EVEREST

April 7, 2014
(Revised: August 27, 2014)

Mr. David Rocha
OC Dana Point Harbor/Project Management
24650 Dana Point Harbor Drive
Dana Point, CA 92629

Copy to: Jon Conk and Craig Hoffman, Project Dimensions, Inc.

Subject: Dana Point Harbor Revitalization Commercial Core Project
Coastal Engineering Support Services – Wave Uprush Analysis

Dear Mr. Rocha:

Everest International Consultants, Inc. (Everest) has prepared this letter report to provide a summary of the data, method, and findings of a wave uprush analysis conducted for the Dana Point Harbor Revitalization Commercial Core Project in support of the Coastal Development Permit application. The Commercial Core Project, as shown in Figure 1, is located at the northeastern corner of the Dana Point Harbor. In the figure, the project boundary is marked with bold yellow line. Since the Dana Point Harbor is protected against ocean swells and storm waves by two rubble mound breakwaters, ocean storm waves have to enter the harbor through the harbor entrance and go around the island in the middle of the harbor before reaching the Commercial Core Project site.

The Commercial Core Project site is primarily surrounded by seawalls except at an area where there is a concrete boat launch ramp. The proposed plan for the Commercial Core Project is shown in Figure 2. As shown in the figure, most of the development for the Commercial Core Project will be on land, except for the proposed dry stack boat storage building which will have a corner of the building sitting on piles that will extend into the harbor basin. The Commercial Core Project will not make any modification to the existing seawalls; hence, this wave uprush analysis was conducted based on existing seawall conditions. In addition, this study does not include any specific coastal impact analysis for the proposed dry stack boat storage building.

The wave uprush analysis was conducted using the ACES program within the CEDAS (version 4.03) suite of programs developed by the U.S. Army Corps of Engineers (Veri-Tech, Inc., 2009) to evaluate whether wave uprush at the seawalls and the boat ramp will result in wave overtopping, and the corresponding wave overtopping rates if wave overtopping does occur. The parameters controlling the onset of wave overtopping and the overtopping rate include wave characteristics (height and period), water level and water depth in front of the seawall and boat ramp structures, as well as the structure characteristics (type and slope) and bottom slope in front of the structure.

In the following report, the data and the analyses that were used to establish the wave conditions and water levels for the wave uprush analysis are first described, followed by the findings and recommendations.

EVEREST INTERNATIONAL CONSULTANTS, INC.
444 West Ocean Boulevard, Suite 1104, Long Beach, CA 90802
TEL (562) 435-9305 ▪ FAX (562) 435-9310

Image Source: Google Earth Pro

Figure 1. Location Map

Source: Project Dimensions

Figure 2. Commercial Core Project Proposed Plan

1. Wave Conditions

The prevailing storm wave climate at Dana Point Harbor are comprised of swell and local sea produced by distinct meteorological patterns: distant northern Pacific Ocean extratropical cyclones, eastern north Pacific Ocean tropical cyclones, extratropical cyclones of the southern Pacific Ocean, wind swell from prevailing northwesterly winds, and passing low pressure systems creating seas both from the west and from the south. The northern Pacific extratropical cyclones cause the greatest impact between November and April. Large south swell from the extratropical South Pacific and from eastern Pacific tropical hurricanes arrive from May through October (USACE 1996). One estimate of these extreme waves was made in 1986 by the USACE (1986) incorporating the very large 1982/1983 winter storm season. A later study (USACE 1996) added new wave data, as well as calculated wave statistics for two different weather populations - extratropical and tropical storms.

Figure 3. Wave Gage Locations

As part of the Dana Point Harbor Revitalization Project, Everest (2008) conducted a wave study of the Dana Point Harbor in 2008. The study utilized the extreme offshore wave statistics established by the USACE (1986, 1996) and transformed the offshore wave heights to two proposed temporary dock locations in the harbor using two different methods: (1) using the results of a physical model test conducted by the USACE (1965) to select the appropriate wave transformation coefficients to bring the offshore waves into the harbor, and (2) using a numerical model CGWAVE to propagate the offshore waves into the harbor. One of the dock locations, marked as Location A in Figure 3, is near the Commercial Core Project. The Everest (2008) study concluded that the 100-year return period wave conditions at this location has a significant wave height of 2.1 feet based on Method 1, and 2.3 feet based on Method 2; and a peak wave period of 15.5 seconds. The significant wave height is a statistical term which represents the average height of the highest one-third of waves of a given wave group.

