DOCKETED

Docket Number:	15-AFC-01
Project Title:	Puente Power Project
TN #:	218873-1
Document Title:	Supplemental Testimony of Dr. Revell
Description:	N/A
Filer:	PATRICIA LARKIN
Organization:	Revell Coastal
Submitter Role:	Intervenor Representative
Submission Date:	6/15/2017 3:00:55 PM
Docketed Date:	6/15/2017

INTERVENOR CITY OF OXNARD

EXHIBIT ___

Supplemental Testimony of Dr. David Revell

Revell Coastal
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

MEMORANDUM

Date: June 14, 2017

To: City of Oxnard

From: David Revell, PhD

Subject: Supplemental Testimony on the Proposed Puente Power Plant

---

Executive Summary

USGS, COSMOS 3.0

- COSMOS 3.0 was not intended for site specific analysis and is based on 2009 topographic data that does not reflect over 200 feet of historic beach variability fronting the Puente project site.
- COSMOS 3.0 relies on dynamic water level, which is not typically used as the basis for engineering hazard identification.
  COSMOS 3.0 relies on Mean High Water (MHW) levels to assess future shoreline changes and does not explicitly show the long-term changes to the upper profile of the beach.

FEMA

- Even setting aside limitations in the FEMA analysis that likely underpredict the 1% storm responses, FEMA maps for existing conditions, with the addition of 2 feet of sea level rise (SLR) based on the state technical method, show coastal flooding at the Mandalay site.

Coastal Resilience Ventura

- The Coastal Resilience Ventura model represents the only mapping and modeling that follows federal coastal hazard guidelines to incorporate beach profile changes with coastal erosion and storm hazards and includes the influence of sea level rise.
- The majority of the public agencies in Ventura and Santa Barbara Counties who are engaged in resiliency planning rely on the Coastal Resilience models.
- Methods applied to the proposed project site under Coastal Resilience Ventura follow approved regulatory approach for coastal flood mapping.

Introduction

This testimony follows the testimony submitted on January 18, 2017 (TN #215427) and the CEC workshop hosted in Oxnard on March 30, 2017 regarding sea level rise and coastal hazard modeling. As more evidence, technical modeling method documentation and data has come to light since the original testimony, refinements to the January testimony are included below. This testimony focuses largely on additional interpretation and analysis on the the FINAL USGS

Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

COSMOS modeling results presented at the March CEC workshop, the FEMA preliminary flood map, and the applicability of the TNC Coastal Resilience modeling.

CEC Coastal hazard workshop

The March CEC workshop highlighted a key difference between the available coastal hazards models that the different flood maps represent. In simple terms, coastal flood hazards identified by FEMA and the Coastal Resilience Ventura models are derived from observed storm events near the Mandalay site. They map a maximum wave run up from a 1% annual chance storm (e.g. 100 year wave event) based on statistics of those historic storm events. This elevation is mapped in FEMA regulatory FIRM maps as the high velocity wave flood zone and identifies a Base Flood Elevation representing the total water level (combined tides and waves).

