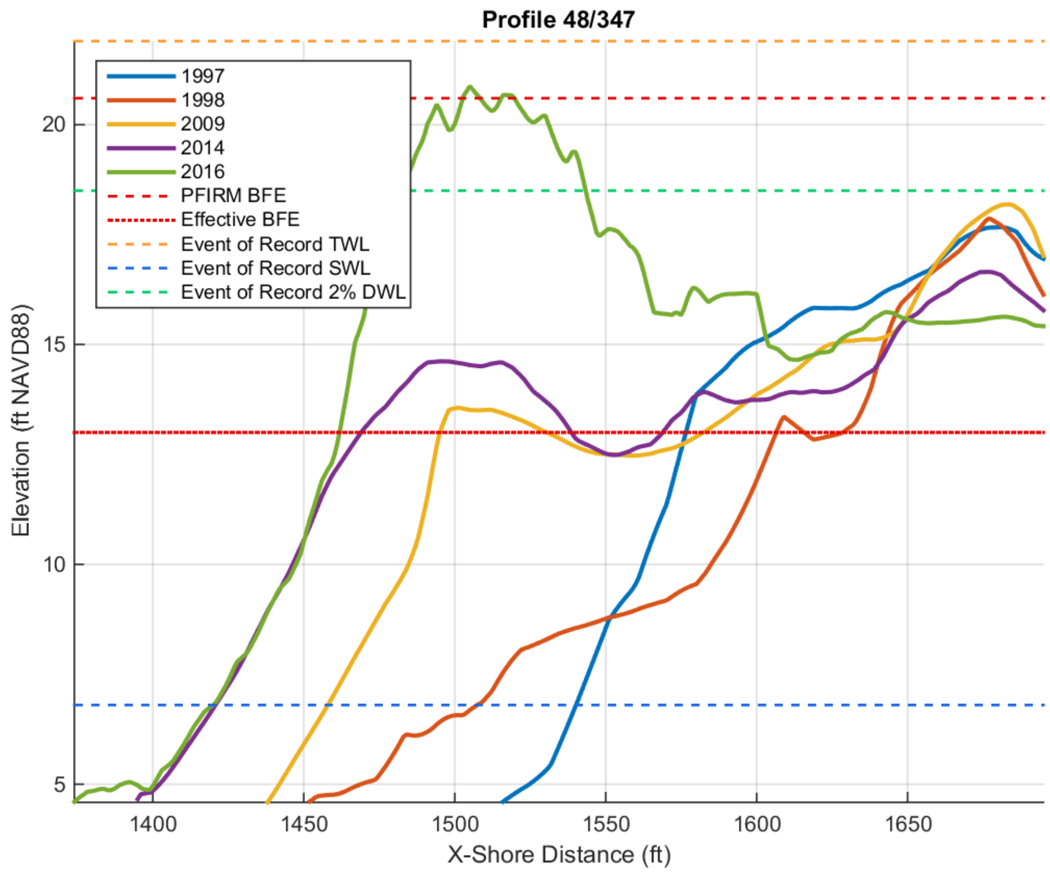

Figure 5-43: Cross Shore Beach Profiles at Transect 48

Transect 49/342

This profile is relatively stable with an overall widening of the beach over time, largely affected by the impoundment of sand updrift of the Channel Islands Harbor and the decline in dredge frequency and volumes. All the dune crest elevations are 2+ feet below the PFIRM base flood elevation. Cross shore beach profiles at Transect 49 are shown in Figure 5-44.

- PFIRM BFE of 20.1 feet (effective FIRM 13 feet) does not exceed the event of record TWL (21.4 feet 1/18/88).
- Event of record SWL of 6.8 feet, H_o of 20.5 feet and T_p of 15.9 seconds are similar to adjacent transects,
- Beach slope used by FEMA was 0.096. Geomorphic analysis on available topography showed an average beach slope of 0.096 range with a range between 0.077 and 0.131.
- Implications of using foreshore beach slopes in the Stockdon runup equation for the storm of record are a TWL of 21.4 feet with the average beach slope and a potential BFE range of 19.3 to 25.5 feet.
- Bore calculation completed using a DWL2% over the crest elevation. FEMA used a DWL2% of 18.2 feet and a crest elevation of 15.0. Geomorphic analysis on available topography showed an average crest of 16.1 feet and a range of 15.0 - 17.8 feet.

- Storm caused changes during the 1997-98 El Niño (October to April):
  - o Beach width narrowed by 24 feet
  - o Dune erosion of 58 feet measured at the toe
- Between 1997 and 2016, the long-term changes were:
  - o Beach width (MHW to crest) widened by 125 feet
  - o MHWs shoreline change widened by 163 feet
  - o Dune increased in elevation by 1.1 feet and migrated seaward by 38 feet

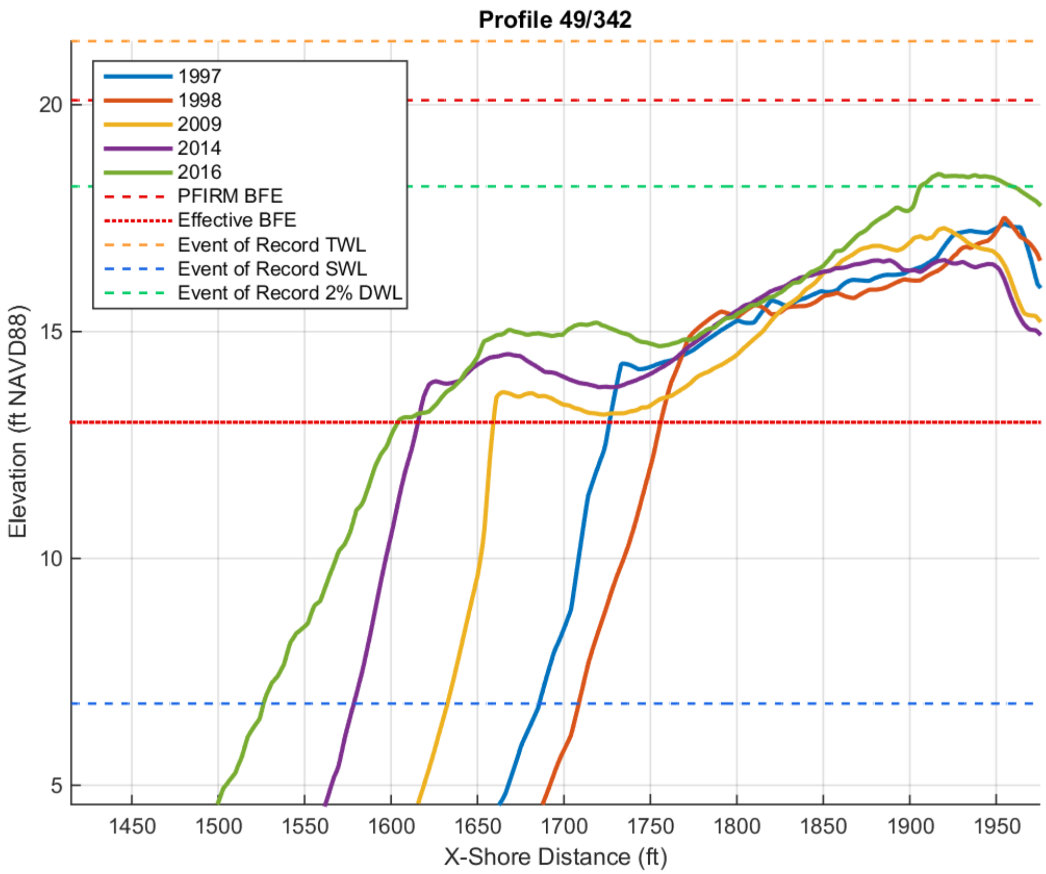

Figure 5-44: Cross Shore Beach Profiles at Transect 49

Transect 50/338

This transects fronts the Mandalay Beach resort and has a relatively well established dune field fronting it with dune crests at least 10+ feet above flood elevations. Since 2009, the beach has widened as a result of changes to the Channel Islands Harbor dredge volumes and frequency. Without application of the MLWP and dune erosion methodology, the bore calculation is not particularly useful and the preliminary BFE may under predict the extent of coastal flooding. Cross shore beach profiles at Transect 50 are shown in Figure 5-45.

- PFIRM BFE of 21.3 feet (effective FIRM 13 feet) does exceed the event of record TWL (22.7 feet from 1/18/88).

- Event of record SWL is 6.5 feet. This SWL is offset by an hour with the adjacent two north transects, H_o of 21.6 feet and T_p of 15.9 seconds are greater than transects to the north and south. It is strange that the record wave event period and wave height changed between neighboring transects for the same event on a nearly uniform stretch of coast. No detailed information or rationale is available for further analysis.
- Beach slope used by FEMA was 0.106. Geomorphic analysis on available topography showed an average beach slope of 0.084 and a range between 0.060 - 0.106.
- Implications of using foreshore beach slopes in the Stockdon runup equation with the storm of record shows TWLs as follows: average beach slope 20.1 feet with a potential BFE range of 17.5 - 22.7 feet.
- Bore calculation completed using a DWL2% over the crest elevation. FEMA used a DWL2% of 18.8 feet and a crest elevation of 27.5 feet. Geomorphic analysis on available topography showed an average crest of 19.1 feet and a range between 18.6 - 19.5 feet.
- Storm caused changes during the 1997-98 El Niño (October to April):
  - Beach width widened by 40 feet
  - Dune erosion of 5 feet measured at the toe
- Between 1997 and 2016, the long-term changes were:
  - Beach width (MHW to crest) widened by 151 feet
  - MHWs shoreline change accreted by 159 feet
  - Dune increased in elevation by 7.3 feet and migrated seaward by 8 feet

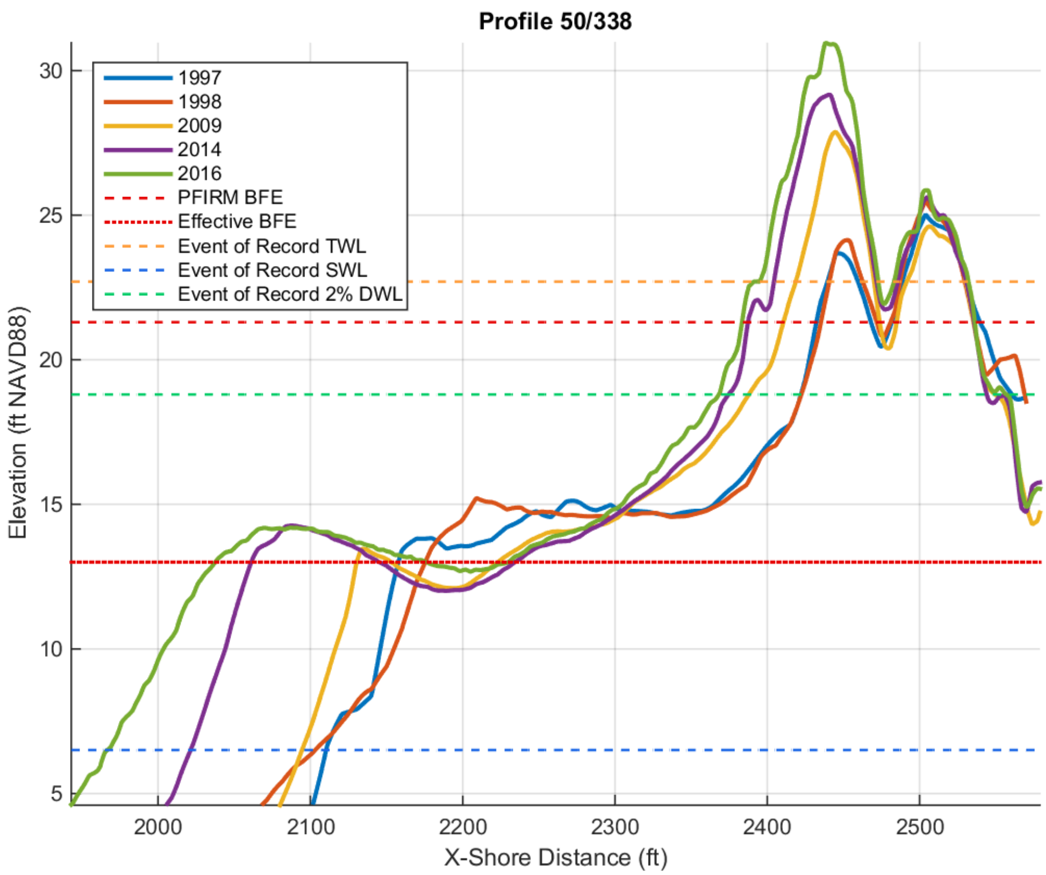

Figure 5-45: Cross Shore Beach Profiles at Transect 50

Transect 51/ 330

This profile near Mandalay Beach resort shows a wide beach with a relatively stable set of dunes well in exceedance of the preliminary BFEs. The transect has shown progressive widening of the beach and dune system, potentially as a result of dredge changes at nearby Channel Islands Harbor. Without application of the MLWP and dune erosion methodology, the bore calculation is not particularly useful and the preliminary BFE may under predict the extent of coastal flooding. Cross shore beach profiles at Transect 51 are shown in Figure 5-46.

- PFIRM BFE (18.3 feet) (effective FIRM 13 feet) is the same as the event of record TWL (18.3 feet from 3/02/83).
- Event of record SWL of 5.7 feet, H_o of 12.9 feet and T_p of 17.5 second is much different than adjacent Transect 50 to the north but consistent with the adjacent Transect 52 to the south. It is strange that the record wave event period changed between neighboring transects for the same event on a nearly uniform stretch of coast. No detailed information is available for further analysis.
- Beach slope used by FEMA was 0.094. Geomorphic analysis on available topography showed and average beach slope of 0.067 range was 0.041 - 0.096.
- Implications of using foreshore beach slopes in the Stockdon runup equation with the storm of record are: a TWL of +15.7 feet with the average beach slope and a potential

BFE range of 13.4 - 18.4 feet.

- Bore calculation completed using a DWL2% over the crest elevation. FEMA used a DWL2% of +18.3 feet and a crest elevation of 26.0. Geomorphic analysis on available topography showed an average crest of 21.4 feet and a range of 20.3 - 22.5 feet.
- Storm caused changes during the 1997-98 El Niño (October to April):
  - o Beach width narrowed by 12 feet
  - o Dune was stable
- Between 1997 and 2016, the long-term changes were:
  - o Beach width (MHW to crest) widened by 123 feet
  - o MHWs shoreline change accreted by 157 feet
  - o Dune increased in elevation by 1.5 feet and migrated seaward by 34 feet

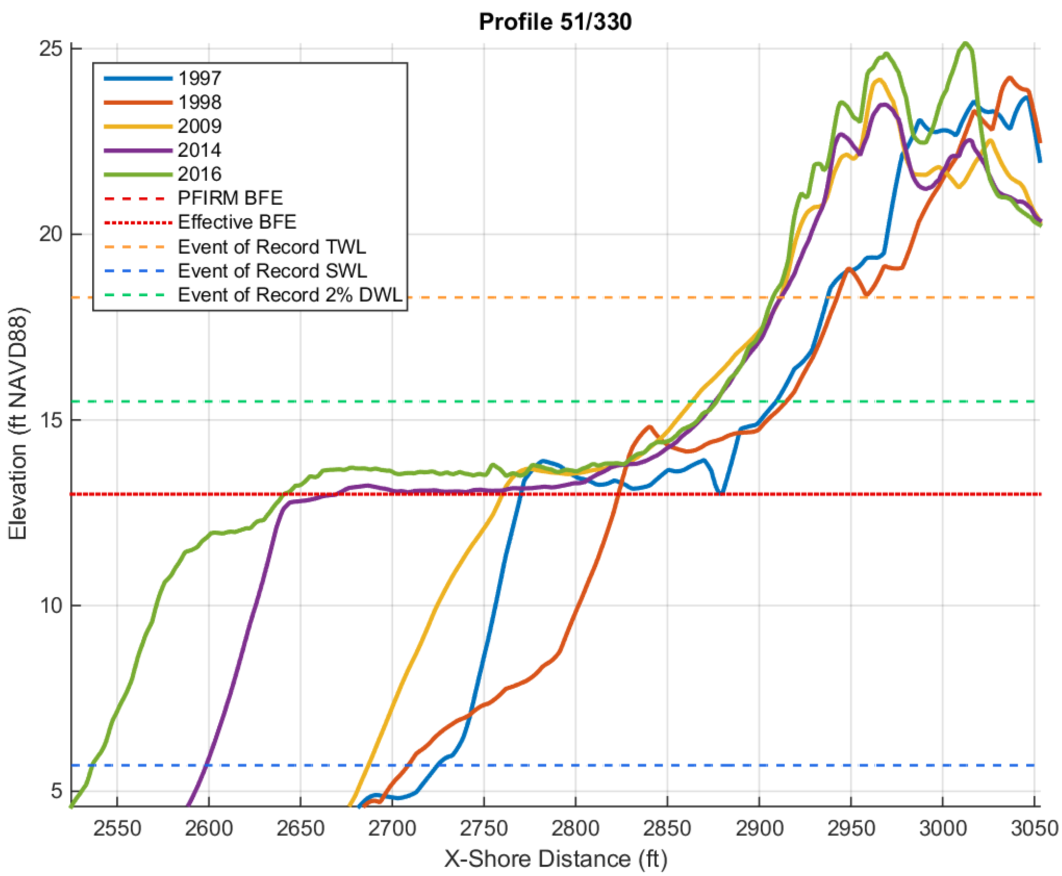

Figure 5-46: Cross Shore Beach Profiles at Transect 51. Note that PFRIM BFE and Event of Record TWL are at the same elevation, 18.3 ft.