In 2011, the US Army Engineering Research & Development Center (ERDC) and Noble Consultants, Inc., conducted a comprehensive condition survey, storm waves, circulation and sedimentation study for Dana Point Harbor. Part of the study includes an update of the prior USACE (1986, 1996) wave studies and used wave hindcast data from1973 to 2008 to define the storm wave conditions outside of Dana Point Harbor, followed by the use of the CMS-Wave Model to transform the offshore waves into the harbor to determine the storm wave conditions at various locations along the west and east breakwaters. One of the locations near the east breakwater, marked as Location B in Figure 3, is just south of the Commercial Core Project near the entrance to Dana Point Harbor. The ERDC and Noble (2011) study estimated that the 100-year return period significant wave height at Location B is 2.9 ft, slightly higher than the 2.3 ft estimated by Everest for Location A. Since Location A is further into the harbor (more sheltered) than Location B, it is expected that the waves at Location A would be smaller than those at Location B which is close to the harbor entrance.

Since the Commercial Core Project site is located farther away from the harbor entrance, and part of the project site is sheltered from waves entering the harbor by breakwaters and the island in the middle of the harbor, it is expected that waves affecting this portion of the project will be smaller than those at Location A. However, there is no existing information or detailed study that has been conducted to determine the precise wave conditions at the project site. Hence, the lower of the two wave conditions estimated by Everest (2008) for Location A (i.e., a 100-year wave height of 2.1 ft and wave period of 15.5 second) was used for this study.

2. WATER LEVELS

The water level at the project location is affected by the tide, wind setup, tsunami, and potential future sea-level rise (SLR).

TIDES

Tides along southern California coast are characterized as mixed, semidiurnal with two daily highs and two daily lows. The closest NOAA tide stations for the Dana Point Harbor are at the City of Newport Beach and the City of Oceanside. The tidal statistics at these two locations are almost the same. For this study, tidal datums at the NOAA tide gage at the Newport Bay Entrance (9410580) were used to define the tidal conditions in Dana Point Harbor. Tidal datums from the 1983-2001 tidal epoch for the Newport Bay Entrance are summarized in Table 1.

Table 1. Tidal Datums for Newport Bay Entrance

Tidal Datum	Elevation (ft, MLLW)
Highest Observed Water Level (1/28/83)	7.667
Mean Higher High Water (MHHW)	5.410
Mean High Water (MHW)	4.672
Mean Sea Level (MSL)	2.772
Mean Low Water (MLW)	0.915
Mean Lower Low Water (MLLW)	0.000
Lowest Observed Water Level (1/20/88)	-2.352

Source: NOAA 2003

WIND SETUP

Wind setup is the rise in water level on the leeward side of a water body caused by wind stress on the surface. For the Commercial Core Project location, wind setup will mainly be caused by wind coming from the southerly direction. Wind data collected from a recording gage at the Ocean Institute for the earlier Everest (2008) study was used for this study to evaluate whether wind setup needs to be included in the wave uprush analyses.