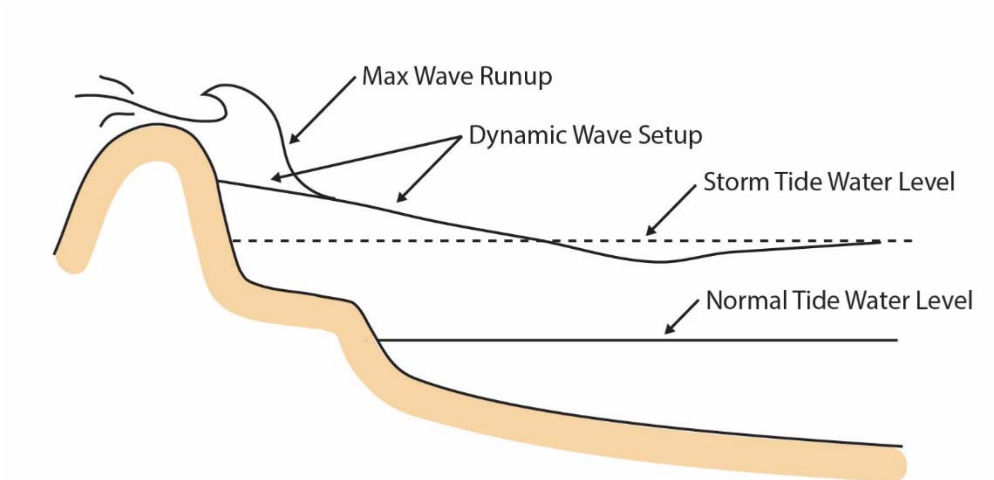

Figure 1. Maximum Wave Run-up versus Dynamic Wave Setup (excerpted and revised from FEMA guidelines)

In contrast, the USGS COSMOS utilizes a composite of downscaled global climate model storms to evaluate potential inundation. This approach excludes historic data of local storm events. Instead, it uses dynamic wave setup water level flood surface with a 1-2 minute inundation frequency (Figures 1, 2). Dynamic wave set up is the essentially static water level that is sustained for at least 2 minutes due to a series of waves breaking at the coast. Wave run up is the maximum height that the waves reach when they break on the shore and rush up the beach.

The difference between these two reference flood elevations to modeling flood hazards can be up to 6.5 feet (~2m) in water level, Barnard et al 2017, (Figure 2).