Transect 52/322

This profile shows the development of the Oxnard shoreline. In 1997 and 1998 the natural dunes with crest elevations about the preliminary BFEs were bulldozed to construct two new houses. Since that time period, the beach has widened and the dunes, while growing, are all below the preliminary BFE. Cross shore beach profiles at Transect 52 are shown in Figure 5-47.

- PFIRM BFE of 17.1 feet (effective FIRM 13 feet) exceeds the event of record TWL (16.9 feet from 3/2/83).
- Event of record SWL of 5.7 feet, H_o of 12.9 feet and T_p of 17.5 seconds are different than Transects 46 through 50 to the north, but consistent with the adjacent Transect 51.
- Beach slope used by FEMA was 0.081. Geomorphic analysis on available topography showed an average beach slope of 0.096 ranging from 0.084 to 0.107.
- Implications of using foreshore beach slopes in the Stockdon runup equation with the storm of record are: a TWL of 18.4 feet with the average beach slope and a potential BFE range of 17.3 - 19.6 feet.
- Bore calculation completed using a DWL2% over the crest elevation. FEMA used a DWL2% of 14.8 feet and a crest elevation of 13.8. Geomorphic analysis on available topography showed an average crest of 13.6 feet and a range of 13.4 -14.0 feet.
- Storm caused changes during the 1997-98 El Niño (October to April):
    - Beach width narrowed by 9 feet
    - Dune accreted 48 feet measured at the toe
- Between 1997 and 2016, the long-term changes were:
    - Beach width (MHW to crest) widened by 58 feet
    - MHWs shoreline change accreted by 167 feet
    - Primary dune crest decreased in elevation by 1.1 feet and migrated seaward by 109 feet as a result of the destruction of the initial dunes to construct homes between 1998 and 2009.

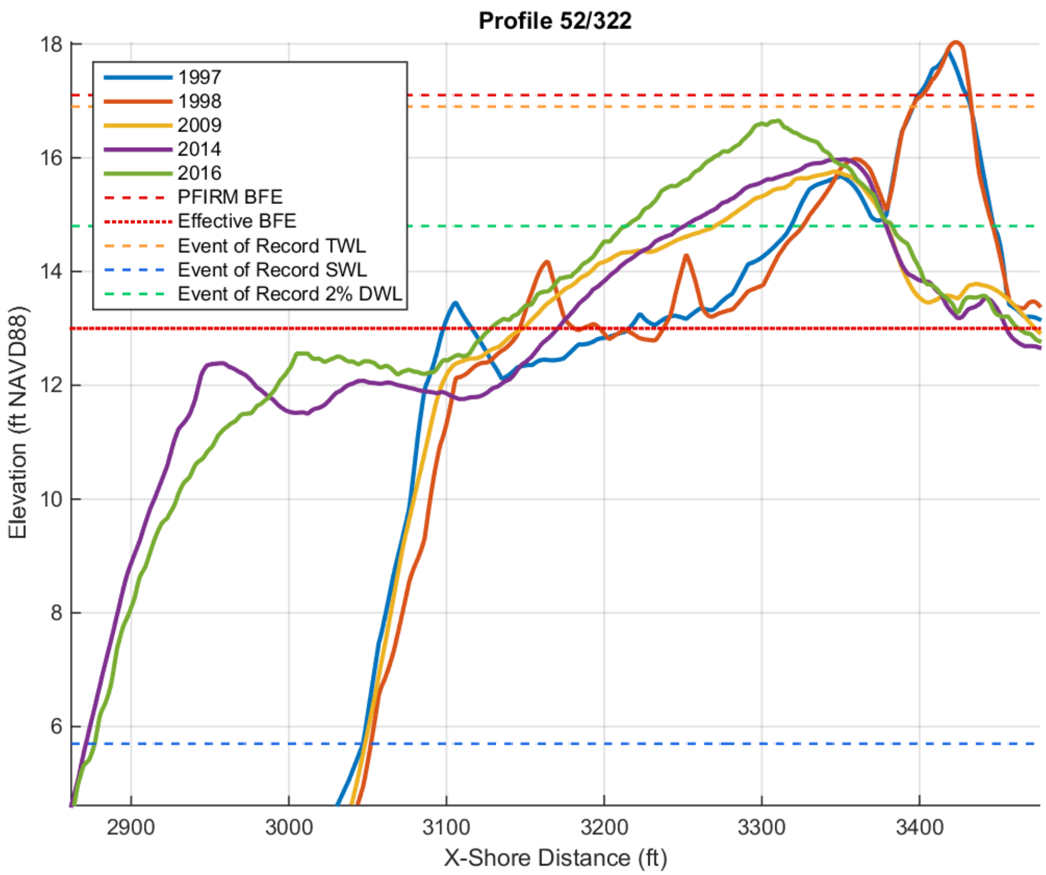

Figure 5-47: Cross Shore Beach Profiles at Transect 52

5.5.2 Recommendation

An appeal may be warranted at Site 5 if the community wishes to challenge the BFEs on multiple basis. However, it should be identified that two distinct arguments that could be made potentially counter each other.

First, for Transect 47, which presently represents the Mandalay Generating station site, the appeal would be based on the grounds that FEMA did not follow the Pacific Guidelines and consider the site as defined under the definition of the PFD, the MLWP, or consider event-based dune erosion caused by a 100-year wave event and flooding by that same event. Further technical basis could be found that the storm applied to the site had a reduced wave period than surrounding transects (thus reducing the wave runup elevation) and that this BFE is less than the storm of record used on either side of this transect for much of Site 4 and portions of the Site 5 transects. In addition, the City of Oxnard could ask for higher resolution transect spacing to clarify the overflow AE zone/coastal confluence flood hazard zones fronting McGrath Lake and the lack of any flood hazard in the Rio Grande Land Grant Site compared to adjacent land use and where there is a documented history of flood damages, which occurred during the 1969 flood event. Preparing this appeal may require some additional analysis and calculations beyond the scope of the current review project.

A second appeal would be for the residential sites in Oxnard Shores on the basis using different storm events of records and varying wave periods compared to the neighboring transects. There are substantial differences in the size of waves, wave periods and geomorphic that could be used to reevaluate the BFE. However, it should be noted that the lack of full application of the FEMA Pacific Guidelines (e.g. MLWP, dune erosion) could very well increase the BFE. Observed flooding during the December 11, 2015 wave event exceeded the mapped VE zones in several places along Oxnard Shores.

5.6 Site 6: Port Hueneme

The PFIRM for City of Port Hueneme is shown in Figure 5-48. While this site was not selected for detailed analysis, it is prudent to highlight the wide variability of the site as it clearly illustrates the presence and absence of the fronting beach. The use of Stockdon based on the 2009 LIDAR is acceptable; however, a more appropriate calculation would have been to consider an eroded profile and use potentially the TAW, as the site has been recently armored as a result of recent erosion. Examination of the beach in front of the City of Port Hueneme shows substantive changes in beach width, nearshore slopes and backshore characterization. Presently, Transects 61 and 62 apply the Stockdon wave runup equation, which is suitable for sandy beaches. Examination of some of the available photos (Figure 5-49 & Figure 5-50) and topographic LIDAR shows extreme variability at these sites with beach width changing significantly as seen in the cross shore profiles at Transect 61 in Figure 5-51. The 2009 LIDAR topography shows a beach that is approximately 600 feet wider than that in 2014 during which time the City of Port Hueneme was undergoing substantial erosion caused by the lack of harbor bypass dredging from Channel Islands Harbor.

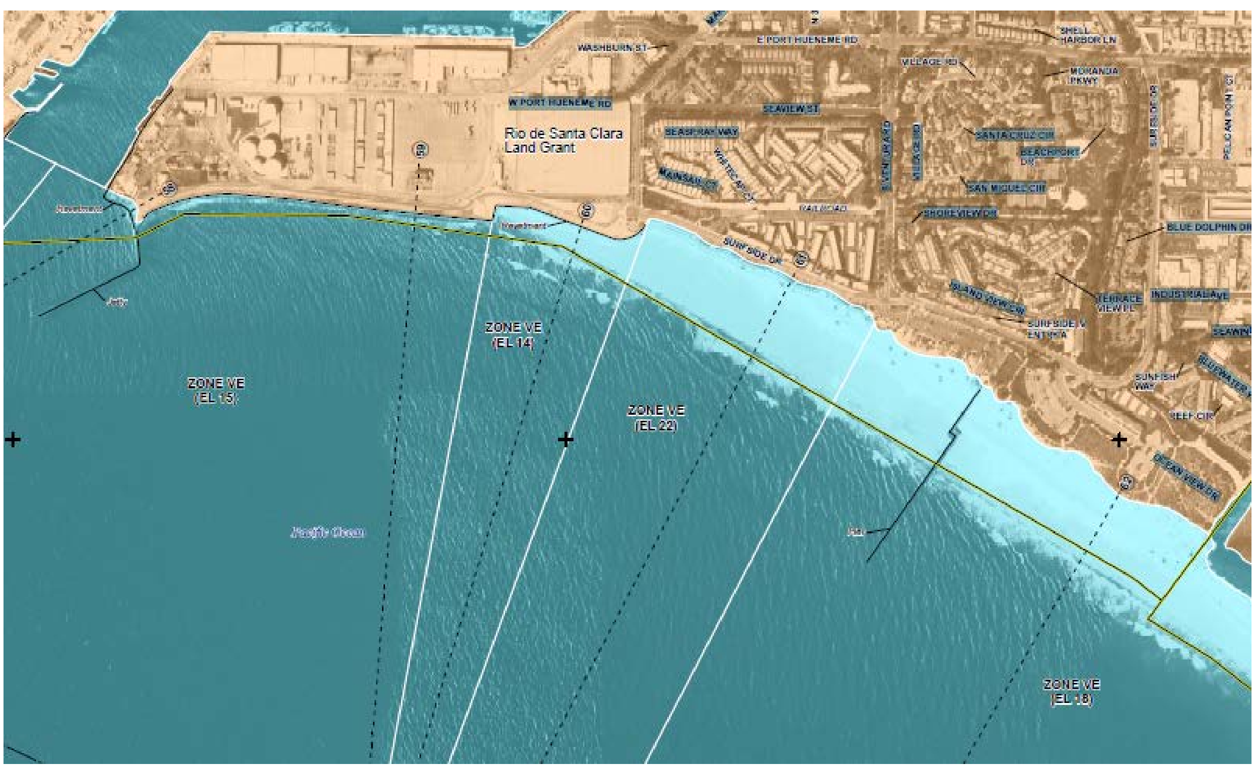

Figure 5-48: Site 6 PFIRM Panel 914F Excerpt (FEMA 2016)

Figure 5-49: Photo at Port Hueneme Pier (California Coastal Records Project 2013)

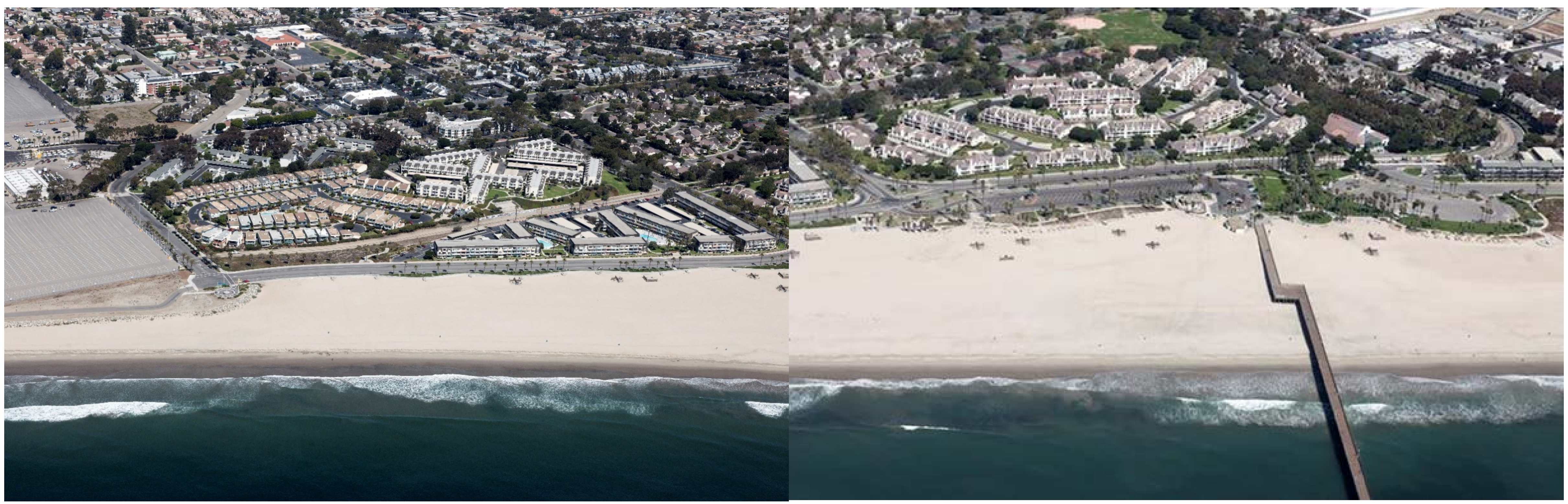

Figure 5-50: Photo at Port Hueneme Pier (California Coastal Records Project 2010)

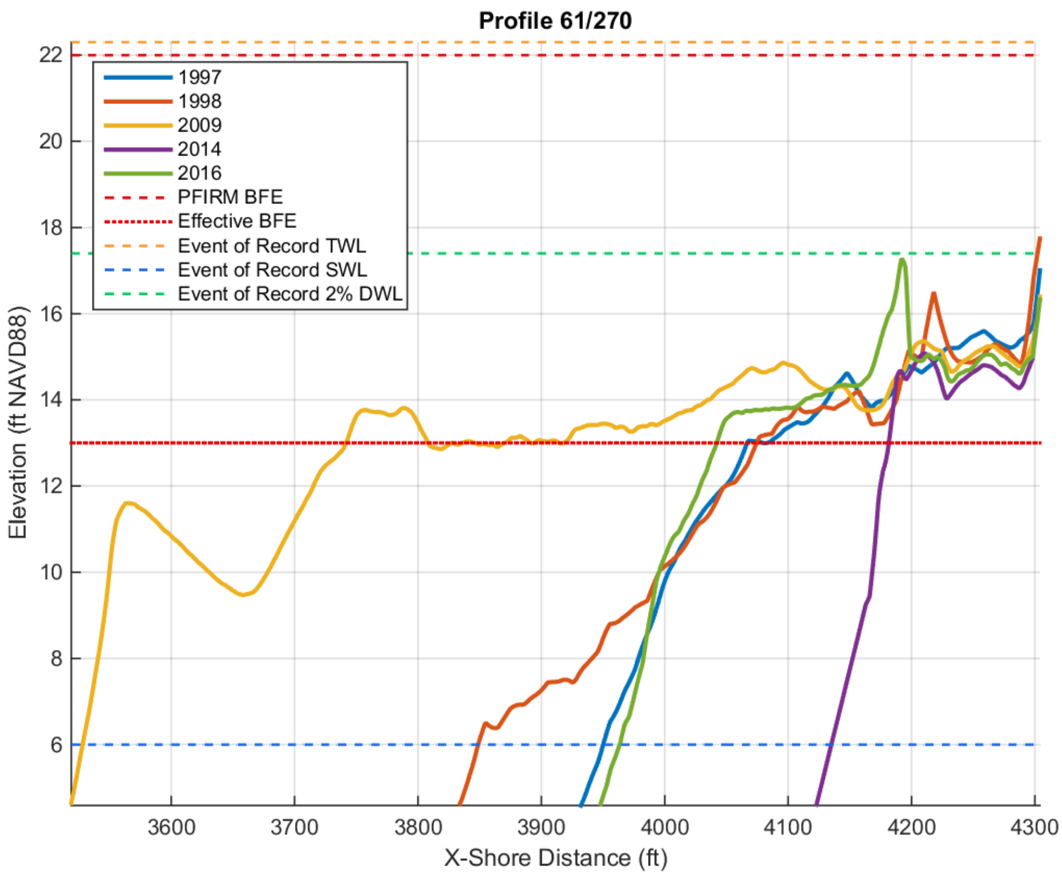

Figure 5-51: Cross Shore Beach Profiles at Transect 61

Appendix C listed applicable comments that are applicable to each transect.