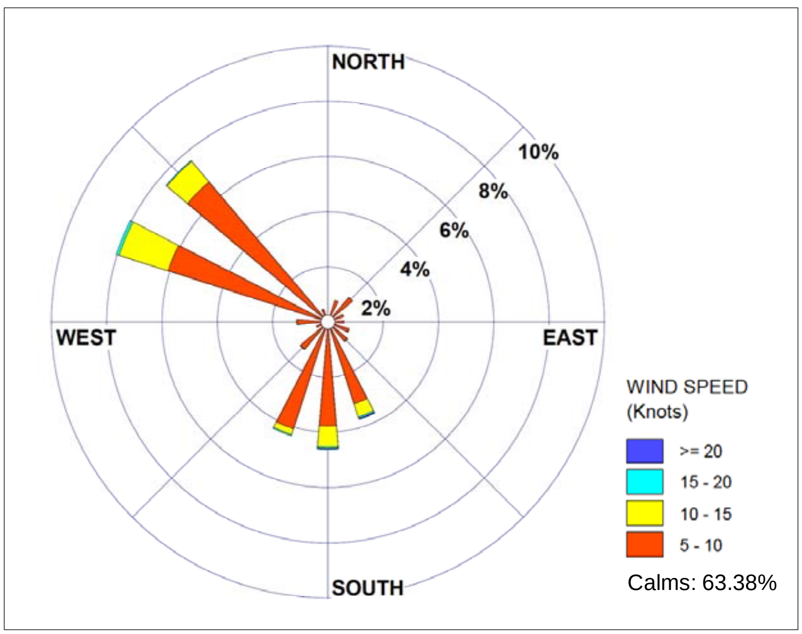


Figure 4. Wind Rose – Ocean Institute, Dana Point

The Ocean Institute data includes a wind record every 5 seconds from 2004 to 2006. The duration of these data allows for a good understanding of the normal wind conditions at the Dana Point Harbor. Figure 4 shows a wind rose constructed based on the 2005 wind data. As shown in the figure, most of the time (over 63% of the time) the wind is calm (less than 5 knots), and approximately 10% of the winds come from the south with wind speed between 5 and 10 knots. This low wind speed and the short fetch (a.k.a. the distance over water the wind blows) would result in insignificant wind setup at the project location.

TSUNAMI

The 2010 Chilean and 2011 Japanese tsunamis were the most significant tsunamis to hit California since the 1964 Alaska tsunami. The 2010 Chilean tsunami was generated by a magnitude 8.8 earthquake on February 26, 2010 at the Maule region near central Chile, and the tsunami subsequently reached the Los Angeles region around noon time on February 27, 2010. On March 11, 2011, a magnitude 9.0 earthquake struck the east coast of the Tohoku region in Japan, generated a large tsunami that arrived the Los Angeles region at around 8:40 am on March 11, 2011. A recent study by Wilson et al. (2011) provided a comprehensive summary of measured (based on tide gage data) or observed (based on eyewitness reports) maximum tsunami amplitudes at various locations along the California coastline including the Dana Point Harbor. For the Dana Point Harbor, the observed maximum tsunami amplitude for the 2010 Chilean tsunami is between 1.6 to 2.0 ft, and for the 2011 Japanese tsunami is 2 ft. However, the authors of the study cautioned that eyewitness observations can sometimes be exaggerated.

The NOAA tide data collected at the La Jolla Scripts Pier and the Los Angeles (LA) outer harbor gages for these two tsunami events were downloaded and analyzed for this study. These two NOAA gages are the closest to Dana Point Harbor providing measured data for these two tsunami events. Figure 5 shows the marigrams at La Jolla and LA outer harbor for the 2010 Chilean event. In the figure, the blue line shows the measured tide and the green line shows the predicted tide. The difference between the measured and predicted tide (shown as the red line in the figure) represents the tsunami wave. It can be seen that the maximum measured tsunami amplitude is approximately 0.7 ft at La Jolla, and 1.2 ft at LA outer harbor. Similar plots for the 2011 Japanese tsunami are shown in Figure 6. For this tsunami event, the maximum tsunami amplitudes at La Jolla are about 0.8 ft, and 1.2 ft at LA outer harbor.

The tsunami amplitudes off the shoreline of Dana Point Harbor is likely between those measured at La Jolla and LA outer harbor (i.e. somewhat around 1 ft for both the 2010 Chilean event and the 2011 Japanese event). These estimated tsunami amplitudes are only about half of those observed at Dana Point Harbor based on eyewitness report. Since Wilson et al. (2011) cautioned that eyewitness report may sometimes be exaggerated; for this study, tsunami amplitudes of 1 ft and 2 ft were used to cover the likely range of tsunami effect to wave uprush at the project location.