REVELL COASTAL
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

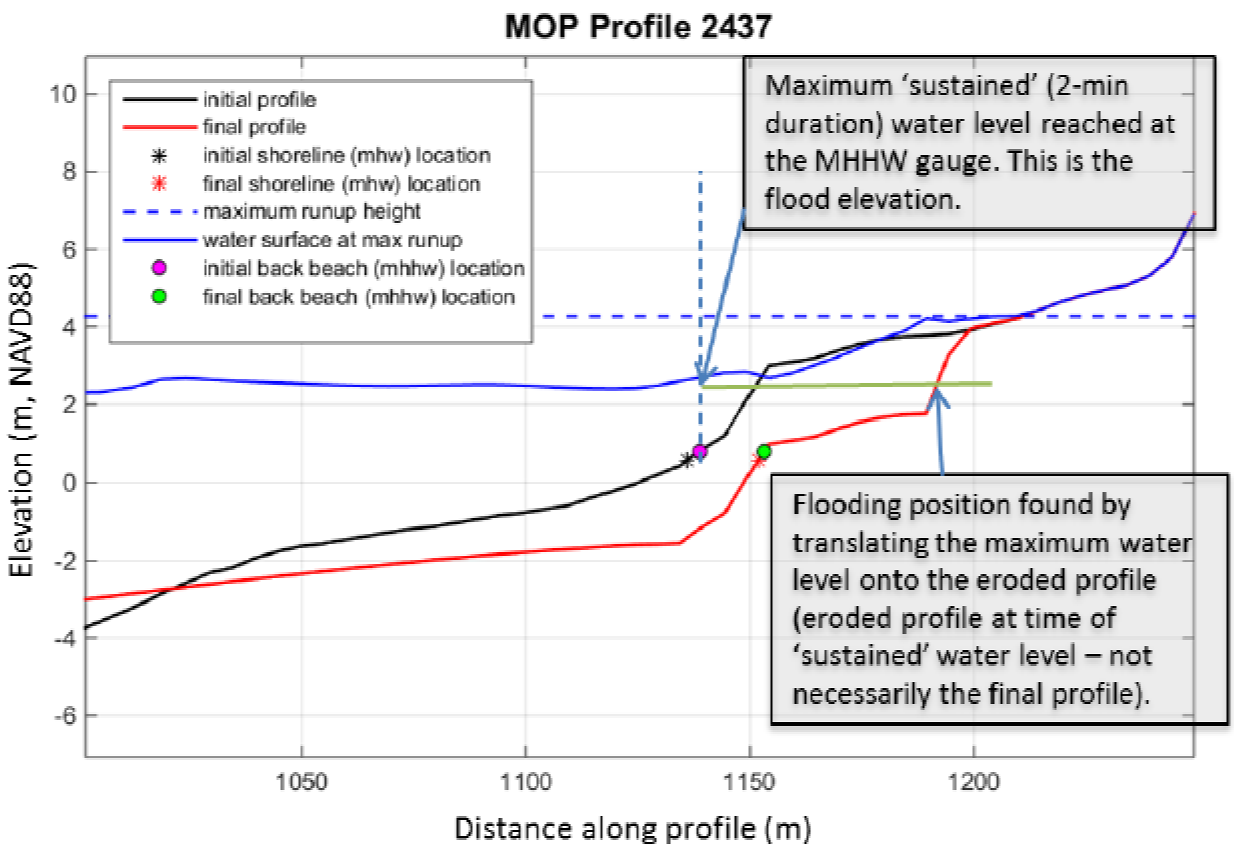

Figure 2. This figure illustrates the differences between using maximum wave run up height (dashed horizontal blue line (FEMA/Coastal Resilience)) and sustained water level flooding (solid green line (COSMOS 3.0)) on a representative beach profile. This level of detail is not yet available for the specific Mandalay site. As shown here, the COSMOS model predicts water levels that are ~2m or 6.5 feet lower than either FEMA or Coastal Resilience Ventura. Please also note that the * represents mean high water shoreline location. (Source: Erikson et al 2017)

The differences between the TNC, COSMOS 3.0, and FEMA are largely based on (1) the selected coastal flood reference (FEMA and TNC contrasted with COSMOS 3.0), (2) models which don't include sea level rise or coastal erosion (FEMA), or (3) models that don't output long term dune erosion (COSMOS 3.0 and FEMA).

USGS COSMOS 3.0

The City previously submitted testimony to the CEC regarding the drawbacks of relying soley on results from the preliminary COSMOS modeling. The following testimony summarizes my understanding of the COSMOS 3.0 final results as presented at the March 30, 2017 CEC workshop.

- First, as Dr. Barnard stated in his presentation, COSMOS 3.0 was designed for community scale planning, not site specific engineering evaluations,

- Second, while many scenarios are available, the closest USGS modeling uses 0.5 m (19.7 inches) of sea level rise, which is less than the 2 feet of sea level rise by 2050 that the CEC requested modelers present.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

- Third, COSMOS 3.0 maps coastal flood hazard zones associated with dynamic wave set up and sustained 1-2 minute flooding and NOT maximum wave run up (Figure 1), which is typically used in regulatory coastal flood hazards mapping. Using dynamic wave setup instead of maximum wave run up can often understate inundation results by more than 6 feet.

- Fourth, the COSMOS COAST module relies on future Mean High Water shoreline projections and uncertainties as the basis for predicting future shoreline position hazards. Mean High Water is a tidal datum based elevation and is not directly interpretable without additional analysis for identifying specific coastal hazards such as long term dune erosion. For example, present day MHW is 4.62 feet NAVD front of the Mandalay site and routinely underwater during low tides with small wave run up. In contrast, FEMA calculates present day wave run up elevations during an extreme storm event to be greater than 20 feet NAVD at this site.

- Fifth, the COSMOS COAST module does not explicitly model long term dune erosion hazards. While the X-Beach module evaluates storm erosion, there are presently no storm erosion extents available. As the project relies on coastal dunes for site protection, long term dune erosion at this site may play a critical role in the vulnerability of the proposed project to coastal flood hazards.

- Finally, the COSMOS 3.0 Final coastal flooding results use 2009-2010 LIDAR data and did not consider the variability of the beach width, nor the sensitivity of the coastal flood results to topographic variability. This site has been documented to have experienced over 200 feet of beach changes including a regional erosion in front of the site of ~220 feet (Slide 28 Barnard et al presentation). COSMOS 3.0 does not consider the impact of a narrower beach condition in its assessment of hazards.