6 INTERPRETATION OF MODELING AND MAPPING RESULTS

The flood zone delineations are based on detailed analyses and are used to calculate the TWL. The TWL includes the SWL, wave setup, and wave runup. TWLs were determined at each wave analysis transect for the 50-percent, 20-percent, 10-percent, 4-percent, 2-percent, 1-percent, and 0.2-percent-annual-chance events. The 1-percent-annual-chance flood elevation is referred to as the BFE. The TWLs are statistical flood levels based on extreme value analysis of a 50-year wave and water level hindcast (from January 1, 1960 to December 31, 2009). These coastal flooding hazard and risk analyses are used to map Special Flood Hazard Areas (SFHA).

This section is intended to highlight some of the key concepts of coastal modeling and flood mapping results from the Ventura CCAMP OPC Study with simple figures and language. The detailed documentation of methods used to map coastal flood hazard zones for the Open Pacific coast shoreline of Ventura is included in IDS4 (FEMA 2016c).

6.1 Flood Zones

IDS4 (FEMA 2016c) defines the four SFHA zones that were mapped in the Study, they have been described in simple terms below. Although other flood zones are displayed on the PFIRMs, they are from previous maps and studies and are not a part of the coastal flood hazard study. Figure 6-1 shows an excerpt from a flood map with three of the coastal SHFA zones: Zone VE, Zone AE, Zone AO, and Zone X. It is important to note that due to map scale resolution, small flood zones (width less than 35 feet) are combined with larger flood zones when they cannot be individually mapped. Figure 6-2 provides a profile representing typical flood zone designations.

- **Zone VE:** Coastal Hazard areas where waves and fast moving water can cause damage during the 1-percent-annual-chance flood, this includes:
  - The breaking wave height zone – where 3 feet or greater wave heights could occur.
  - The wave runup zone – where the ground profile is 3 feet or more below the 2% wave runup elevation and where the runup height above the Stillwater elevation (SWEL) is greater than 3 feet.
  - The wave overtopping splash zone – the landward distance that water from waves could splash over the top of the beach/dune or top of a coastal structure.
  - The high-velocity flow zone – the landward distance that water from waves that splash over the top of the beach/dune or top of a coastal structure could be moving fast (≥ 200 ft^3/sec^2).
  - The primary frontal dune – the landward limit of a beach dune (heel) where the slope changes from steep to mild.
- **Zone AE:** Areas that could be inundated by the 1-percent-annual-chance flood. Many of these zones that were calculated are too small to be shown on the maps (width less than 35 feet) and are combined with zone VE). The criteria includes:
  - Wave heights less than 3 feet.
  - Runup heights less than 3 feet above the still water level.
  - TWL is less than 3 feet above ground elevation.
- **Zone AO:** Areas of shallow and slow moving floodwaters below the criteria for zone AE. Due to map scale limitations, many of these zones that were calculated are too small to be shown on the maps and are combined with zone AE or zone VE.

- **Zone X:** (Shaded tan) Flood hazard areas that could be inundated by the 0.2-percent-annual-chance flood or inundated by the 1-percent-annual-chance flood hazard with average depths of 1 foot or less. Area determined to be outside the 0.2-percent-annual-chance floodplain is unshaded.

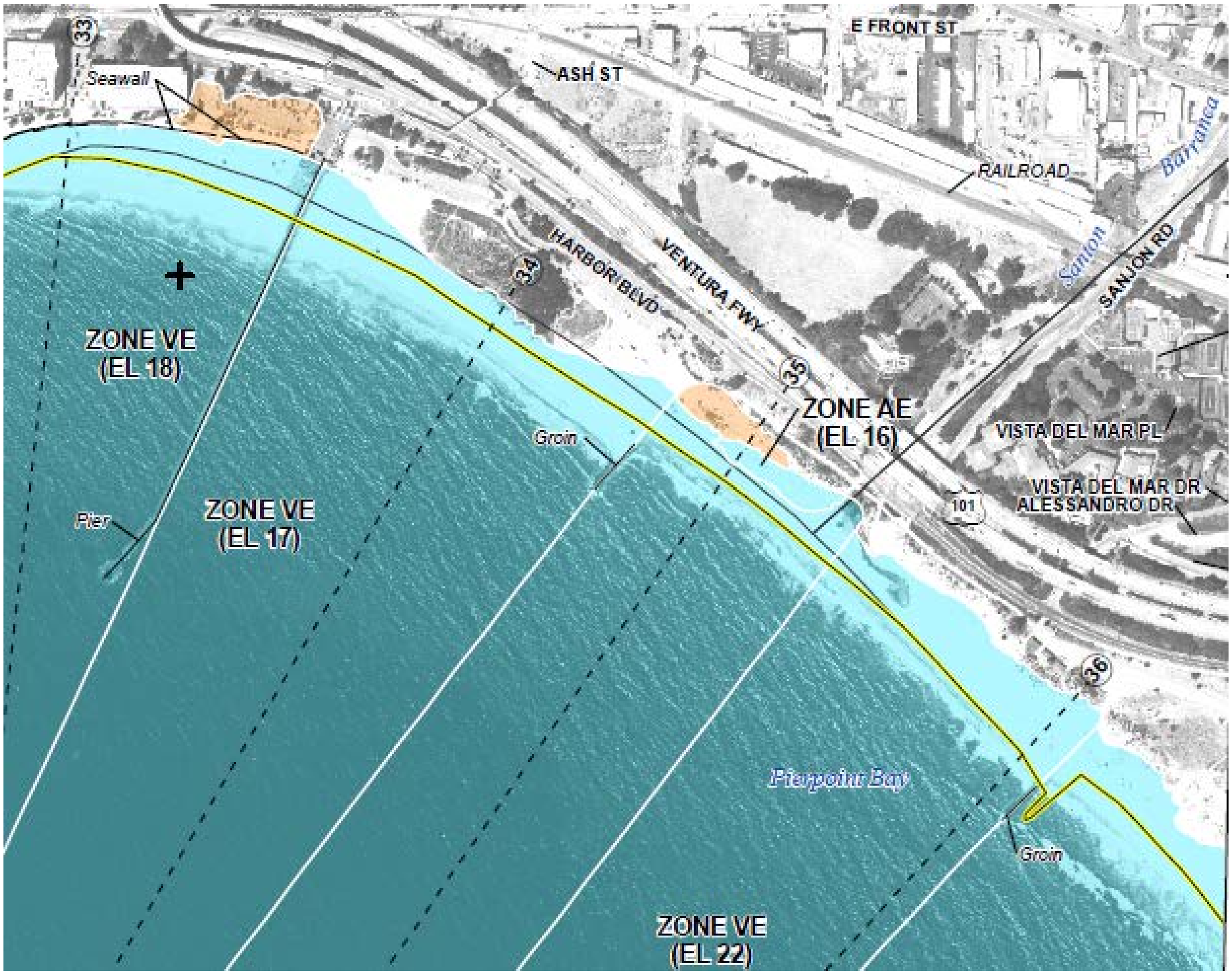

Figure 6-1: PFIRM Panel 743F Excerpt Showing Zone VE, AE and X (Tan) (FEMA 2016)

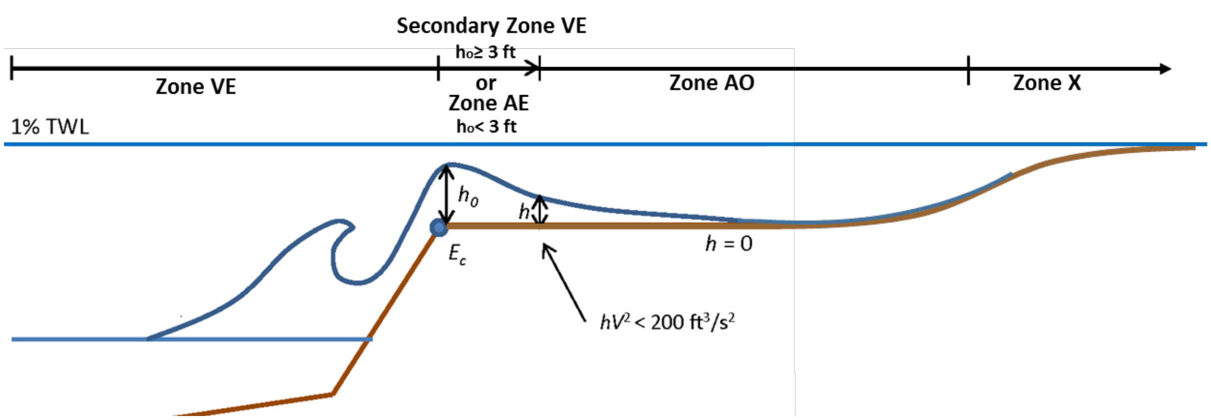

Figure 6-2: Hypothetical Profile Illustrating FEMA SFHA Zones

6.2 Flood Mapping

BFE values are listed as whole foot values on the map; however, the TWL, which is calculated to the nearest 0.1 foot, is used to determine the landward limit of the modeled runup. The BFE for a runup reach is the 1-percent-annual-chance TWL (wave runup elevation). The flood zone designation of zone VE or zone AE is based on the magnitude of wave runup above the ground level. The mapping for transects with overtopping is discussed in Section 6.2.2.

6.2.1 Transition Zone Mapping

According to the Pacific Guidelines 2005, insertion of transition zones is allowable in areas with varying runup zones to avoid large differences in BFEs and to smooth the change in flood boundaries; however, transition zones are not to be used if there is a very abrupt change in topography, such as the end of a structure. Placement of transition zones was not required for Ventura County (IDS4 [FEMA 2016c]).

6.2.2 Overtopping

Wave overtopping occurs when the potential limit of TWL exceeds the crest elevation of the controlling topographic feature, such as a dune, bluff, or coastal structure. Several controlling topographic features in Ventura County were exceeded by the elevation of the 1-percent-annual-chance TWL (Table 6-1). At these transects, the results of the wave runup, bore propagation, and splash overtopping analysis from IDS3 (FEMA 2016b) were translated to landward hazard zones. The difference between applications of splash versus bore overtopping analysis were discussed in Section 4.10. If the resulting zone was too narrow to be mapped as an independent zone due to map scale limitations (width less than 35 feet), the overtopping runup zones were either integrated into the primary coastal zone VE or, where the VE and AO overtopping zones together were at least 35 feet, combined to create a secondary zone VE. Mapping the overtopping zones begins by delineating the crest from a crest point to interpolate the crest line throughout the reach. If the overtopping zones are too small to be shown on the map, they are integrated into the primary coastal zone VE by moving the delineated crest line the overtopping distance, creating the landward edge of the primary coastal zone VE. If the overtopping zones are wide enough to map (35 feet or greater), the delineated crest boundary remains in place and creates the limit between the primary coastal zone VE and any subsequent overtopping zones.

Using Transect 89 in Malibu area as an example, as listed in Table 6-1, the 1% TWL is 20.2 feet NAVD88 (round to a BFE of 20 feet), the BFE of the secondary VE zone is 18.8 feet, the landward extent of secondary VE zone (called Width of V in IDS4) is 11.7 feet, the AO zone depth is 1.3 feet above the crest, and the landward extend of the AO zone measured from the crest is 30.9 feet. Hence, the width of AO zone (called Width of A in IDS4) is 19.2 feet by subtracting 11.7 from 30.9. The Width of A listed in Table 6-2 is 19.3 feet, likely due to rounding accuracy. For this transect, since the sum of the secondary VE zone and AO zone is 30.9 feet, which is less than 35 feet. Therefore, the primary VE zone with a BFE of 20 feet was extended 30.9 feet landward beyond crest. Without applying the map limitation, there would be a secondary VE zone with a BFE of 19 feet.

For Transect 88 also in the Malibu area, as listed in Table 6-1, the 1% TWL is 33.6 feet NAVD88 (round to a BFE of 34 feet), the BFE of the secondary VE zone is 20.0 feet, the landward extent of secondary VE zone (called Width of V in IDS4) is 31.0 feet, the AO zone depth is 0.2 feet above the crest, and the landward extend of the AO zone measured from the crest is 37.2 feet. Hence, the width of AO zone (called Width of A in IDS4) is 6.2 feet by subtracting 31.0 from 37.2 as listed in Table 6-2. For this transect, since the sum of the secondary VE zone and AO zone is 37.29 feet, which is more than 35 feet. Hence, a secondary VE zone with BFE of 20.0 feet was mapped.

Overtopping was analyzed at 60 of the 90 transects for the County. Table 6-1 contains the mapped scenario for transects receiving overtopping treatment for the 1-percent and 0.2-percent-annual-chance TWL. The primary coastal VE zone BFE is provided in the table as the 1% TWL value (4^{TH} Column). Table 6-2 provides an explanation of the overtopping mapping decisions made at each transect and the overtopping distances used in the mapping. Overtopping widths are provided for the individual zones including the secondary VE (referred to as Width of V in Table 6-2), AO (referred to as Width of O in Table 6-2), and X (Width of X) to support mapping decisions based on the 35-foot minimum mappable distance criteria according to IDS4 (FEMA 2016c). However, this treatment was not consistent with Section D.4.9.4 of the Pacific Guidelines, which states: *Because digital FIRM data can be easily enlarged, the map scale limitations should be reviewed by the Mapping Partner with the FEMA study representative and community officials*.

For Faria Beach area (Mapping Transects 15 through 18), both the landward secondary VE zone and AO zone were mapped as the primary VE zone since the landward extents are less than 35 feet, as shown in Table 6-1.

6.2.3 Sheltered Waters Analysis

There are no sheltered waters within Ventura County that required detailed wave hazard analysis. However, there are three locations (Ventura Harbor, Channel Islands Harbor, and Port Hueneme) where harbor analysis was evaluated with runup results considering: (1) the influence of the transmission of waves overtopping the breakwater during high wave events; and (2) the diffraction of wave propagating around the tip of the water at the harbor entrance. Results are translated to landward hazard zones based on the 1-percent-annual-chance TWL for Mapping Transects 43, 53, 58, and 57.

6.2.4 Non-Studied Streams and Tie-In Locations

No streams were studied for this physical map revision (PMR). Tie-ins between coastal high hazard areas and embayments/lagoons and riverine flooding areas were made at several locations including: Ventura River, Santa Clara River, and McGrath Lake Overflow. Revisions to effective riverine flooding sources were limited to the immediate area of the coastal and riverine interfaces, and were performed with the primary aim of maintaining logical transitions between effective and revised mapping data. All areas covered by the Ventura PMR coastal study are coded as STUDY6. All elevations will refer to NAVD88. The detailed tie-in decisions were discussed in IDS4 (FEMA 2016c).