EVEREST

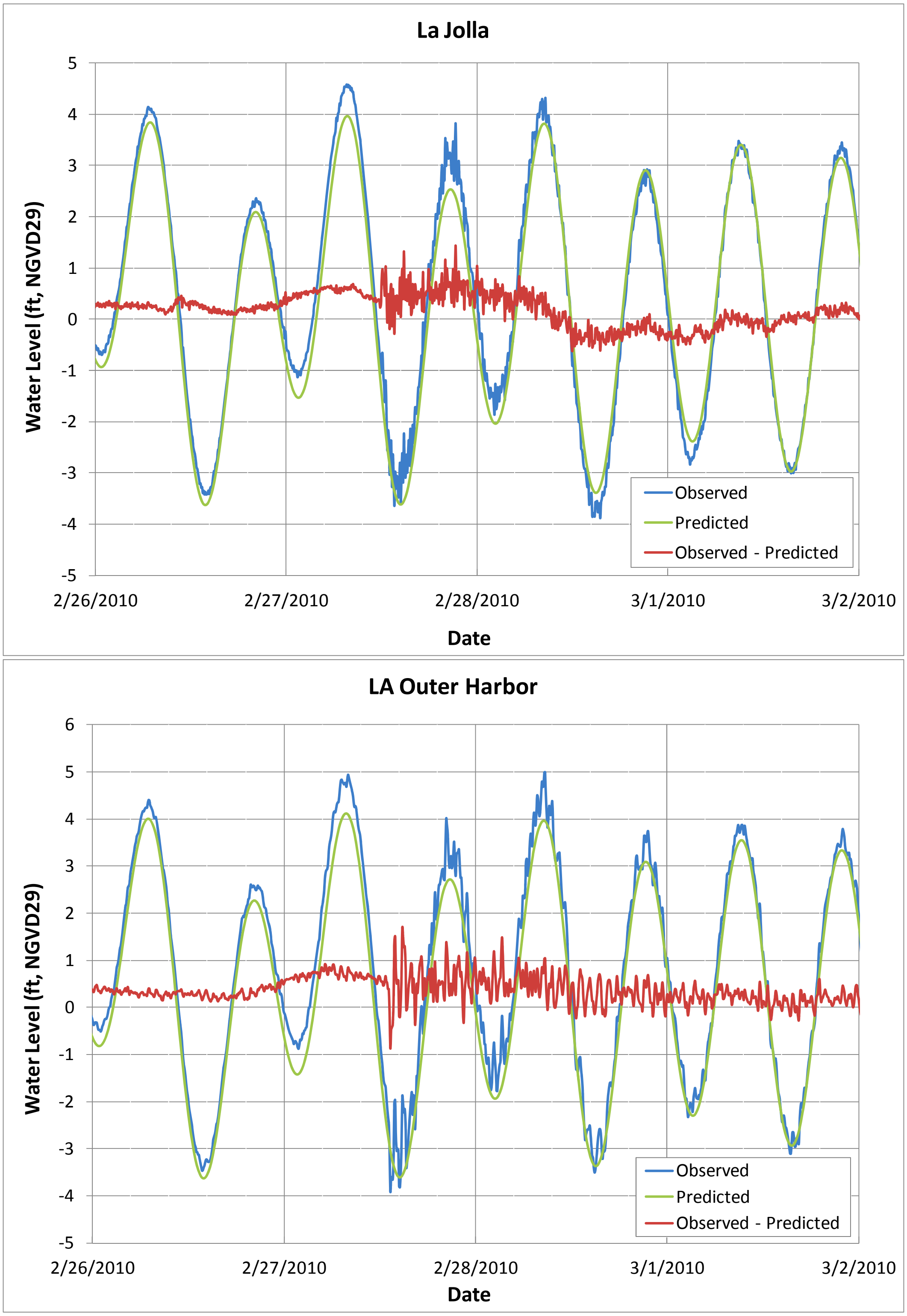


Figure 5. Marigrams for La Jolla and LA Outer Harbor during the February 27, 2010 Chilean Tsunami