FEMA

Presently, as part of the FEMA Coastal Change and Mapping Project, coastal flood maps are being revised based on the 2005 Pacific Coast Flood guidelines (NHC 2005). The analysis transect nearest to the Mandalay site shows a change in the Base Flood Elevations from 13 feet NAVD to 20 feet NAVD. These maps do not account for sea level rise or long term dune erosion.

The Pacific Coast Flood guidelines contain a 5-step methodology for determining flood risks in coastal areas like the Mandalay site. The County of Ventura and the cities within (including the City of Oxnard), commissioned a detailed technical review of the methodology and specific methods applied at each analysis transect in Ventura County. This review shows that the FEMA contractor excluded 3 of the five steps from the Pacific Coast Flood guidelines when generating the Ventura County maps. Consequently, the most recent FEMA map likely underpredicts existing flood risk at the project site and throughout the City of Oxnard.

The FEMA guidelines methodology shown in Figure 3 is based on the backshore setting which in the case of the proposed Puente Plant is a Beach/Dune. Technical review and analysis were conducted based on the the preliminary FIRM maps and Interim Data Submittals (IDS) created by the FEMA contractor Michael Baker/AECOM.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

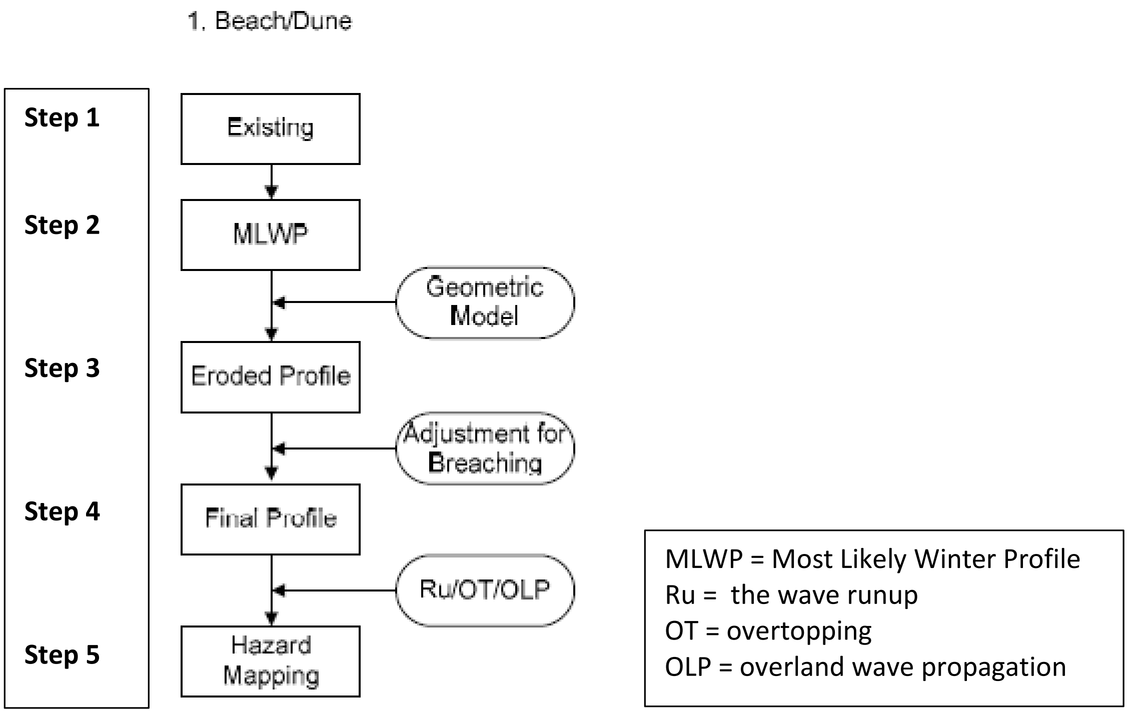

Figure 3. Excerpt from the FEMA Pacific Coast Flood guidelines for Beach/Dune Coastal Setting (NHC 2005).