General Review Comments:

16. *Minimum mappable distance criterion: A 35-foot minimum distance criterion was applied in the mapping for transects with overtopping. If the resulting landward runup zone was less than 35 feet, the overtopping runup zones were either integrated into the primary coastal Zone VE or, where the VE and AO overtopping zones together were at least 35 feet, combined to create a secondary zone VE. The resulting mapped BFE in the runup zones is often 5 feet higher than the calculated BFE. This practice is inconsistent with Pacific Guidelines (Section D.4.9.4) as the community officials were not consulted about setting 35-foot as the minimum mappable distance criterion. With today's technology, it is recommended to include the secondary VE zones and the AO zones with calculated width in the digital FIRMs, which can have much higher resolution than the hard copy maps.*

Table 6-1: Summary of Overtopping Results

Analysis Transect	Mapping Transect	Shore type	1% TWL (ft NAVD)	Crest Ele (ft NAVD)	TWL-Crest Exceedance (ft)	Runup Type	VE Zone BFE (ft NAVD)	Landward extent of VE Zone (ft) ‡	AO Zone Depth** (ft)	Landward extent of AO Zone (ft) ‡ (10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1-percent TWL Event										
10	89	Seawall + Bluff	20.2	16.7	3.4	Splash	18.8	11.7	1.3	30.9
14_F	88	Bluff	33.6	11.7	21.9	Bore	20.0	31.0	0.2	37.2
72*	83	Beach	22.3	14.5	7.8	Bore	17.5	21.4	0.7	40.6
93*	81	Beach	25.9	13.5	12.4	Bore	18.2	35.6	0.4	50.6
128*	78	Beach	22.4	18.8	3.6	Bore	20.2	0.0	0.0	40.8
141*	77	Beach	16.9	9.1	7.8	Bore	12.0	20.6	0.7	39.0
157_F*	76	Beach	26.3	14.3	12.0	Bore	18.8	31.7	0.4	45.7
160*	75	Beach	18.5	9.7	8.7	Bore	13.0	23.3	0.6	40.3
163	74	Revetment +Beach	23.5	15.5	8.0	Bore	18.6	15.4	0.6	28.5
165_F*	73	Beach	18.1	11.3	6.8	Bore	13.9	15.5	0.8	33.8
169_F*	72	Beach	19.9	12.2	7.7	Bore	15.2	22.2	0.7	42.7
175_F*	71	Beach	19.9	10.6	9.4	Bore	14.1	27.0	0.5	44.4
189*	69	Beach	14.8	12.5	2.3	Bore	13.4	0.0	0.0	19.9
202_F*	67	Beach	17.8	12.8	5.0	Bore	14.7	8.7	1.0	32.3
211*	66	Beach	17.3	16.7	0.5	Bore	16.9	0.0	0.0	10.2
218*	65	Beach	15.6	7.3	8.3	Bore	10.5	22.7	0.6	40.7
231*	64	Beach	15.1	13.2	1.8	Bore	13.9	0.0	0.0	20.0
240	63	Beach	15.7	12.8	2.9	Bore	13.9	0.0	0.0	19.4
270*	61	Beach	22.0	15.0	7.0	Bore	17.7	15.8	0.7	33.2
288	58	Breakwater + Revetment +Beach	14.6	14.0	5.4	Bore	16.0	4.6	1.0	14.5
290	56	Bluff	18.1	16.3	5.2	Bore	18.3	6.5	1.0	21.8
293*	55	Beach	24.0	13.1	10.9	Bore	17.3	27.4	0.5	41.4
301*	54	Beach	21.5	13.0	8.5	Bore	16.2	19.8	0.6	34.8
322*	52	Beach	17.1	13.8	3.3	Bore	15.0	0.0	0.0	22.4
342*	49	Beach	20.1	15.0	5.1	Bore	17.0	7.4	1.0	26.4
347*	48	Beach	20.6	16.7	3.9	Bore	18.2	1.6	1.3	29.6
426*	41	Beach	17.6	16.7	0.9	Bore	17.0	0.0	0.0	12.0
430*	40	Beach	18.4	15.4	3.0	Bore	16.5	0.0	0.0	22.0
434*	39	Beach	16.0	14.2	1.8	Bore	14.9	0.0	0.0	18.4

Analysis Transect	Mapping Transect	Shore type	1% TWL (ft NAVD)	Crest Ele (ft NAVD)	TWL-Crest Exceedance (ft)	Runup Type	VE Zone BFE (ft NAVD)	Landward extent of VE Zone (ft) ‡	AO Zone Depth** (ft)	Landward extent of AO Zone (ft) ‡ (10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
438*	38	Beach	19.3	14.9	4.4	Bore	16.6	4.9	1.2	29.0
446*	36	Beach	22.2	21.0	1.1	Bore	21.5	0.0	0.0	15.7
452*	34	Beach	16.8	14.3	2.5	Bore	15.3	0.0	0.0	21.2
469	30	Bluff	22.0	14.6	7.4	Bore	17.4	17.7	0.7	35.1
480*	29	Beach	25.2	9.6	15.6	Bore	15.5	37.4	0.3	48.9
502	26	Seawall + Bluff	21.0	15.1	5.9	Bore	17.3	10.1	0.9	26.7
506_F	25	Bluff	18.7	14.8	3.9	Bore	16.3	1.4	1.3	24.4
515_F	24	Bluff	19.6	15.1	4.5	Bore	16.8	4.5	1.1	24.0
525	23	Seawall + Beach	18.1	17.1	1.0	Splash	17.7	12.3	1.2	31.2
529_F*	22	Beach	19.1	14.9	4.2	Bore	16.5	3.0	1.2	25.5
531_F*	21	Beach	18.5	12.1	6.4	Bore	14.6	10.6	0.8	24.8
533_F	20	Bluff	27.3	14.9	12.3	Bore	19.6	27.5	0.4	39.2
539_F	19	Bluff	27.6	12.5	15.2	Bore	18.2	33.3	0.3	44.0
546_F	18	Bluff	28.9	18.8	10.1	Bore	22.7	20.7	0.5	32.5
549	17	Seawall + Bluff	24.5	16.1	8.4	Bore	19.3	17.7	0.6	31.4
554	16	Bluff	24.1	19.7	4.5	Splash	20.6	19.4	0.9	34.7
556	15	Seawall + Bluff	21.3	13.2	8.0	Bore	16.3	12.4	0.6	22.8
561_F	14	Bluff	26.1	12.1	14.0	Bore	17.4	31.4	0.4	42.6
565	13	Seawall + Bluff	21.0	14.5	6.5	Bore	17.0	29.7	0.8	68.3
567	12	Seawall + Bluff	26.0	14.4	11.6	Bore	18.8	24.3	0.4	35.6
568_F	11	Bluff	36.8	14.7	22.1	Bore	23.1	43.7	0.2	52.4
580_F	10	Bluff	26.0	15.3	10.8	Bore	19.4	25.8	0.5	39.3
592_F	9	Bluff	30.0	14.8	15.2	Bore	20.6	29.4	0.3	38.8
601_F	8	Bluff	34.4	10.8	23.6	Bore	19.8	47.2	0.2	55.9
610_F	7	Bluff	32.6	31.3	1.3	Splash	31.7	6.5	0.0	24.3
633_F	5	Bluff	29.3	17.4	11.9	Bore	21.9	16.9	0.4	24.4
667_F	2	Bluff	32.5	28.2	4.3	Splash	29.3	17.6	1.0	32.0
677	1	Bluff	12.8	12.4	0.4	Splash	12.4	1.0	0.0	9.7
Analysis Transect	Mapping Transect	Shoretype	0.2% TWL (ft NAVD)	Crest Elevation (ft NAVD)	TWL-Crest Exceedance (ft)	Type	VE Zone BFE (ft NAVD)	Landward extent of VE Zone (ft) ‡	AO Zone Depth** (ft)	Landward extent of AO Zone (ft) ‡
0.2-percent TWL Event ◊										
449*	35	Beach	17.1	16.2	0.9	Bore	16.6	0.0	0.0	7.0

Notes:

**Denotes beach transects where beach/backshore development transition was selected for overtopping.*

***At each transect, the AO depth is taken as the bore or jet depth from overtopping and is measured from the crest. The depth is calculated during the overtopping analysis at the landward limit of the VE zone, where $hV^2 = 200\ ft^3/s^2$. V is the bore or jet velocity at this limit and h is the depth. Please refer to IDS3 for more details.*

‡ Landward extent refers to the landward distance relative to the crest.

◊ The VE and AO zones associated with the 0.2-percent-annual-chance TWL events are mapped as a Shaded X zone.

NAVD = NAVD88

Table 6-2: Summary of Overtopping Zone Treatments

1% Annual Chance		Overtopping Widths (ft)			Overtopping Zone Treatment in Mapping
Analysis Transect	Mapping Transect	Width of V	Width of A	Total	
10*	89	11.7	19.3	30.9	Merge V & A limits to extend VE Zone 30.9 ft beyond crest
14_F	88	31.0	6.2	37.2	Merge V & A limits to map VE Zone 37.2 ft beyond crest. Apply 20 ft VE Zone BFE per Table 6-1.
72	83	21.4	19.2	40.6	Merge V & A limits to map VE Zone 40.6 ft beyond crest. Apply 18 ft VE Zone BFE per Table 6-1.
93*	81	35.6	15.0	50.6	Merge V & A limits to map VE Zone 50.6 ft beyond crest. Apply 18 ft VE Zone BFE per Table 6-1.
128	78	0.0	40.8	40.8	Map AO Zone with a depth of 1ft 40.8 ft beyond crest
141	77	20.6	18.4	39.0	Merge V & A limits to map VE Zone 39 ft beyond crest. Apply 12 ft VE Zone BFE per Table 6-1.
157_F	76	31.7	14.0	45.7	Merge V and A limits to map VE Zone 45.7 ft beyond crest. Apply 19 ft VE Zone BFE per Table 6-1.
160	75	23.3	17.0	40.3	Merge V and A limits to map VE Zone 40.3 ft beyond crest. Apply 13 ft VE Zone BFE per Table 6-1.
163	74	15.4	13.1	28.5	Merge V and A limits to extend VE Zone 28.5 ft beyond crest
165_F	73	15.5	18.2	33.8	Merge V and A limits to extend VE Zone 33.8 ft beyond crest
169_F	72	22.2	20.5	42.7	Merge V & A limits to map VE Zone 42.7 ft beyond crest. Apply 15 ft VE Zone BFE per Table 6-1
175_F	71	27.0	17.4	44.4	Merge V & A limits to map VE Zone 44.4 ft beyond crest. Apply 14 ft VE Zone BFE per Table 6-1
189	69	0.0	19.9	19.9	Merge V and A limits to extend VE Zone 19.9 ft beyond crest
202_F	67	8.7	23.6	32.3	Merge V and A limits to extend VE Zone 37.5 ft beyond crest
211	66	0.0	10.2	10.2	Merge V and A limits to extend VE Zone 10.2 ft beyond crest
218	65	22.7	18.0	40.7	Merge V & A limits to map VE Zone 40.7 ft beyond crest. Apply 11 ft VE Zone BFE per Table 6-1
231	64	0.0	20.0	20.0	Merge V & A limits to extend VE Zone 20 ft beyond crest

1% Annual Chance		Overtopping Widths (ft)			Overtopping Zone Treatment in Mapping
Analysis Transect	Mapping Transect	Width of V	Width of A	Total	
141	77	20.6	18.4	39.0	Merge V & A limits to map VE Zone 39 ft beyond crest. Apply 12 ft VE Zone BFE per Table 6-1
157_F	76	31.7	14.0	45.7	Merge V & A limits to map VE Zone 45.7 ft beyond crest. Apply 19 ft VE Zone BFE per Table 6-1
240	63	0.0	19.4	19.4	Merge V and A limits to extend VE Zone 19.4 ft beyond crest
270	61	15.8	17.4	33.2	Merge V and A limits to extend VE Zone 33.2 ft beyond crest
288	58	4.6	10.0	14.5	Merge V and A limits to extend VE Zone 14.5 ft beyond crest
290	56	6.5	15.3	21.8	Merge V and A limits to extend VE Zone 21.8 ft beyond crest
342	49	7.4	19.1	26.4	Merge V and A limits to extend VE Zone 26.4 ft beyond crest
347	48	1.6	28.0	29.6	Merge V and A limits to extend VE Zone 29.6 ft beyond crest
426	41	0.0	12.0	12.0	Merge V and A limits to extend VE Zone 12.0 ft beyond crest
430	40	0.0	22.0	22.0	Merge V and A limits to extend VE Zone 22.0 ft beyond crest
434	39	0.0	18.4	18.4	Merge V and A limits to extend VE Zone 18.4 ft beyond crest
438	38	4.9	24.1	29	Merge V and A limits to extend VE Zone 29 ft beyond crest
446	36	0.0	15.7	15.7	Merge V and A limits to extend VE Zone 15.7 ft beyond crest
452	34	0.0	21.2	21.2	Merge V and A limits to extend VE Zone 21.2 ft beyond crest
469	30	17.7	17.4	35.1	Merge V & A limits to map VE Zone 35.1 ft beyond crest. Apply 17 ft VE Zone BFE per Table 6-1
480	29	37.4	11.5	48.9	Merge V & A limits to map VE Zone 48.9 ft beyond crest. Apply 16 ft VE Zone BFE per Table 6-1
502	26	10.1	16.6	26.7	Merge V and A limits to extend VE Zone 26.7 ft beyond crest
506_F	25	1.4	23.1	24.4	Merge V and A limits to extend VE Zone 24.4 ft beyond crest
515_F	24	4.5	19.5	24.0	Merge V and A limits to extend VE Zone 24 ft beyond crest
525	23	12.3	18.9	31.2	Merge V and A limits to extend VE Zone 31.2 ft beyond crest
529_F	22	3.0	22.5	25.5	Merge V and A limits to extend VE Zone 25.5 ft beyond crest
531_F	21	10.6	14.3	24.8	Merge V and A limits to extend VE Zone 24.8 ft beyond crest
533_F	20	27.5	11.7	39.2	Merge V & A limits to map VE Zone 39 ft beyond crest. Apply 20 ft VE Zone BFE per Table 6-1
539_F	19	33.3	10.7	44.0	Merge V & A limits to map VE Zone 44 ft beyond crest. Apply 18 ft VE Zone BFE per Table 6-1
546_F	18	20.7	11.8	32.5	Merge V and A limits to extend VE Zone 32.5 ft beyond crest
549	17	17.7	13.7	31.4	Merge V and A limits to extend VE Zone 31.4 ft beyond crest
554	16	19.4	15.2	34.7	Merge V and A limits to extend VE Zone 34.7 ft beyond crest
556	15	12.4	10.4	22.8	Merge V and A limits to extend VE Zone 22.8 ft beyond crest
561_F	14	31.4	11.2	42.6	Merge V & A limits to map VE Zone 42.6 ft beyond crest. Apply 17 ft VE Zone BFE per Table 6-1
565	13	29.7	38.6	68.3	Merge V & A limits to map VE Zone 68.3 ft beyond crest. Apply 17 ft VE Zone BFE per Table 6-1

1% Annual Chance		Overtopping Widths (ft)			Overtopping Zone Treatment in Mapping
Analysis Transect	Mapping Transect	Width of V	Width of A	Total	
567	12	24.3	11.3	35.6	Merge V & A limits to map VE Zone 35.6 ft beyond crest. Apply 19 ft VE Zone BFE per Table 6-1
568_F	11	43.7	8.7	52.4	Merge V & A limits to map VE Zone 52.4 ft beyond crest. Apply 23 ft VE Zone BFE per Table 6-1
580_F	10	25.8	13.4	39.3	Merge V & A limits to map VE Zone 39.3 ft beyond crest. Apply 19 ft VE Zone BFE per Table 6-1
592_F	9	29.4	9.4	38.8	Merge V & A limits to map VE Zone 38.8 ft beyond crest. Apply 21 ft VE Zone BFE per Table 6-1
601_F	8	47.2	8.7	55.9	Merge V & A limits to map VE Zone 55.9 ft beyond crest. Apply 20 ft VE Zone BFE per Table 6-1
610_F	7	6.5	17.8	24.3	Merge V and A limits to extend VE Zone 24.3 ft beyond crest
633_F	5	16.9	7.6	24.4	Merge V and A limits to extend VE Zone 24.4 ft beyond crest
667_F	2	17.6	14.4	32.0	Merge V and A limits to extend VE Zone 32 ft beyond crest
677	1	1.0	8.7	9.7	Merge V and A limits to extend VE Zone 9.7 ft beyond crest

Notes:

† Indicates overtopping was only experienced during the 0.2- percent event

** Overtopping only applied at specific location within reach*

7 REVIEW FINDINGS AND RECOMMENDATIONS

FEMA distributed PFIRMs, FIS reports, SOMA, and GIS databases for the County and Incorporated Areas on September 30, 2016. This is Phase 2 of the OPC Study of CCAMP. The PFIRMs are intended to supersede the current effective FIRMs. There are significant changes in SFHA zone designations within the jurisdiction of the Cities of Ventura, Oxnard and Port Hueneme (the Cities) and the County of Ventura. This technical review evaluated the information provided by FEMA and BakerAECOM that details the basic parameters, assumptions and methods used to characterize the 100-year coastal storm hazards along Ventura County, as well as the mapping results. This section summarizes review findings and recommendations for both FEMA and communities.