EVEREST

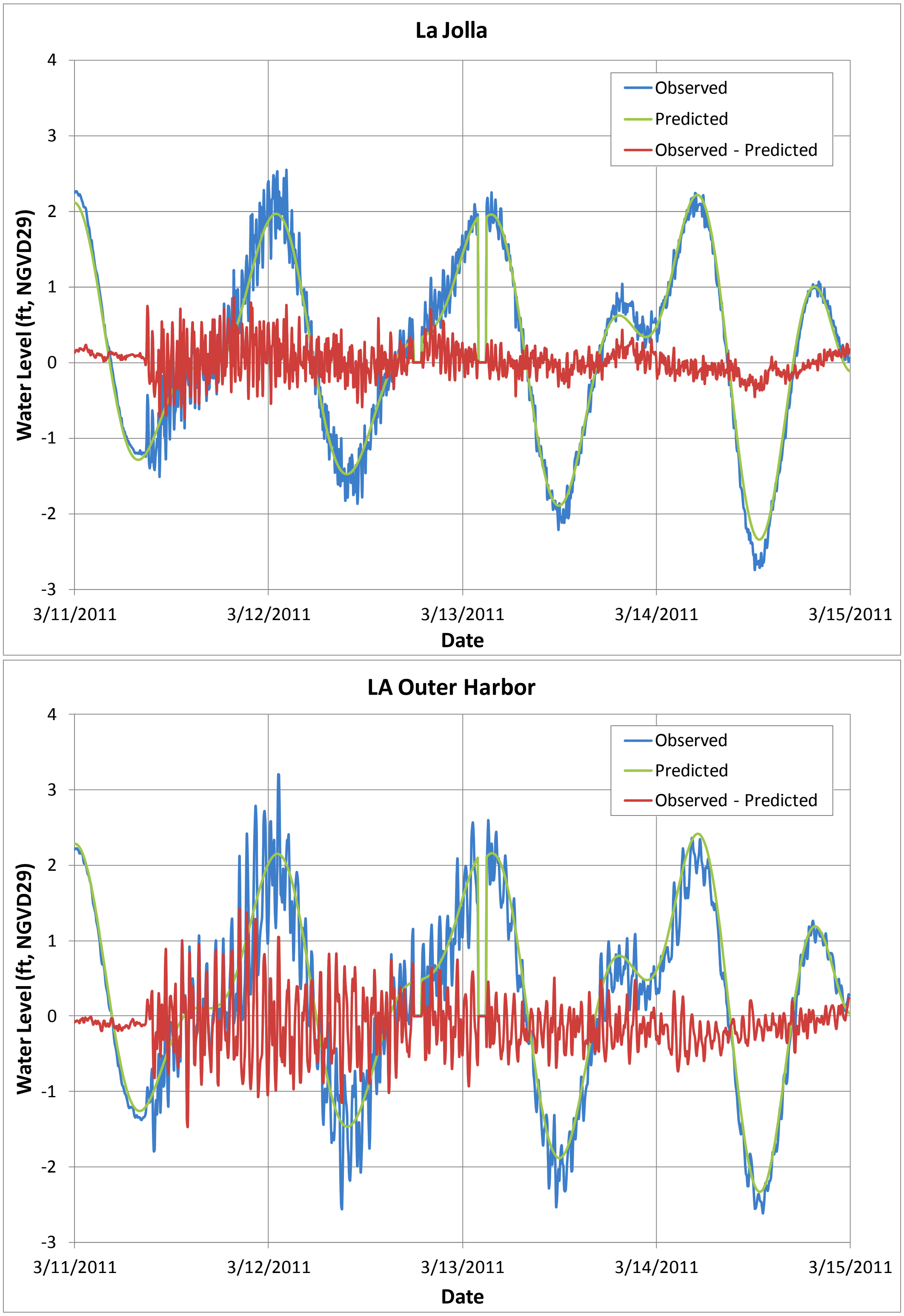


Figure 6. Marigrams for La Jolla and LA Outer Harbor during the March 11, 2011 Japanese Tsunami

EVEREST

SEA-LEVEL RISE

On October 14, 2013, the California Coastal Commission (CCC) released the Draft Sea-Level Rise Policy Guidance for public comment (CCC, 2013). The draft guidance document was prepared by CCC staff to provide a theoretical framework for assessment of sea-level rise in Local Coastal Programs and Coastal Development Permits. The draft guidance policies recognize the science on sea-level rise is constantly evolving, but at the time of the report's publication, the best available science on sea-level rise in California is the 2012 *National Research Council (NRC) Report, Sea-Level Rise for the Coasts of California, Oregon and Washington: Past, Present and Future* (NRC, 2012). The NRC-recommended sea-level rise projections for Southern California (south of Cape Mendocino) are summarized in Table 2. The CCC guidance also recognizes the scientific uncertainty associated with sea-level rise projections, and recommends that analyses for coastal hazards should be conducted for both the low and high bounds of the ranges shown in the table.