The FEMA methodology to mapping the coastal flood hazards is summarized from the guidelines as follows:[1]

- **Step 1** starts with available topography (in this case the November 2009 LIDAR was used);
- **Step 2** then identifies a Most Likely Winter Profile through analysis of the beach response to 100% chance storm event (a 1 year event);
- **Step 3** applies the 1% annual chance storm event (a 100 year event) with a geometric model of dune erosion to identify the event based erosion of the dune and the eroded profile;
- **Step 4** evaluates the eroded profile to determine if the potential for dune breaching and hydraulic connectivity increases; and
- **Step 5** applies the 1% annual chance storm to the final profile, calculating the wave run up elevation using Stockdon 2006, wave overtopping and overland wave propogation through the final hydraulically connected profile to map the coastal flood hazard with the appropriate Base Flood Elevations delineated.

Based on the technical review, overall, the application of the FEMA methodology to Beach and Dune coastal settings was not fully applied by the FEMA contractor. Specifically Steps 2, 3, and 4 were not applied to this site. As a results, the

[1] It is important to note that in addition to these steps to develop the coastal flood hazard maps, there are a series of nearshore wave modeling and hydraulic calcuations based on the largest 100+ historic storm events which are conducted to determine the 1% annual chance storm at each transect analysis location.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

study simply shows the effect of a 1% annual chance storm (e.g. 100 year wave event) on a wide summer beach in 2009 and very likely underpredicts the potential flood hazard across the City of Oxnard. If the FEMA maps had considered the erosion associated with a large wave event the proposed Mandalay site would be likely exposed to more direct wave runup.

The Stockdon wave run-up calculation is influenced by three primary factors, in order of importance –

1. the foreshore beach slope upon which the waves rush up the beach,
2. wave period, and
3. wave height.

Testimony submitted on January 18, 2017 (TN #215427) shows a range of beach slopes from available historic topographic data sets taken directly in front of the site and the implications of those observed beach slopes on the range of wave run up elevations. Simply by making a different assumption on the beach slope, the wave run up elevations can be calculated in a range from 18.9 to 38.6 feet base flood elevations (Table 2, TN #215427).

I have reviewed the FEMA analysis of transect #47, which is the transect closest to the Mandalay site. This analysis shows two additional irregularities when compared with transects that are immediately adjacent to the transact 47:

- Proposed new FEMA maps show a Base Flood Elevation of 20.1 feet at transect 47, which is actually lower than the Total Water Level (tides+wave setup +wave run-up) that would have occurred during wave event of record on January 18, 1988. Assuming the same beach slope from 2009, the Total Water Level in front of the site would have been 20.4 feet during that 1988 storm.

- FEMA's calculation of the largest historic wave event (from 1/18/1988) at transect 47 assumes a tide elevation of 6.8 feet, wave height of 20.4 feet, and wave period of 14. seconds. However, FEMA's analysis of Total Water Level for transects immediately adjacent to transect 47 use a wave period of 17 seconds instead of the 14 seconds assumed at transect 47 even though these transects all encompass a relatively uniform stretch of coast. This reduction in wave period on the wave run up elevation calculations results in a lower base flood elevation for transect 47. Had FEMA used the same 17 second wave period used for adjacent transects, the base flood elevation in front of the Mandalay site would be 22.1 feet.

These two irregularities reduce the overall wave run up elevation calculations mapped in the preliminary FEMA coastal flood maps. In addition to the lack of adherence to the overall FEMA methods, it is highly likely that the draft FEMA flood maps underestimate the coastal flood hazards at the Mandalay site.