7.1 Summary of General Review Findings

The general findings that apply to either the entire analysis or a significant number of transects are listed below:

Methods

- The analysis profile relied on a single LiDAR data set. The Most Likely Winter Profile (MLWP) analysis was not performed as requested in the Pacific Guidelines. This would lead to underestimates of both flood hazard extent and BFE.
- Primary Frontal Dunes (PFD) analysis was not conducted nor an explanation provided as to why the preliminary FIRM mapping effort failed to identify any PFD outside of Transect 68.
- Event-Based Erosion analysis was not conducted in the preliminary FIRM mapping analysis outside of Transect 68.

Backshore Analysis

- The description of the method used to delineate d_{toe} and d_{crest} in the IDS is lacking and the vagueness may affect the mapping of the inland extent of flooding. In addition, there is no discussion of the presence or mapping of the d_{heel} which may affect the PFD determination.
- The BFE analysis was based on a single 2009 LiDAR dataset with wide beaches and high dunes in many areas. The topographic profiles can vary greatly between seasons, dredge cycles, and years (such as pre- and post-El Niño winters). In some cases, beach widths can change up to 200 feet over a few years. Therefore, it is important to consider a range of potential morphologies when determining flood elevations and extents.
- Cobbles and the role they have seasonally in dissipating or reducing wave run up was not considered in the PFIRM mapping.

Transects

- The transect numbering scheme in the IDS should correspond to the PFIRM transect numbers allowing reviewers to understand the technical approach and results applied at each location.
- There are large differences in BFE between neighboring transects. PFIRMs for the Ventura County show that the difference in BFEs between neighboring transects is more than 10 feet

around the following transects: 1-2, 4-5, 6-7, 10-11, 11-12, 30-31, 79-80, 87-88, 88-89. It is very difficult for floodplain managers and planners to interpret and implement the map results. This is particularly true for transacts separating neighboring residential properties. This practice is also not consistent with Pacific Guidelines (Section D.4.9.6) which states:

> "*Transition zones may be necessary between areas with high runup elevations to avoid large differences in BFEs and to smooth the changes in flood boundaries.*"

- Additional transects may be warranted in locations where the BFE between neighboring transects exceeds a certain threshold regardless of the shore feature similarities, additional transect(s) should be added between those neighboring transects as a transitional reach to transit the BFE from one to another.

Hydraulic Conditions – Waves and Water levels

- The pattern of BFE should be close to the typical pattern of refracted waves inside the Santa Barbara Channel.
- Wave analysis transects begin at a depth of ~40 m. Using wave parameters at the 40-m depth from the nearshore wave model as input parameters for the wave runup analysis is a poor choice for reaches with oblique wave approach angles and wave refraction such as around the many headlands in the north County. Some of the 2-D wave phenomena captured in a 2-D refraction model are not adequately represented in 1-D transect based analysis, potentially leading to overestimates of the BFE.
- Wave approach angle is not considered, which could lead to up to a 10% overestimate of wave heights and thus in BFE. Waves approach the shore in an oblique angle in many reaches along the Ventura coastline as a result of wave refraction around headlands. It should be considered in the runup analysis.
- The wave periods are not homogeneous across the region or even adjacent transects at 40-m depth for a single storm event.
- The shore slopes are not considered in determining the wave breaking criterion (ratio of wave height to water depth), which may lead to underestimate of wave height. Using appropriate ratio of wave height to water depth is recommended.
- Consistence checks of parameters used between neighboring transects showed that in some reaches (such as between Transects 4 and 5, 12 and 13, 16 and 17, etc.), there are substantial differences. It is strange that the neighboring transects would have different wave periods and sometimes different SWL for the same storm event at the 40-m depth.

Coastal Structures

- Treatment of shore protection structures has a significant impact on BFEs. Many rock revetments along the County coastline were engineered with multiple layers of rock sized to resist extreme wave forces and survived equivalent to and larger than the 1% annual chance storm event. Per the Pacific Guidelines (Section D4.7.3), these structures may be recognized on flood hazard maps. However, no structures are recognized in the study.
- For Transects 4, 6, 9, 11, 14, 21, 22 ,25, 56, 59, 60, 67, 71, 72, 73, 76, 82 and 88 where engineered revetments survived the 1% annual chance flood, a more representative failure

mode for analysis is partial failure mode.

- Roughness factor due to presence of cobbles, offshore reefs, and rock from failed revetment structures were not considered, which would lead to overestimate of BFE. A composite roughness factor should be used instead of using roughness factor of sandy or earthen materials. Rock revetments were completely removed from the transect geometry and the roughness factor was replaced with that of sand for the analysis of the structure failure scenario. The roughness treatment was not consistent with Section D.4.7.3.2 of the Pacific Guidelines, which states:

  "*the Mapping Partner shall select an appropriate roughness factor when conducting runup and overtopping analyses on the failed structure*."

Mapping

- A 35-foot minimum distance criterion was applied in the mapping for transects with overtopping. If the resulting landward runup zone was less than 35 feet, the overtopping runup zones were either integrated into the primary coastal Zone VE or, where the VE and AO overtopping zones together were at least 35 feet, combined to create a secondary zone VE. The resulting mapped BFE in the runup zones is often 5 feet higher than the calculated BFE. This practice is inconsistent with Pacific Guidelines (Section D.4.9.4) as the community officials were not consulted about setting 35-foot as the minimum mappable distance criterion.

Based on results of general technical review, five sites were selected for detailed review. The detailed review evaluated the general site condition, historical aerial photos, wave patterns, historical profiles for sandy beaches, as well as the parameters and methodology used in the transect analysis. The detailed analysis and findings were summarized site by site from north to south in Section 5.0. The findings included whether the BFE is under- or overestimated and whether an appeal may be warranted. The recommendations for communities were also summarized in Section 7.2.

7.2 Recommendations for FEMA

Overall, the OPC study benefited from new technologies and extensive high resolution coastal data; it was a very comprehensive study and is more accurate and detail compared to the prior study. Based on review of the study for Ventura County, the following recommendations are provided for FEMA and its mapping contractor:

Comment 1. Consistence check of parameters used between neighboring transects is recommended. It is strange that the neighboring transects would have different wave periods and sometimes different SWL for the same storm event at the 40 m depth. For example, during the March 1, 1983 (3/1/1983 23:00) storm, the wave period varies significantly from 11.9 to 19.2 seconds among neighboring transects from 75 through 80, and from 19.2 seconds at Transect 87 to 15.9 seconds at both Transects 86 and 88. Although wave height can vary greatly due to the refraction patterns, the wave period and SWL is typically homogeneous across the region at 40-m depth during any given storm event. (Section 4.1)

Comment 2. Please consider wave approach angle which could likely lead to a reduction in BFE. Waves approach the shore at oblique angles in many reaches along the Ventura coastline and should be considered in the runup analysis. (Section 4.1)

Comment 3. The pattern of BFE shall be close to the typical pattern of refracted waves inside the Santa Barbara channel. Please check and explain. (Section 4.1)

Comment 4. Correct AE zone mapping errors for the reach between transects 44 and 45, and between 46 and 47. There are some odd discrepancies around the Rio de Santa Clara Land Grant where no coastal flood mapping has been identified despite the fact this area was flooded during the 1969 riverine flood event and is exposed to both riverine and coastal flood hazards (Section 4.2)

Comment 5. Add transects to support the VE zone designations for coast between transects 88 and 89, and south of transect 90. (Section 4.2)

Comment 6. It is recommended that transects begin at a shallower depth around -15 to -20 m bathymetry contours instead of -40 m. Using wave parameters at the 40-m depth from the nearshore wave model as input parameters for the wave runup analysis is a poor choice for reaches with oblique wave approach angles and wave refraction. As some of the 2-D wave phenomena captured in the 2-D model cannot be captured in 1-D transect based analysis. These may lead to overestimate of the BFE. Please update the analysis. (Section 4.2)

Comment 7. The transect numbering scheme in the IDS shall correspond to the PFIRM transect numbers allowing reviewers to understand the technical approach and results applied at each location. Please renumber transects accordingly. (Section 4.2)

Comment 8. Limit the difference on BFE between neighboring transects. PFIRMs for the Ventura County show that the difference in BFEs between neighboring transects is more than 10 feet around the following transects: 1-2, 4-5, 6-7, 10-11, 11-12, 30-31, 79-80, 87-88, 88-89. If the difference in BFE between neighboring transects exceeds a certain threshold regardless of the shore feature similarities, additional transect(s) should be added between those neighboring transects. If an isolated feature resulted in large BFE variations, a minimum of two transects should be used to bracket the BFE around the feature, and a transitional reach be provided to transit the BFE from one to another. Otherwise, it is very difficult for floodplain managers to interpret and implement the map results. This is particularly true for transacts separating neighboring residential properties. This practice is also not consistent with Pacific Guidelines (Section D.4.9.6) which states: Transition zones may be necessary between areas with high runup elevations to avoid big differences between BFEs and to smooth the changes in flood boundaries. (Section 4.2)

Comment 9. Please identify the Primary Frontal Dunes (PFD) or explain why the preliminary FIRM mapping effort failed to identify any PFD outside of transect 68. (Section 4.4)

Comment 10. Please justify the use of a single topographic data set without performing the Most Likely Winter Profile (MLWP) analysis. The BFE analysis was based on a single 2009 LiDAR dataset with wide beaches and high dunes in many areas. The topographic profiles can vary greatly between seasons and years (such as pre- and post-El Niño winters). In some cases, beach widths can change up to 200 feet over a few years. Therefore, it is important to consider a range of potential morphologies when determining flood elevations and extents. The study contractor should follow the Pacific Guidelines, determine the Most Likely Winter Profile

(MLWP) before performing wave runup analysis. Skipping the step of determining the MLWP would lead to underestimates of both flood hazard extent and BFE. (Section 4.5)

Comment 11. Please perform Event-Based Erosion analysis or explain why the preliminary FIRM mapping effort failed to perform Event-Based Erosion analysis outside of transect 68. (Section 4.6)

Comment 12. Treatment of shore protection structures has a significant impact on BFEs. Many rock revetments (at Transects 4, 6, 9, 11, 14, 21, 22 ,25, 56, 59, 60, 67, 71, 72, 73, 76, 82 and 88 along the County coastline) were engineered with multiple layers of rock sized to resist extreme wave forces and survived equivalent to and larger than the 1% annual chance storm event. Per the Pacific Guidelines (Section D4.7.3), these structures may be recognized on flood hazard maps. However, no structures were recognized in the study as they are not certified. For these structures, a more representative failure mode for analysis is partial failure mode. Please apply the partial failure mode and appropriate roughness coefficient in the analyses of these transects. (Section 4.7.1)

Comment 13. Please consider the beach slope effect on the wave breaking criterion (ratio of wave height to water depth) and use an appropriate ratio of wave height to water depth in the analysis. Without considering the slope effect would lead to underestimate of wave height. (Section 4.9)

Comment 14. Please provide methods used to define and identify dtoe and dcrest in the IDS. Please also include a discussion of the dheel and incorporate those into the hazard mapping. (Section 4.9)

Comment 15. Roughness factor due to presence of cobbles, offshore reefs, and rock from failed revetment structures were not considered, which would lead to overestimate of BFE. A composite roughness factor should be used instead of using roughness factor of sandy/earthen materials. Rock revetments were completely removed from the transect geometry and the roughness factor was replaced with that of sand for the analysis of the structure failure scenario. The roughness treatment was not consistent with Section D.4.7.3.2 of the Pacific Guidelines, which states: *the Mapping Partner shall select an appropriate roughness factor when conducting runup and overtopping analyses on the failed structure. Please correct.* (Section 4.9)

Comment 16. Minimum mappable distance criterion: A 35-foot minimum distance criterion was applied in the mapping for transects with overtopping. If the resulting landward runup zone was less than 35 feet, the overtopping runup zones were either integrated into the primary coastal Zone VE or, where the VE and AO overtopping zones together were at least 35 feet, combined to create a secondary zone VE. The resulting mapped BFE in the runup zones is often 5 feet higher than the calculated BFE. This practice is inconsistent with Pacific Guidelines (Section D.4.9.4) as the community officials were not consulted about setting 35-foot as the minimum mappable distance criterion. With today's technology, it is recommended to include the secondary VE zones and the AO zones with calculated width in the digital FIRMs, which can have much higher resolution than the hard copy maps. (Section 6.2.4)

Comment 17. Transects 13, 23, 24, 25 and 33, where Stockdon runup method may have been misapplied to cobble beaches, or revetment backed beaches as opposed to using the more appropriate TAW runup equations, which likely lead to overestimate of runup. Please check that the appropriate equation was used and recalculate the BFE if necessary.

Appendix C listed above comments that are applicable to each transect.

7.3 Recommendations for Communities

Based on the general technical review, five sites were identified for further detailed review. This section summarizes recommendations based on the detailed review for each site.

7.3.1 Site 1: Mussel Shoals Beach (Transects 4 and 5)

Transect 4: BFE is likely underestimated since the treatment of MLWP is not performed.

Transect 5: BFE is likely overestimated due to the following reasons:

- Wave approach angle is oblique along an offshore shale reef, which may warrant a TWL reduction.
- Roughness reduction factor for cobbles and failed structure presence was not considered. TWL could be reduced if a reduction factor is considered.
- The calculated landward extent of AO zone was 24.4 feet with an elevation of 5 feet lower than the elevation of seaward VE zone. The AO zone is mapped as VE zone due to map scale limitations (width less than 35 feet).

7.3.2 Site 2: Seacliff Community and Hobson Park (Transect 8)

Transect 8: BFE is likely overestimated due to the following reasons:

- The existing coastal structure has a significant effect on the BFE. Historical aerial imagery shows the revetment in place in 1972. Including the structure in the analysis would lower the TWL by about 9 feet. However, FEMA certification is required for the structure to be credited in the analysis.
- Current aerial imagery shows an offshore reef, sand, cobble, and the rock revetment along this reach. Roughness reduction factor for cobbles, wave energy dissipation offshore, and failed structure presence was not considered. TWL could be reduced if a reduction factor is considered.

7.3.3 Site 3: Pitas Point (Faria Beach) to Solimar (Transects 11 - 20)

Transects 11 and 12: BFEs are likely overestimated due to the following reasons:

- Roughness reduction factor for cobbles and failed structure presence was not considered. TWL could be reduced if a reduction factor is considered.
- For Transect 12, wave approach angle is oblique and may warrant a small TWL reduction.
- For Transect 12, the statistical analysis of using the maximum likelihood GEV/AM method may be a poor choice as the BFE is 5 feet higher than the TWL of the record event on 1/18/1988. This is very different from other transects in the County, in which the BFE is pretty close to the TWL of the record event.

Transects 13 & 14: BFEs are likely overestimated due to the following reasons:

- Wave approach angle is oblique, but not considered in FEMA analysis, which may warrant a small TWL reduction.
- Aerial imagery shows the presence of cobble, rock, and sand at this transect. A composite

roughness factor should be considered instead of that for sand.