Table 2. Potential Sea Level Rise Ranges Using Year 2000 as the Baseline for Southern California (NRC Report 2012)

YEAR	RANGE OF SEA LEVEL RISE (INCHES)
2030	1.6 – 12
2050	5 – 24
2100	16.5 – 66

Section 8.6.3.4 of the Dana Point Harbor Revitalization Plan and District Regulations states that wave uprush analyses shall consider long-term (75 years) projection for sea-level rise. The Commercial Core Project is scheduled to start construction in Year 2015; hence sea-level rise projection for Year 2090 was estimated. Sea-level rise projection for Year 2060 was also estimated and used for the wave uprush analysis. The CCC (2013) draft guidance policies provide equations for estimating sea-level projections for years not within a few years of those shown in Table 2. Based on the CCC equations, the sea-level rise projections for Year 2060 are between 0.53 and 2.57 feet; and for Year 2090, between 1.28 and 4.67 ft. The CCC guidance also states that since the mean sea level in California has remained relative constant in the past 15 years, there is no need to adjust for sea-level rise for projects with start dates prior to about 2015 or 2020.

3. WAVE OVERTOPPING

As mentioned earlier, the wave uprush analysis for this study was conducted using the ACES program to determine whether wave overtopping will occur at the project location. Based on the properties of the seawall and boat ramp structures along the perimeters of the Commercial Core Project, the analysis was conducted for three different structure types – two types of seawalls and the boat launch ramp. The locations and pictures for these two seawall types and the boat ramp are shown in Figure 7 and Figure 8, respectively.

As shown in Figure 8, Type 1 Seawall has a vertical concrete surface near the top, and sloping ripraps at the bottom. While Type 2 Seawall has a similar vertical concrete top portion, it has a sloping concrete apron near the bottom instead of ripraps. Based on the survey data, the Type 1 and Type 2 seawalls have similar crest elevations of between 9.8 to 10 ft (MLLW) and also similar toe elevations at approximately -7 ft (MLLW). However, the rough ripraps for Type 1 and smooth concrete apron for Type 2 would result in different wave uprush under the same wave and water level conditions. Hence, wave uprush analyses for these two seawall types were analyzed separately. For the uprush analyses, a crest elevation of 9.9 ft (MLLW) was used for both the Type 1 and Type 2 Seawalls. As shown in Figure 8, the boat ramp has a smooth concrete surface with a very gentle slope. Based on the design drawings, the boat ramp has a similar crest elevation (approximately 10 Ft, MLLW) as the seawalls but with a slightly deeper toe (at approximately -8 ft, MLLW).