FEMA and Sea Level Rise

The FEMA FIRM maps only map existing flood hazards. These maps do not consider sea level rise. To evaluate the effect of sea level rise on existing flood hazards, it is insufficient to simply add sea level rise to the base flood elevation since wave run up dynamics change with different water surface elevation. In order to provide guidance on how to evaluate sea level rise induced changes to the FEMA FIRM maps, the California Department of Water Resources commissioned a study which resulted in a technical methods manual to escalate FEMA maps with sea level rise (see testimony submitted on January 18, 2017 TN #215427). The City followed this methodology and the results are shown in Figure 4.

As can clearly be seen in Figure 4, using 2 feet of sea level rise shows that the proposed power plant site would be exposed to high velocity coastal flooding.

Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

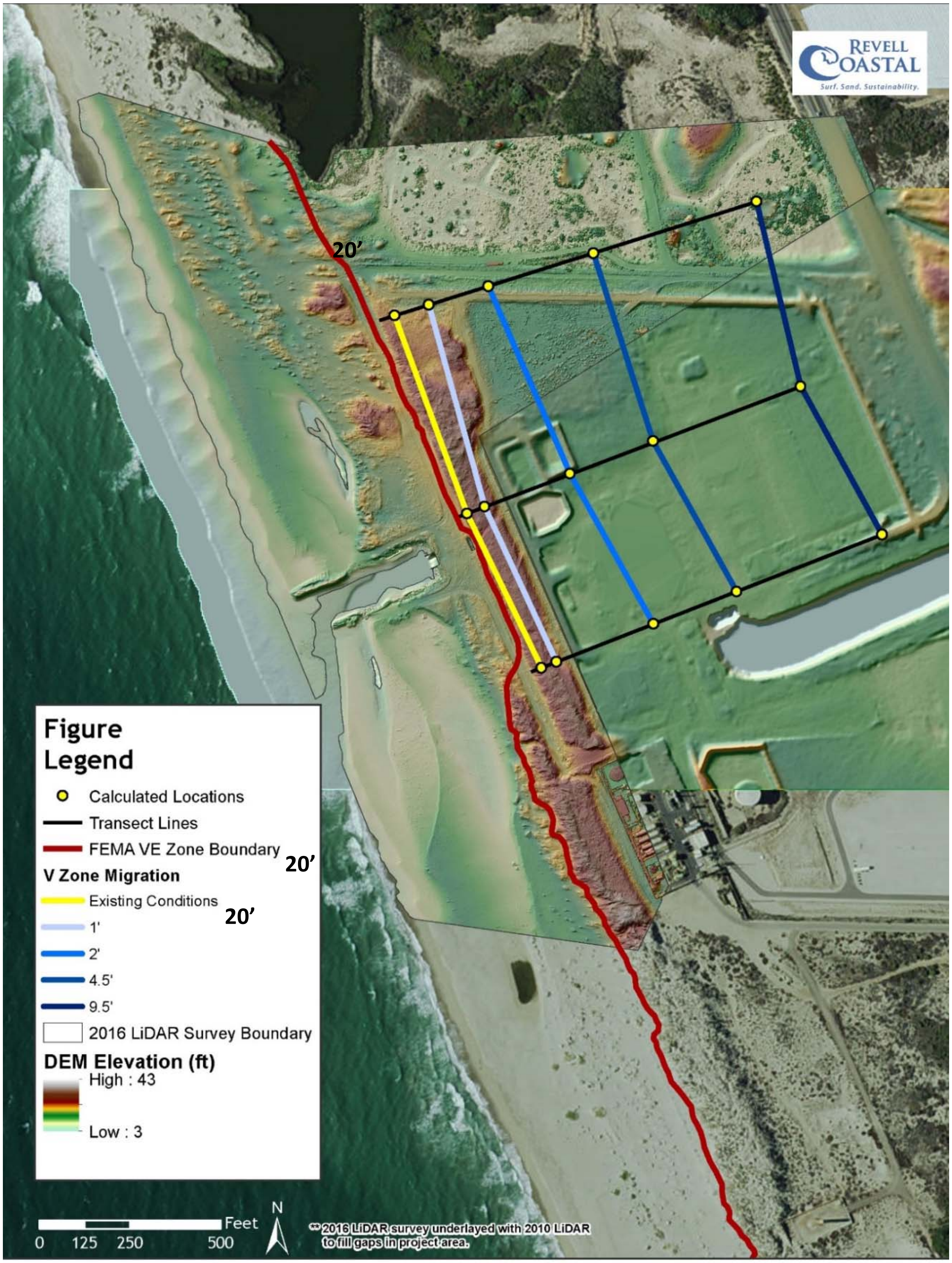

Figure 4. FEMA PFIRM escalated with sea level rise (excerpt from testimony submitted on January 18, 2017 TN #215427)

Revell Coastal
Surf. Sand. Sustainability.

568 Bethany Curve
Santa Cruz, CA 95060
Phone: 831-854-7873
Email: revellcoastal@gmail.com
Website: www.revellcoastal.com

Coastal Resilience

The Nature Conservancy and Ventura County (not the City of Oxnard) funded this modeling work to support regional adaptation planning, decision support, site specific conservation acquisitions, and sea level rise planning. This model was completed in final form in 2013, peer reviewed by local experts and observers on the ground, and is publicly available along with a substantive technical documentation report. The model was designed to address Southern California coastal flooding and erosion due to both sea level rise and storms driven by climate change.

The FSA disregards the TNC modeling work saying it is a worst case scenario approach and overly conservative. It is the only model available, however, that follows the majority of the steps outlined by FEMA for regulatory flood mapping by using a maximum wave run up elevation and a beach profile that evolves from storms.