Transects 15 & 16: BFE for 15 is acceptable; BFE for 16 is likely overestimated due to the following reasons:

- For Transect 15, wave approach angle is oblique along an offshore shale reef, which may warrant a TWL reduction. However, the BFE will be higher if the MLWP treatment is performed.
- For Transect 16, the runup slope consists of a sandy foreshore and rock placed along back of beach, a composite roughness factor should be assumed which may lower TWLs.
- The calculated landward extent of AO zone was less than 35 feet with an elevation a few feet lower than the elevation of seaward VE zone. The AO zone is included in and mapped as seaward VE zone due to map scale limitations (width less than 35 feet). Otherwise, the BFE of the landward VE zone will be lower as shown in Table 6-1.

Transects 17 & 18: BFEs are likely overestimated due to the following reasons:

- Historical imagery shows a rock revetment exposed at the toe of the seawall in some locations. The revetment would contribute to a rougher runup slope and hence a reduced TWL.
- The calculated landward extent of AO zone was less than 35 feet with an elevation of 5 feet lower than the elevation of seaward VE zone. The AO zone is included in and mapped as seaward VE zone BFE due to map scale limitations (width less than 35 feet). Otherwise, the BFE of the landward VE zone will be lower as shown in Table 6-1.

Transects 19 & 20: BFEs are likely overestimated due to the following reasons

- Historical aerial imagery shows the revetment in place in 1972 and current aerial imagery shows an offshore reef, sand, and the rock revetment along this reach. A composite roughness factor should be assumed even for failed condition which may lower TWLs.

7.3.4 Site 4: Pierpont (Transects 38 – 41)

BFE changes shown in PFIRMs do not show the typical increase in wave height observed moving from north to south toward Ventura Harbor. BFEs, except at Transect 38, may be underestimated due to the following reasons:

- Calculations of MLWP or event based erosion were not completed, which would lead to underestimate the BFE and the coastal flood extents.
- The roughness reduction factor of cobble presence during the winter was not considered, which may lower BFE.
- 2009 topographic data used in the FEMA study has higher dunes than others, limiting the landward extent of the VE zone.
- Observed flooding from December 11, 2015 exceeds the mapped extents in the PFIRMs.

7.3.5 Site 5: Oxnard Shores (Transects 47–52)

Adjacent transects at this site show substantial variability due to neighboring transects using different wave periods and SWLs from different times during the same storm event along a relatively uniform stretch of coast. The site also exhibits a decrease in wave heights going south, which was not reflected in the TWL data. BFE may be underestimated due to the following reasons:

- The wave period used is shorter than that used in the neighboring transects.
- Changes in beach morphology due to dredging regimes, altering beach slope and width.
- If the Pacific Guidelines were followed, the MLWP, PFD and event-based erosion analysis were performed, the flood extent would likely be expanded and the BFEs will likely be higher.

7.3.6 Site 6: Port Hueneme (Transects 61 and 62)

The beach width, nearshore slopes and backshore characterizations changed substantially in the past due to influence of the Channel Islands Harbor bypass dredging. The beach width of the 2009 LiDAR used in the Study is approximately 600 feet wider than that in 2014, during which time the City of Port Hueneme was undergoing substantial erosion caused by the lack of harbor bypass dredging. If the Pacific Guidelines were followed, the analysis of MLWP was performed, the flood extent would likely be expanded and the BFEs will likely be higher.

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Appendix A

Data Inventory

M&N		
	CLIENT	County of Ventura
	PROJECT	TECHNICAL REVIEW OF FEMA CALIFORNIA COASTAL ANALYSIS AND MAPPING (CCAMP)
	DESIGN FOR	DATA INVENTORY CA 3/24/17
		JN: 9733

Source	Date	Document	Description	Notes
FEMA	12/9/2016	FIRMDB_09302016_Ventura County_California	GIS Files	PFIRM GIS Files
FEMA	2017	IDS	Reports	Intermediate Data Submittal reports and supporting documents/data for CCAMP/OPC
FEMA	9/30/2016	VenturaCounty_PFIRM	Maps/Reports	PFIRM map panels, Preliminary FIS
FEMA	1/20/2010	VenturaCounty_FIRM	Maps/Reports	Effective FIRM panels, Effective FIS
FEMA	2005	FEMA Guidelines_PacificCoast Flood Hazard Analysis(Jan 2005).pdf	Report	Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States
NOAA	12/10/1997 - 26/10/1997	FallWC_1997_Combined.tif	LiDAR DEM	Coastal LiDAR TopoBathy DEM of Ventrua County for the Fall of 1997. Mosaic dataset, horizontal and vertical units are in feet, limited to no offshore bathymetry, State Plane Coordinate System California V 1983, pre-El Niño
NOAA	12/10/1997 - 26/10/1997	FallWC_1997_1.tif - FallWC_1997_7.tif	LiDAR DEM	Combined Coastal LiDAR TopoBathy DEM of Ventrua County for the Fall of 1997. Combined dataset with error values removed, horizontal and vertical units are in feet, limited to no offshore bathymetry, State Plane Coordinate System California V 1983, pre-El Niño
NOAA	8/4/1998 - 28/4/1998	SpringWC_1998_1.tif - SpringWC_1998_7.tif	LiDAR DEM	Coastal LiDAR TopoBathy DEM of Ventrua County for the Spring of 1998. Mosaic dataset, horizontal and vertical units are in feet, limited to no offshore bathymetry, State Plane Coordinate System California V 1983, post-El Niño

M&N		
	CLIENT	County of Ventura
	PROJECT	TECHNICAL REVIEW OF FEMA CALIFORNIA COASTAL ANALYSIS AND MAPPING (CCAMP)
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		JN: 9733

Source	Date	Document	Description	Notes
NOAA	8/4/1998 - 28/4/1998	SpringWC_1998_Combined.tif	LiDAR DEM	Combined Coastal LiDAR TopoBathy DEM of Ventrua County for the Spring of 1998. Combined dataset with error values removed, horizontal and vertical units are in feet, limited to no offshore bathymetry, State Plane Coordinate System California V 1983, post-El Niño
NOAA	1/1/2009 - 1/1/2011	WC_DEM_2010_1.tif - WC_DEM_2010_4.tif	LiDAR DEM	Coastal LiDAR TopoBathy DEM of Ventrua County for 2009-2011. Mosaic dataset of topography and bathymetry over 2 years, horizontal and vertical units are in meters, State Plane Coordinate System California V 1983
NOAA	1/1/2009 - 1/1/2011	WC_DEM_2010_Combined.tif	LiDAR DEM	Combined Coastal LiDAR TopoBathy DEM of Ventrua County for 2009-2014. Combined dataset of topography and bathymetry over 2 years, vertical units converted to feet, State Plane Coordinate System California V 1983
NOAA	8/9/2014 - 5/10/2014	WC_DEM_2014_1.tif - WC_DEM_2014_4.tif	LiDAR DEM	Combined Coastal LiDAR TopoBathy DEM of Ventrua County for Fall 2014. Mosaic dataset of topography and bathymetry in Fall 2014, horizontal and vertical units are in meters, State Plane Coordinate System California V 1983
NOAA	8/9/2014 - 5/10/2014	WC_DEM_2014_Combined.tif	LiDAR DEM	Combined Coastal LiDAR TopoBathy DEM of Ventrua County for Fall 2014. Combined dataset of topography and bathymetry in Fall 2014, vertical units have been converted to feet, State Plane Coordinate System California V 1984
County of Ventura office of sustainability	Multiple	Sea Level Rise and Climate Change Impacts in Ventura County Images.ppt	Photos	Photos of various flooding and erosion extents - photos dated and credited on slides

M&N		
	CLIENT	County of Ventura
	PROJECT	TECHNICAL REVIEW OF FEMA CALIFORNIA COASTAL ANALYSIS AND MAPPING (CCAMP)
	DESIGN FOR	DATA INVENTORY CA 3/24/17
		JN: 9733

Source	Date	Document	Description	Notes
County of Ventura	2017	VenturaCountyFloodPlainManagementOrdinance.pdf	Document	Ventura County Flood Plain Management Ordinance.
County of Ventura	2005	VC Coastal 2005 Lidar Topo	GIS Files	Multiple GIS Shapefiles
City of Ventura	02/14/1996	1996DO17.tif	Map	Bathymetry figure of Ventura Pier, also details the destruction of the pier, units are in feet, NAD 1927, California Coordinate System V, 1in = 50ft scale. Bathymetry of Ventura Pier (and destruction).
City of Ventura	06/17/1997	1997DO47.pdf	Drawings	Details the specifications of the pier repair and construciton. Features diagrams of the pier dimensions, bracings, and and deck plans. Ventura Pier reconstruction engineering plan.
City of Ventura	1998	1998DO58.pdf	Drawings	Details the specifications of the pier extension and its construciton. Features diagrams of the pier dimensions, bracings, deck plans, and site specific bathymetry at the time of construction. Ventura Pier extension engineering plan.
City of Ventura	11/14/2016	111416_BrocktonLn_T38.pdf	Drawing	Photos and beach profile Brockton Lane. Transect 38 panel 744.
City of Ventura	11/14/2016	111416_BrunswickLn_T40.pdf	Drawing	Photos and beach profile Brunswuck Lane. Transect 40 panel 744.
City of Ventura	11/14/2016	111416_CamdenLn_T41.pdf	Drawing	Photos and beach profile Camden Lane. Transect 41 panel 744.
City of Ventura	11/14/2016	111416_GreenockLn.pdf	Drawing	Photos and beach profile Greenock Lane.
City of Ventura	11/14/2016	111416_MarthasVinyardCt.pdf	Drawing	Photos and beach profile Marthas Vinyard Court.

M&N		
	CLIENT	County of Ventura
	PROJECT	TECHNICAL REVIEW OF FEMA CALIFORNIA COASTAL ANALYSIS AND MAPPING (CCAMP)
	DESIGN FOR	DATA INVENTORY CA 3/24/17
		JN: 9733

Source	**Date**	**Document**	**Description**	**Notes**
City of Ventura	11/14/2016	111416_SeawardAve_T39.pdf	Drawing	Photos and beach profile Seaward Avenue. Transect 38 panel 744.
City of Ventura	11/17/2016	Ventura_OPC-CCAMP_30 Day Initial Comments_111716.pdf	Letter	Letter from Brad Starr to FEMA with initial PFIRM/FIS comments.
City of Oxnard	12/11/2015	Oxnard Mandalay GS NRG beach flooding photos Dec 11 2015	Photos	Photos of various flood and erosion extents from December 2015. Wave and erosion damages at oxnard shores and mandalay
BEACON	Multiple	BEACON BEACHES 2017 .pdf	Photos	Photos of various flood and erosion extents from recent years. Wave and erosion damages between 2015 and 2017

Appendix B

Transect Review Summary

Ventura County PFIRM Overall Transect Review - 8/18/2017

Color Coding: [blue] = Detailed review performed

PFIRM Transect No.	Analysis Transect No.	Jurisdiction	Effective BFE (FT, NAVD88)	PFIRM BFE (FT, NAVD88)	Priority for Detailed Review (Yes/No/Maybe)	Transect Layout-Spacing	Extreme TWL (Overestimate/Underestimate/Acceptable)	Runup equation used	Event based erosion (EBE, Y/N)	MLWP (Y/N)	MLWP Comments	Overtopping/Overland Flow, Comments	Multiple VE zones (Y/N)	Coastal Structure Considered in PFIRM	Backshore Type	1%BFE exceeds the record event? (Y/N)
1	677	Unincorporated	12	12.8	Yes, Rincon Pt	Waves approach from oblique angle to transect. 1D transect not representative of nearshore wave refraction & runup patterns	U, input wave parameters for peak TWL are low (5 ft @ 16s)	Stockdon, may not suitable for runup on cobble beaches	N	N	N/A	Y	N	N	Bluff (should be cobble delta)	N
2	667	Unincorporated	12	32.5	Yes, Rincon Pt	OK to represent the reach, but transition zone should be added between #1 and #2 as well as #2 and #3	O, larger wave input (12 ft @ 12 s). TWL assume no rock or roughness factor. TWL represents splash height not flood level	TAW, depth at toe probably conservative due to presence of rock and reef	N	N	N/A	Y, OT should be considered since TWL >> EG	N	Revet, failed	Bluff. Revetment along PCH. Structure will be maintained in place to protect Hwy 101. Failed geometry (smooth slope) a poor assumption.	Y
3	646	Unincorporated	12	14.9	No	OK	U, TWL doesn't include erosion or runup against backshore revetment	Stockdon	N	N	N (need to look at seasonal changes, MLWP)	N, no overtopping for intact or failed case	N	Revet, failed	Sandy beach backed by Revetment along PCH, not factored into TWL	Y
4	637	Unincorporated	12	16.2	Yes, Mussel Shoals	OK	U, assumed beach slope, incorrect backshore type applied in calc	Stockdon (TAW is not applicable and check applicability of Stockdon)	N	N	N (need to look at seasonal changes)	N	N	Revet, failed	narrow beach fronting Bluff (1:1) with revetment, except TAW calc not applied at this transect	N
5	633	Unincorporated	13	29.3	Yes, Mussel Shoals	OK to represent the reach, but transition zone should be added between #4 and #5 as well as #5 and #6	O, assume no rock or roughness factor. TWL represents splash height not flood level	TAW	N	N	N (need to look at seasonal changes)	Y, OT should be considered since TWL >> EG	N	Revet, failed	Bluff (1:1)	Y
6	627	Unincorporated	13	20.0	No	OK	U, shallow depth at toe of structure applied (2-4 ft)	TAW, depth at toe limits Hb	N	N	N (need to look at seasonal changes)	N (For revet failed). Y, (For revet intact). Hwy at +25 here, probably little to no OT during 1% TWL	N	Revet, failed	Bluff. Revetment along PCH. Structure will be maintained in place to protect Hwy 101. Failed geometry a poor assumption.	N
7	610	Unincorporated	11	32.6	No	OK	O, TWL assume no rock or roughness factor and very steep slope (1:1). TWL represents splash height not flood level	TAW	N	N	N/A	Y, Hwy at +30 here, probably little to no OT during 1% TWL	N	Revet, failed	Bluff. Revetment along PCH. Structure will be maintained in place to protect Hwy 101. Failed geometry (steep, smooth slope) a poor assumption.	Y

Note: O = Overestimate; A = Acceptable; U = Underestimate

PFIRM Transect No.	Analysis Transect No.	Jurisdiction	Effective BFE (FT, NAVD88)	PFIRM BFE (FT, NAVD88)	Priority for Detailed Review (Yes/No/Maybe)	Transect Layout-Spacing	Extreme TWL (Overestimate/Underestimate/Acceptable)	Runup equation used	Event based erosion (EBE, Y/N)	MLWP (Y/N)	MLWP Comments	Overtopping/Overland Flow, Comments	Multiple VE zones (Y/N)	Coastal Structure Considered in PFIRM	Backshore Type	1%BFE exceeds the record event? (Y/N)
8	601	Unincorporated	11	34.4	Yes, Seacliff	OK	O, TWL assume no rock or roughness factor and very steep slope (1:1). TWL represents splash height not flood level	TAW	N	N	N/A	Y, VE2 mapped with BFE of 20 (~10 > EG). Need to find out how they estimated this BFE & landward boundary of VE2 zone.	Y	Revet, failed	Bluff + Offshore reef. Revetment along development recently repaired and will likely be maintained. Failed geometry (steep, smooth slope) a poor assumption.	Y
9	592	Unincorporated	13	30.0	Yes	OK	O	TAW	N	N	N/A	Y	Y	Revet, failed	Bluff.	N
10	580	Unincorporated	13	26.0	No	OK		TAW	N	N	N (need to look at seasonal changes)	Y	Y	Revet, failed	Bluff.	Y
11	568	Unincorporated	13	36.8	Yes	OK	O, TWL assume no rock or roughness factor. TWL represents splash height not flood level	TAW	N	N	N/A	Y	Y	Revet, failed	Mobile park fronted by large, well constructed revetment. Unlikely to fail. No dry beach.	N
12	567	Unincorporated	13	26.0	Yes	Waves approach from oblique angle to transect. 1D transect not representative of nearshore wave refraction & runup patterns	O, Waves travel parallel to shore and are reduced by nearshore reef.	TAW	N	N	N/A	Y	Y	Seawall	Private homes w/o continuous seawall, revetment, or a combination of both. No dry beach exists. The revetment doesn't appear to be engineered, should not be considered in analysis. Unknown condition/construction/maintenance of private seawalls.	Y
13	565	Unincorporated	12	21.0	Yes	Waves approach from oblique angle to transect. 1D transect not representative of nearshore wave refraction & runup patterns	O, Waves travel parallel to shore and are reduced by nearshore reef.	Stockdon, lilely wrong for overtopped events	N	N	N/A	Y	Y	Seawall	Same as above	N
14	561	Unincorporated	12	26.1	Yes	Waves approach from oblique angle to transect. 1D transect not representative of nearshore wave refraction & runup patterns	O, Waves travel parallel to shore and are reduced by nearshore reef.	TAW	N	N	N/A	Y	Y	Revet, failed	Same as above	N
15	556	Unincorporated	12	21.3	Yes	Waves approach from oblique angle to transect. 1D transect not representative of nearshore wave refraction & runup patterns	O, Waves travel parallel to shore and are reduced by nearshore reef.	TAW	N	N	N/A	Y	N	Seawall	Same as above	N