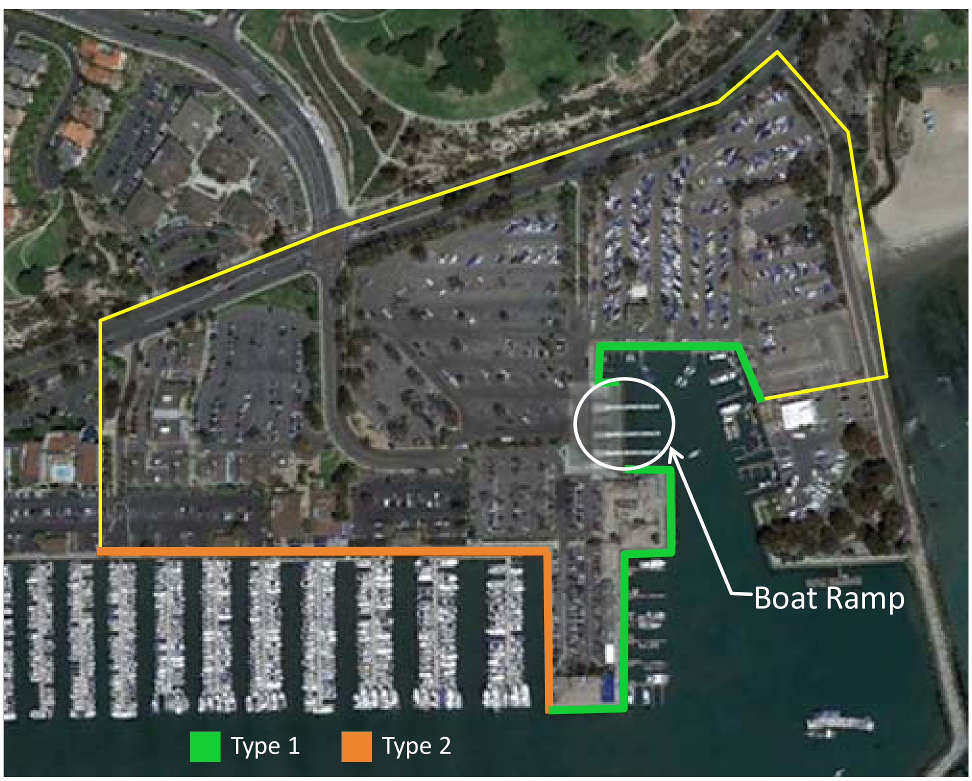
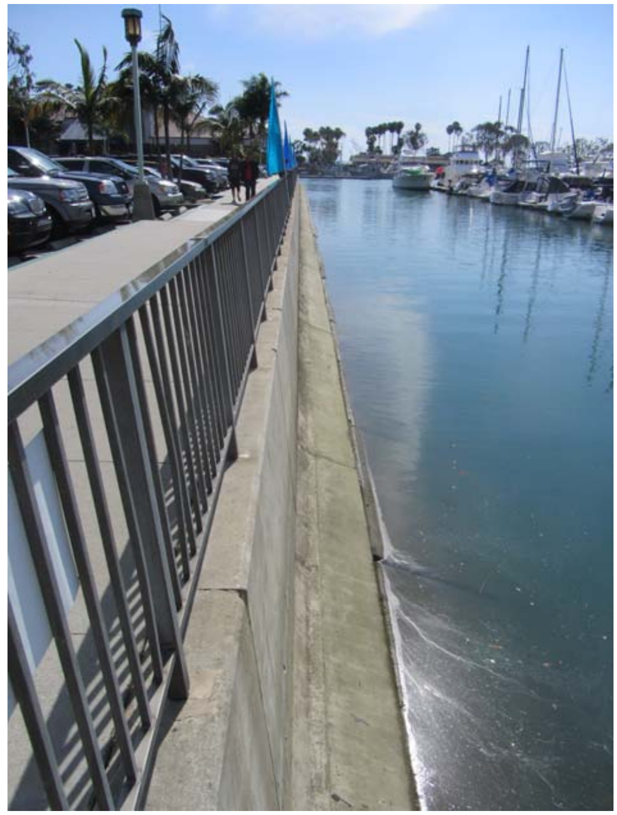


Figure 7. Locations for Type 1 and Type 2 Seawalls and Boat Ramp

a. Type 1 Seawall



b. Type 2 Seawall

c. Boat Ramp

Figure 8. Site Photographs

Section 8.6.3.4 of the Dana Point Harbor Revitalization Plan and District Regulations states that the following conditions shall be considered for a wave uprush study: high tide conditions combined with long-term (75 years) projection for sea-level rise and 100-year storm event. A 100-year storm event has a one percent chance of occurring in any given year, or on the average will occur once in every 100 years. For this study, the MHHW was used to represent the high tide conditions. Statistically, the MHHW represents a water level that is higher than about 95 percent of all the water levels in a 19-year tidal epoch. In summary, wave uprush analyses for the three types of structures at the Commercial Core Project were conducted using the 100-year storm wave conditions (significant wave height of 2.1 ft, peak wave period of 15.5 sec) for the following conditions: (1) MHHW for Year 2015, (2) the effects of adding a 1-ft and 2-ft tsunamis, (3) the effects of projected lower bound (0.53 ft), moderate (1.34 ft) and higher bound (2.57 ft) sea-level rise in Year 2060, and (4) the effects of projected lower bound (1.28 ft), moderate (2.59 ft) and upper bound (4.67 ft) sea-level rise in Year 2090. The results of the uprush analyses are summarized in Table 3.