The TNC model follows much of the FEMA methodology and explicitly follows 4 of the 5 suggested steps, only excluding the Most Likely Winter Profile (step 2 in FEMA section above - NHC 2005). Although reliance on the 2009 data (and not the MLWP) would tend to understate coastal hazards, the Coastal Resilience Ventura model adds in a long term dune erosion component and uses a “maximum storm wave of unlimited duration” to model dune erosion during storms. This method is consistent with the FEMA Pacific Coast Flood guidelines using the modified Komar and Allan approach to evaluating storm induced dune erosion (NHC 2005).

References

Barnard et al 2017. Coastal Vulnerability in Ventura County using COSMOS. Presentation at CEC workshop on Coastal Hazards mapping March 30, 2017.

Erikson, L.H., Barnard, P.L., O’Neill, A.C., Vitousek, S., Limber, P., Foxgrover, A.C., Herdman, L.H., and Warrick, J., 2017. CoSMoS 3.0 Phase 2 Southern California Bight: Summary of data and methods. U.S. Geological Survey. http://dx.doi.org/10.5066/F7T151Q4

ESA 2016 (TN #215428-4). Relating Future Coastal Conditions to Existing FEMA Flood Hazard Maps: Technical Methods Manual. Prepared for California Department of Water Resources and the California Ocean Science Trust. P. 114.

NHC 2005 – Northwest Hydraulic Consultants, prepared for U.S. Federal Emergency Management Agency. Final Draft Guidelines for Coastal Flood Hazard Analysis and Mapping for the Pacific Coast of the United States. January 2005.

Stockdon, H.F., Holman, R.A., Howd, P.A., and Sallenger, Jr., A.H., 2006, Empirical parameterization of setup, swash, and runup, Coastal Engineering, 53, pp. 573-588

I, Dr. David Revell, prepared the forgoing testimony and the basis for this testimony is set forth in the testimony itself and is incorporated by reference.

It is my professional opinion that the prepared testimony is valid and accurate with respect to the issues and statements expressed therein.

I am personally familiar with the facts and conclusions in the prepared testimony and, if called as a witness, could testify competently thereto.

I declare under penalty of perjury under the laws of the State of California that the forgoing is true and correct.

Executed June 14, 2017, at Santa Cruz, CA.

David Revell