Note: O = Overestimate; A = Acceptable; U = Underestimate

PFIRM Transect No.	Analysis Transect No.	Jurisdiction	Effective BFE (FT, NAVD88)	PFIRM BFE (FT, NAVD88)	Priority for Detailed Review (Yes/No/Maybe)	Transect Layout-Spacing	Extreme TWL (Overestimate/Underestimate/Acceptable)	Runup equation used	Event based erosion (EBE, Y/N)	MLWP (Y/N)	MLWP Comments	Overtopping/Overland Flow, Comments	Multiple VE zones (Y/N)	Coastal Structure Considered in PFIRM	Backshore Type	1%BFE exceeds the record event? (Y/N)
16	554	Unincorporated	12	24.1	Yes	OK	O	TAW	N	N	N (need to look at MLWP to determine appropriate runup method)	Y	N	N	Bluff.	Y
17	549	Unincorporated	12	24.5	Yes	OK	O	TAW	N	N	N (need to look at seasonal changes)	Y	N	Seawall	Residential with individual seawalls, fronted by narrow beach.	Y
18	546	Unincorporated	12	28.9	Yes	OK	O, Should consider revetment. TWL assumes no rock or roughness factor. TWL represents splash height not flood level	TAW	N	N	N (need to look at seasonal changes)	Y	N	Revet, failed	Revetment along PCH will likely be maintained in place. Failed geometry (steep, smooth slope) a poor assumption.	Y
19	539	Unincorporated	12	27.6	Yes	OK	O, Should consider revetment. TWL assumes no rock or roughness factor. TWL represents splash height not flood level	TAW	N	N	N/A	Y	Y	Revet, failed	Residential parcels with continuous revetment.	Y
20	533	Unincorporated	12	27.3	Yes	OK	O, Should consider revetment. TWL assumes no rock or roughness factor. TWL represents splash height not flood level	TAW	N	N	N/A	Y	Y	Revet, failed	same as above	Y
21	531	Unincorporated	12	18.5	Yes	OK		Stockdon, should be TAW for overtopped events	N	N	N (need to look at seasonal changes)	Y	N	Revet, failed	same as above	N
22	529	Unincorporated	13	19.1	No	OK		TAW okay	N	N	N (need to look at seasonal changes)	Y	N	Revet, failed	Revetment along Rincon Parkway, beach is seasonal and usually gone in MLWP	N
23	525	Unincorporated	13	18.1	No	OK	U, ? No dry beach, waves runup at vertical seawall.	Stockdon, should be TAW for overtopped events	N	N	N/A	Y	N	N	No dry beach. Cobbles. Vertical seawall.	Y
24	515	Unincorporated	13	19.6	No	Transect may not be representative of conditions at east end of zone where State Beach Access Road bows out onto beach.	A ?	Stockdon, should be TAW for overtopped events	N	N	N (need to look at seasonal changes)	Y	N	N	No dry beach. Vertical seawall. Cobbles.	N
25	506	Unincorporated	13	18.7	No	OK	A ?	Stockdon, should be TAW for overtopped events	N	N	N (need to look at seasonal changes)	Y	N	Revet, failed	Revet / Emma Wood SB / Bluff / Cobbles.	N

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26	502	Unincorporated	13	21.0	No	OK	O ?	TAW	N	N	N/A	Y	N	Seawall. Should be failed.	Seawall / Emma Wood SB / Bluff /Cobbles.	Y
27	492	Unincorporated	14	25.7	No	OK	O	Stockdon, OK for cobble beach?	N	N	N (need to look at seasonal changes)	Y (only 0.2%)	N	N	Emma Wood SB / Bluff /Cobbles.	Y
28	487	Ventura	14	23.6	Yes	Not representative. West half of zone is unrevetted cobble beach, East half of zone is revetted sandy beach.	A	DIM/TAW Should be Stockdon?	N	N	N (need to look at seasonal changes)	Y (only 0.2%)	N	N, Should consider Revetment in east half of zone. RR will maintain/expand revetment.	RR tracks are along the back of the beach. Half of this zone has a rock revetment fronting the tracks. The RR will likely extend the revetment as erosion continues. Cobbles.	Y
29	480	Ventura	12	25.2	Yes	OK, representative of river delta.	A	Stockdon	N	N	N (need to look at seasonal changes)	Y	N	N	Beach. Cobbles.	N
30	469	Ventura	12	22.0	Yes	OK, Strange shoreline in this area, transect captures narrowest portion in zone.	A	Stockdon / TAW	N	N	N (need to look at seasonal changes)	Y	Y	N	Bluff (cobble beach not represented in TAW with roughness)	N
31	463	Ventura	16	11.4	Yes	Waves approach from oblique angle to transect. 1D transect not representative of nearshore wave refraction & runup patterns	U - water reaches on top of promenade	DIM/TAW	N	N	N (need to look at seasonal changes)	N	N	N	bluff (cobble beach not represented in DIM with roughness, TAW may be more applicable)	N
32	459	Ventura	16	10.8	Yes	Waves approach from oblique angle to transect. 1D transect not representative of nearshore wave refraction & runup patterns	U - water reaches on top of promenade	DIM/TAW	N	N	N (need to look at seasonal changes)	N	N	seawall	seawall + bluff (cobble beach not represented in DIM with roughness, TAW may be more applicable)	N
33	457	Ventura	12	18.2	Yes	OK	U- waves have reached deck of pier at ~25' NAVD	Stockdon (should be TAW)	N	N	N (need to look at seasonal changes)	N	N	seawall	seawall + bluff (with narrow ephemeral sand beach with intermittently exposed cobble beach not represented in stockdon)	N
34	452	Ventura	12	16.8	Yes	OK	U- waves have reached deck of pier at ~25' NAVD	stockdon	N	N	N (need to look at seasonal changes)	Y	N	N	beach (intermittent cobbles)	N
35	449	Ventura	12	15.7	Yes	OK	U -slightly low waves	stockdon	N	N	N (need to look at seasonal changes)	Y (only 0.2%)	N	N	beach (intermittent cobbles)	N

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36	446	Ventura	12	22.2	Yes	OK	O - possibly due to steep beach slope and cobbles	stockdon (beach slope doubles from T35-T36)	N	N	N (need to look at seasonal changes)	Y	N	N	beach (intermittent cobbles)	N
37	443	Ventura	12	17.7	Yes	OK	A	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	N	N	N	beach	N
38	438	Ventura	12	19.3	Yes	OK	A/O - perhaps	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y (only 1%)	N	retaining wall - non wave loading	beach	N
39	434	Ventura	12	16.0	Yes	OK	U - slope may be too low, biased by groin field	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	retaining wall - non wave loading	beach	N
40	430	Ventura	12	18.4	Yes	OK	U - slope may be too low, biased by groin field	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	retaining wall - non wave loading	beach	N
41	426	Ventura	13	17.6	Yes	OK	U - slope may be too low, biased by groin field	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	retaining wall - non wave loading	beach	N
42	423	Ventura	13	14.0	Yes	slopes may be affected by proximity to groin	U - slope may be too low, biased by groin field	stockdon (DIM/TAW)	N	N	N (need to look at seasonal changes)	N, (revet failed). Y (Revetment intact, only 0.2%). Need to look at City reports overtopping into harbor	N	revetment, failed	revetment and beach	N
43	415	Ventura	13	9.4	Yes	OK	A	stockdon	N	N	N (need to look at seasonal changes)	N	N	breakwater	breakwater and beach	N
44	410	Ventura	13	20.2	Yes	OK	A	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y, (Failed scenario only 0.2%) Y, (Intact)	N	retaining wall - non wave loading	beach	N
45	383	Oxnard	13	19.4	Yes	OK	U - slope and waves seem low	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	N	N	N	beach	N
46	375	Oxnard	13	19.3	Yes	OK	U - slope and waves seem low	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	N	N	N	beach	N
47	359	Oxnard	13	20.1	Yes	OK	U - waves seem low	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	N	N	N	beach	N

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48	347	Oxnard	13	20.6	Yes	OK	U - waves seem low	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	N	beach	N
49	342	Oxnard	13	20.1	Yes	OK	U - waves seem low	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	N	beach	N
50	338	Oxnard	13	21.3	Yes	OK	A	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	N	N	N	beach	N
51	330	Oxnard	13	18.3	Yes	OK	U - waves seem low	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	N	N	N	beach	N
52	322	Oxnard	13	17.1	Yes	OK	U - waves seem low	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	N (near small retaining walls which could influence map extents)	beach	Y
53	308	Oxnard	16	10.8	Yes	OK	O - wave should be more sheltered , check beach condition during lidar flight	stockdon (DIM/TAW)	N	N	N (need to look at seasonal changes)	Y (only 0.2%)	N	breakwater	breakwater and beach	Y
54	301	County/Port Huen	16	21.5	Yes	OK	U- waves low	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	N (should be yes)	beach	Y
55	293	County/Port Huen	16	24.0	Yes	Should be more shore normal	A	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	N (should be yes)	beach	N
56	290	Port Hueneme	Zone A	18.1	Yes	OK	A	DIM/TAW	N	N	N (need to look at seasonal changes)	Y	N	N (should be yes, revetment)	bluff (revetment)	N
57	286	Port Hueneme	Zone A	13.6	Yes	OK	O - diffraction out of canyon maybe make waves smaller?	stockdon	N	N	N (need to look at seasonal changes)	Y (only 0.2%)	N	breakwater	breakwater and beach	N
58	288	Port Hueneme	Zone A	14.6	Yes	OK, strange location	O - diffraction out of canyon maybe make waves smaller?	stockdon and DIM/TAW	N	N	N (need to look at seasonal changes)	Y	N	breakwater and revetment	breakwater, revetment, and beach	N
59	277	Port Hueneme	Zone A	14.6	Yes	OK	U - need to consider run up wave splash	stockdon (also need DIM/TAW)	N	N	N (need to look at dredging changes)	N, OT should be considered since TWL >> EG	N	revetment, failed	revetment and bluff (only revetment)	N

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60	274	Port Hueneme	Zone A	14.1	Yes	OK	U - need to consider run up wave splash	stockdon (also need DIM/TAW)	N	N	N (need to look at dredging changes)	N, OT should be considered since TWL >> EG	N	N (Y recent erosion response may have placed revetment or seawall here, FEMA indicates a failed revetment)	bluff and revetment (only revetment)	N
61	270	Port Hueneme	Zone A	22.0	Yes	OK	O - beach slope too steep?	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	N (Y recent erosion response may have placed revetment or seawall here)	beach	N
62	263	Port Hueneme	Zone A	18.1	Yes	OK	A	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	N	N	N	beach	N
63	240	Oxnard	13	15.7	No	OK	U - low slope	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y (only 0.2%)	N	N	beach	N
64	231	Oxnard	13	15.1	No	OK	U - low slope	stockdon	N (Need to account for EBE)	N	N (need to look at seasonal changes)	Y	N	N	beach	N
65	218	Unincorporated	-	15.6	No	OK	A?	stockdon	N	N	N (need to look at seasonal changes)	Y, Bore overtopping	Y	N	beach	N
66	211	Unincorporated	-	17.3	No	OK	A	stockdon	N	N	N (need to look at seasonal changes)	Y	N	N, Groins are present in this Zone	beach	N
67	202	Unincorporated	-	17.8	No	OK	A	stockdon and DIM/TAW	N	N	N/A	Y (failed condition). Y (intact only 0.2%)	N	revetment, failed	revetment and beach, Revetment in in good condition. Protects military runway and will be maintained.	N
68	195	Unincorporated	-	19.1	No	OK	A	stockdon	Y	N	N (need to look at seasonal changes)	N	N	N	dune	N
69	189	Unincorporated	-	14.8	No	OK	U, Should be similar to 68. Slope assumption may be too shallow.	stockdon	N	N	N (need to look at seasonal changes)	Y	N	N	beach	Y
70	181	Unincorporated	-	15.5	No	OK,Drawn in steepest / narrowest beach portion of zone	U, Wave height is low.	stockdon	N	N	N (need to look at seasonal changes)	N	N	N	beach	N

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71	175	Unincorporated	-	19.9	No	Orientation may be skewed. Transect and zone do not extend as far seaward compared to all other transects and zones. This may be a poor assumption as there is a submarine canyon offshore	O?, Revetment is in good condition, likely to be maintained. Failure runup analysis a poor assumption.	stockdon and DIM/TAW	N	N	N/A	Y (failed condition)	Y	revetment, failed	revetment and bluff	N
72	169	Unincorporated	-	19.9	No	Orientation may be skewed. Transect and zone do not extend as far seaward compared to all other transects and zones. This may be a poor assumption as there is a submarine canyon offshore	O?, Revetment is in good condition, likely to be maintained. Failure runup analysis a poor assumption.	stockdon (should be DIM/TAW)	N	N	N/A	Y	Y	revetment, failed	revetment and bluff	N
73	165	Unincorporated	-	18.1	No	Transect and zone do not extend as far seaward compared to all other transects and zones. This may be a poor assumption as there is a submarine canyon offshore	U, Wave height is low.	stockdon (should be DIM/TAW)	N	N	N/A	Y	N	revetment, failed	revetment	N
74	163	Unincorporated	-	23.5	No	OK, Skew may not be normal to wave approach.	O?, Wave height may be low. Beach backed by small non-engineered revetment, a better assumption may consider as a sandy beach and use Stockdon method.	stockdon and DIM/TAW	N	N	N/A	Y	N	revetment, failed	revetment and sandy beach - intermittent cobbles as well	Y
75	160	Unincorporated	-	18.5	No	OK	U, Wave height is low.	stockdon	N	N	N (need to look at seasonal changes)	Y	Y	N	sandy beach - intermittent cobbles as well	N
76	157	Unincorporated	-	26.3	No	OK	A? Wave height may be low. Revetment is in good condition, likely to be maintained. Failure runup analysis a poor assumption.	stockdon (should be DIM/TAW)	N	N	N/A	Y	Y	revetment, failed	revetment and bluff	N
77	141	Unincorporated	-	16.9	No	OK	A	stockdon	N	N	N (need to look at seasonal changes)	Y	N	N	sandy beach - intermittent cobbles as well	N
78	128	Unincorporated	-	22.4	No	Panel 1104 Missing, Revetted structure encroaches coastline in this zone	A?	stockdon	N	N	N (need to look at seasonal changes)	Y	N	N	sandy beach - intermittent cobbles as well	N
79	115	Unincorporated	18	21.7	No	OK	A, Period seems low	DIM/TAW	N	N	N (need to look at seasonal changes)	Y (only 0.2%)	N	N, non continuous revetment does exist in zone.	bluff	N

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80	102	Unincorporated	18	35.1	No	OK	O, Period/Wave Height seems low. Revetment will be maintained to protect HWY 1, Failure a poor assumption.	stockdon (should be DIM/TAW)	N	N	N/A	Y (only 0.2%)	N	revetment, failed.	revetment and bluff	Y
81	93	Unincorporated	13	25.9	No	OK	O, Beach slope may be too steep	stockdon	N	N	N (need to look at seasonal changes)	Y	Y	N	sandy beach - intermittent cobbles as well	N
82	79	Unincorporated	16	20.2	No	OK	A, Revetment will be maintained to protect HWY 1, Failure a poor assumption.	DIM/TAW	N	N	N/A	Y (only 0.2%)	N	revetment, failed.	revetment and bluff	N
83	72	Unincorporated	13	22.3	No	OK	O, Pocket beach, slope may be too steep.	stockdon	N	N	N (need to look at seasonal changes)	Y	N	N	sandy beach - intermittent cobbles as well	N
84	51	Unincorporated	15	27.7	No	OK	O, Waves may be reduced by nearshore reef. Revetment will be maintained to protect HWY 1, Failure a poor assumption.	stockdon and DIM/TAW	N	N	N/A	N	N	revetment, failed.	revetment and bluff	Y
85	45	Unincorporated	15	20.0	No	Transect at break in revetment.	O, Waves may be reduced by nearshore reef. Revetment failure a poor assumptuion.	stockdon and DIM/TAW	N	N	N/A	N	N	revetment, failed.	revetment and bluff	N
86	22	Unincorporated	14	19.6	No	Panel 1137 Missing	O, Waves may be reduced by nearshore reef. Revetment failure a poor assumptuion.	stockdon and DIM/TAW	N	N	N/A	N	N	N	bluff	N
87	18	Unincorporated	14	17.8	No	Panel 1137 Missing	A?	stockdon (should be DIM/TAW)	N	N	N/A	N	N	N	bluff	N
88	14	Unincorporated	14	33.6	No	Panel 1137 Missing	O, Revetment will be maintained to protect HWY 1, Failure a poor assumption.	stockdon and DIM/TAW	N	N	N/A	Y	N	revetment, failed.	revetment and bluff	N
89	10	Unincorporated	14	20.2	No	Panel 1137 Missing	O	DIM/TAW	N	N	N/A	Y	N	Seawall	seawall and bluff	N
90	6	Unincorporated	14	19.0	No	Panel 1137 Missing	A?	stockdon	N	N	N (need to look at seasonal changes)	N	N	N	bluff	N

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Appendix C

Comments and List of Applicable Comments for Each Transect

LIST OF RECOMMENDATIONS FOR FEMA

Comment 1. Consistence check of parameters used between neighboring transects is recommended. It is strange that the neighboring transects would have different wave periods and sometimes different SWL for the same storm event at the 40 m depth. For example, during the March 1, 1983 (3/1/1983 23:00) storm, the wave period varies significantly from 11.9 to 19.2 seconds among neighboring transects from 75 through 80, and from 19.2 seconds at Transect 87 to 15.9 seconds at both Transects 86 and 88. Although wave height can vary greatly due to the refraction patterns, the wave period and SWL is typically homogeneous across the region at 40-m depth during any given storm event. (Section 4.1)

Comment 2. Please consider wave approach angle which could likely lead to a reduction in BFE. Waves approach the shore at oblique angles in many reaches along the Ventura coastline and should be considered in the runup analysis. (Section 4.1)

Comment 3. The pattern of BFE shall be close to the typical pattern of refracted waves inside the Santa Barbara channel. Please check and explain. (Section 4.1)

Comment 4. Correct AE zone mapping errors for the reach between transects 44 and 45, and between 46 and 47. There are some odd discrepancies around the Rio de Santa Clara Land Grant where no coastal flood mapping has been identified despite the fact this area was flooded during the 1969 riverine flood event and is exposed to both riverine and coastal flood hazards (Section 4.2)

Comment 5. Add transects to support the VE zone designations for coast between transects 88 and 89, and south of transect 90. (Section 4.2)

Comment 6. It is recommended that transects begin at a shallower depth around -15 to -20 m bathymetry contours instead of -40 m. Using wave parameters at the 40-m depth from the nearshore wave model as input parameters for the wave runup analysis is a poor choice for reaches with oblique wave approach angles and wave refraction. As some of the 2-D wave phenomena captured in the 2-D model cannot be captured in 1-D transect based analysis. These may lead to overestimate of the BFE. Please update the analysis. (Section 4.2)

Comment 7. The transect numbering scheme in the IDS shall correspond to the PFIRM transect numbers allowing reviewers to understand the technical approach and results applied at each location. Please renumber transects accordingly. (Section 4.2)

Comment 8. Limit the difference on BFE between neighboring transects. PFIRMs for the Ventura County show that the difference in BFEs between neighboring transects is more than 10 feet around the following transects: 1-2, 4-5, 6-7, 10-11, 11-12, 30-31, 79-80, 87-88, 88-89. If the difference in BFE between neighboring transects exceeds a certain threshold regardless of the shore feature similarities, additional transect(s) should be added between those neighboring transects. If an isolated feature resulted in large BFE variations, a minimum of two transects should be used to bracket the BFE around the feature, and a transitional reach be provided to transit the BFE from one to another. Otherwise, it is very difficult for floodplain managers to interpret and implement the map results. This is particularly true for transacts separating neighboring residential properties. This practice is also not consistent with Pacific Guidelines (Section D.4.9.6) which states: Transition zones may be necessary between areas with high runup elevations to avoid big differences between BFEs and to smooth the changes in flood boundaries. (Section 4.2)

Comment 9. Please identify the Primary Frontal Dunes (PFD) or explain why the preliminary FIRM mapping effort failed to identify any PFD outside of transect 68. (Section 4.4)

Comment 10. Please justify the use of a single topographic data set without performing the Most Likely Winter Profile (MLWP) analysis. The BFE analysis was based on a single 2009 LiDAR dataset with wide beaches and high dunes in many areas. The topographic profiles can vary greatly between seasons and years (such as pre- and post-El Niño winters). In some cases, beach widths can change up to 200 feet over a few years. Therefore, it is important to consider a range of potential morphologies when determining flood elevations and extents. The study contractor should follow the Pacific Guidelines, determine the Most Likely Winter Profile (MLWP) before performing wave runup analysis. Skipping the step of determining the MLWP would lead to underestimates of both flood hazard extent and BFE. (Section 4.5)

Comment 11. Please perform Event-Based Erosion analysis or explain why the preliminary FIRM mapping effort failed to perform Event-Based Erosion analysis outside of transect 68. (Section 4.6)

Comment 12. Treatment of shore protection structures has a significant impact on BFEs. Many rock revetments (at Transects 4, 6, 9, 11, 14, 21, 22 ,25, 56, 59, 60, 67, 71, 72, 73, 76, 82 and 88 along the County coastline) were engineered with multiple layers of rock sized to resist extreme wave forces and survived equivalent to and larger than the 1% annual chance storm event. Per the Pacific Guidelines (Section D4.7.3), these structures may be recognized on flood hazard maps. However, no structures were recognized in the study as they are not certified. For these structures, a more representative failure mode for analysis is partial failure mode. Please apply the partial failure mode and appropriate roughness coefficient in the analyses of these transects. (Section 4.7.1)

Comment 13. Please consider the beach slope effect on the wave breaking criterion (ratio of wave height to water depth) and use an appropriate ratio of wave height to water depth in the analysis. Without considering the slope effect would lead to underestimate of wave height. (Section 4.9)

Comment 14. Please provide methods used to define and identify dtoe and dcrest in the IDS. Please also include a discussion of the dheel and incorporate those into the hazard mapping. (Section 4.9)

Comment 15. Roughness factor due to presence of cobbles, offshore reefs, and rock from failed revetment structures were not considered, which would lead to overestimate of BFE. A composite roughness factor should be used instead of using roughness factor of sandy/earthen materials. Rock revetments were completely removed from the transect geometry and the roughness factor was replaced with that of sand for the analysis of the structure failure scenario. The roughness treatment was not consistent with Section D.4.7.3.2 of the Pacific Guidelines, which states: *the Mapping Partner shall select an appropriate roughness factor when conducting runup and overtopping analyses on the failed structure. Please correct.* (Section

4.9)

Comment 16. Minimum mappable distance criterion: A 35-foot minimum distance criterion was applied in the mapping for transects with overtopping. If the resulting landward runup zone was less than 35 feet, the overtopping runup zones were either integrated into the primary coastal Zone VE or, where the VE and AO overtopping zones together were at least 35 feet, combined to create a secondary zone VE. The resulting mapped BFE in the runup zones is often 5 feet higher than the calculated BFE. This practice is inconsistent with Pacific Guidelines (Section D.4.9.4) as the community officials were not consulted about setting 35-foot as the minimum mappable distance criterion. With today's technology, it is recommended to include the secondary VE zones and the AO zones with calculated width in the digital FIRMs, which can have much higher resolution than the hard copy maps. (Section 6.2.4)

Comment 17. Transects 13, 23, 24, 25 and 33, where Stockdon runup method may have been misapplied to cobble beaches, or revetment backed beaches as opposed to using the more appropriate TAW runup equations, which likely lead to overestimate of runup. Please check that the appropriate equation was used and recalculate the BFE if necessary.

Ventura County PFIRM - Refers to List of Recommendations

Color Coding: [blue] = Detailed review performed

PFIRM Transect No.	Analysis Transect No.	Jurisdiction	Effective BFE (FT, NAVD88)	PFIRM BFE (FT, NAVD88)	Comment #s in Report
1	677	Unincorporated	12	12.8	1, 2, 3, 6, 7, 8, 10, 13, 15
2	667	Unincorporated	12	32.5	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
3	646	Unincorporated	12	14.9	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
4	637	Unincorporated	12	16.2	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
5	633	Unincorporated	13	29.3	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
6	627	Unincorporated	13	20.0	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
7	610	Unincorporated	11	32.6	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
8	601	Unincorporated	11	34.4	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16
9	592	Unincorporated	13	30.0	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16
10	580	Unincorporated	13	26.0	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16
11	568	Unincorporated	13	36.8	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16
12	567	Unincorporated	13	26.0	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16
13	565	Unincorporated	12	21.0	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16, 17
14	561	Unincorporated	12	26.1	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16
15	556	Unincorporated	12	21.3	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
16	554	Unincorporated	12	24.1	1, 2, 3, 6, 7, 8, 10, 13, 15
17	549	Unincorporated	12	24.5	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
18	546	Unincorporated	12	28.9	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
19	539	Unincorporated	12	27.6	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16
20	533	Unincorporated	12	27.3	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16
21	531	Unincorporated	12	18.5	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
22	529	Unincorporated	13	19.1	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
23	525	Unincorporated	13	18.1	1, 2, 3, 6, 7, 8, 10, 12, 13, 15,17
24	515	Unincorporated	13	19.6	1, 2, 3, 6, 7, 8, 10, 12, 13, 15,17
25	506	Unincorporated	13	18.7	1, 2, 3, 6, 7, 8, 10, 12, 13, 15,17
26	502	Unincorporated	13	21.0	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
27	492	Unincorporated	14	25.7	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
28	487	Ventura	14	23.6	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
29	480	Ventura	12	25.2	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
30	469	Ventura	12	22.0	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 16

PFIRM Transect No.	Analysis Transect No.	Jurisdiction	Effective BFE (FT, NAVD88)	PFIRM BFE (FT, NAVD88)	Comment #s in Report
31	463	Ventura	16	11.4	1, 2, 3, 6, 7, 8, 10, 13, 15
32	459	Ventura	16	10.8	1, 2, 3, 6, 7, 8, 10, 12, 13, 15
33	457	Ventura	12	18.2	1, 2, 3, 6, 7, 8, 10, 12, 13, 15, 17
34	452	Ventura	12	16.8	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 15
35	449	Ventura	12	15.7	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14, 15
36	446	Ventura	12	22.2	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14, 15
37	443	Ventura	12	17.7	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14, 15
38	438	Ventura	12	19.3	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14, 15
39	434	Ventura	12	16.0	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14, 15
40	430	Ventura	12	18.4	1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 14, 15
41	426	Ventura	13	17.6	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14, 15
42	423	Ventura	13	14.0	1, 2, 3, 6, 7, 8, 10, 12, 13, 14, 15
43	415	Ventura	13	9.4	1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 14, 15
44	410	Ventura	13	20.2	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14
45	383	Oxnard	13	19.4	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14
46	375	Oxnard	13	19.3	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14
47	359	Oxnard	13	20.1	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14
48	347	Oxnard	13	20.6	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14
49	342	Oxnard	13	20.1	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14
50	338	Oxnard	13	31.3	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14
51	330	Oxnard	13	18.3	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14
52	322	Oxnard	13	17.1	1, 2, 3, 6, 7, 8, 9, 10, 11, 13, 14
53	308	Oxnard	16	10.8	1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 14
54	301	County/Port Hueneme	16	21.5	1, 2, 3, 6, 7, 8, 10, 11, 13, 14
55	293	County/Port Hueneme	16	24.0	1, 3, 6, 7, 8, 9, 10, 11, 13, 14
56	290	Port Hueneme	Zone A	18.1	1, 3, 6, 7, 8, 10, 13, 14
57	286	Port Hueneme	Zone A	13.6	1, 3, 6, 7, 8, 10, 13, 14, 15
58	288	Port Hueneme	Zone A	14.6	1, 3, 6, 7, 8, 10, 12, 13, 14
59	277	Port Hueneme	Zone A	14.6	1, 3, 6, 7, 8, 10, 12, 13, 14
60	274	Port Hueneme	Zone A	14.1	1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14
61	270	Port Hueneme	Zone A	22.0	1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14
62	263	Port Hueneme	Zone A	18.1	1, 3, 6, 7, 8, 9, 10, 11, 13, 14

PFIRM Transect No.	Analysis Transect No.	Jurisdiction	Effective BFE (FT, NAVD88)	PFIRM BFE (FT, NAVD88)	Comment #s in Report
63	240	Oxnard	13	15.7	1, 3, 6, 7, 8, 9, 10, 11, 13, 14
64	231	Oxnard	13	15.1	1, 3, 6, 7, 8, 9, 10, 11, 13, 14
65	218	Unincorporated	-	15.6	1, 3, 6, 7, 8, 9, 10, 11, 13, 14, 16
66	211	Unincorporated	-	17.3	1, 3, 6, 7, 8, 9, 10, 11, 13, 14
67	202	Unincorporated	-	17.8	1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14
68	195	Unincorporated	-	19.1	1, 3, 6, 7, 8, 11, 13, 14
69	189	Unincorporated	-	14.8	1, 3, 6, 7, 8, 9, 10, 11, 13, 14
70	181	Unincorporated	-	15.5	1, 3, 6, 7, 8, 9, 10, 11, 13, 14
71	175	Unincorporated	-	19.9	1, 3, 6, 7, 8, 10, 12, 13, 14, 16
72	169	Unincorporated	-	19.9	1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16
73	165	Unincorporated	-	18.1	1, 3, 6, 7, 8, 10, 13, 14
74	163	Unincorporated	-	23.5	1, 3, 6, 7, 8, 9, 10, 11, 13, 14, 15
75	160	Unincorporated	-	18.5	1, 3, 6, 7, 8, 9, 10, 11, 13, 14, 15
76	157	Unincorporated	-	26.3	1, 3, 6, 7, 8, 9, 10, 13, 14, 16
77	141	Unincorporated	-	16.9	1, 3, 6, 7, 8, 9, 10, 11, 13, 14
78	128	Unincorporated	-	22.4	1, 3, 6, 7, 8, 9, 10, 11, 13, 14
79	115	Unincorporated	18	21.7	1, 3, 6, 7, 8, 9, 10, 11, 13, 14
80	102	Unincorporated	18	35.1	1, 3, 6, 7, 8, 10, 13, 14
81	93	Unincorporated	13	25.9	1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16
82	79	Unincorporated	16	20.2	1, 3, 6, 7, 8, 10, 12, 13, 14, 15
83	72	Unincorporated	13	22.3	1, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15
84	51	Unincorporated	15	27.7	1, 3, 6, 7, 8, 10, 12, 13, 14, 15
85	45	Unincorporated	15	20.0	1, 3, 6, 7, 8, 10, 12, 13, 14, 15
86	22	Unincorporated	14	19.6	1, 3, 6, 7, 8, 10, 13, 14
87	18	Unincorporated	14	17.8	1, 3, 6, 7, 8, 10, 13, 14
88	14	Unincorporated	14	33.6	1, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15
89	10	Unincorporated	14	20.2	1, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15
90	6	Unincorporated	14	19.0	1, 3, 5, 6, 7, 8, 10, 13, 14