4. SUMMARY OF FINDINGS

1. At 2015, overtopping of the seawalls and boat ramp will occur during high tide (MHHW) and a 100-year storm event.
2. For the same water level and wave conditions, Type 1 Seawall with ripraps will have less overtopping compared with the Type 2 Seawall with a smooth concrete apron.
3. For the same water level and wave conditions, overtopping at the boat ramp with a gentle slope will be higher than those at the seawalls.
4. As expected, including the effect of a 1-ft or 2-ft tsunami event to the water levels during a 100-year storm event will lead to substantial increase in overtopping at the seawalls and the boat ramp. For example, at MHHW, including the effect of a 1-ft tsunami will increase overtopping rates for Type 1 Seawall from 0.008 ft^3/sec/ft to 0.036 ft^3/sec/ft, i.e. by a factor of 4.5.
5. For Year 2060, with the projected sea-level rise, there will be substantial increase in wave overtopping at the seawalls and the boat ramps as compared to Year 2015. For example, at MHHW, for a moderate projection of sea-level rise of 1.34 ft, wave overtopping for Type 1 Seawall will increase from 0.008 ft^3/sec/ft to 0.058 ft^3/sec/ft, i.e. by a factor of 7.3.
6. For Year 2090, with the projections of sea-level rise of 4.67 ft (higher bound), the area will be inundated (i.e. water elevation higher than the crest elevation of the structures) during MHHW.
7. For Year 2090, with a moderate projection of sea-level rise of 2.59 ft, there will be substantial increase in wave overtopping at the seawalls and the boat ramp as compared to Year 2015. For example, at MHHW, wave overtopping for Type 1 Seawall will increase from 0.008 ft^3/sec/ft to 0.301 ft^3/sec/ft, i.e. by a factor of 37.6.

EVEREST

Table 3. Estimated Overtopping Rates during a 100-year Storm Wave Event for Types 1 and 2 Seawalls and Boat Ramp at the Commercial Core Project Location

Condition	Water Level (ft, MLLW)	Structure Overtopped by Wave?			Wave Overtopping Rate (cubic ft per sec per linear ft)		
		Type 1 Seawall	Type 2 Seawall	Boat Ramp	Type 1 Seawall	Type 2 Seawall	Boat Ramp
2015 MHHW	5.41	yes	yes	yes	0.008	0.026	0.183
2015 MHHW + 1-ft Tsunami	6.41	yes	yes	yes	0.036	0.077	0.331
2015 MHHW + 2-ft Tsunami	7.41	yes	yes	yes	0.141	0.219	0.589
2060 MHHW (with 0.53 ft SLR - Low)	5.94	yes	yes	yes	0.018	0.046	0.251
2060 MHHW (with 1.34 ft SLR - Moderate)	6.75	yes	yes	yes	0.058	0.110	0.403
2060 MHHW (with 2.57 ft SLR - High)	7.98	yes	yes	yes	0.293	0.395	0.816
2090 MHHW (with 1.28 ft SLR - Low)	6.69	yes	yes	yes	0.053	0.103	0.389
2090 MHHW (with 2.59 ft SLR - Moderate)	8.00	yes	yes	yes	0.301	0.403	0.825
2090 MHHW (with 4.67 ft SLR - High)	10.02	Inundated*	Inundated	Inundated	N/A	N/A	N/A

* *Water level higher than crest elevation of structure*

N/A = not applicable

5. Recommendations

The 100-year storm wave condition used for this study was estimated based on results of prior studies. The closest location where wave conditions were predicted by the prior studies is at a location south of the Commercial Core Project site (shown as Location A in Figure 3). Wave heights at the Commercial Core Project site are likely to be smaller than those at Location A; hence, the estimated wave overtopping rates shown in Table 3 are conservative. If more accurate prediction of wave overtopping is needed due to the adoption of regulatory standards, a detailed wave model study may be needed to further define the wave conditions at the Commercial Core Project location.

As mentioned earlier, this study only focuses on the wave uprush of the seawalls and the boat ramp of the Commercial Core Project during a 100-year storm event and under the influence of a 1-ft and 2-ft tsunami, a specific coastal impact study may be needed for the proposed dry stack boat storage building. Wave and current loadings on the piles of the building during a 100-year storm and tsunami conditions should be considered in the design of the piles. Potential wave and current induced scouring around the piles should also be evaluated and incorporated in the design.

The incorporation of sea level rise for this study follows the California Coastal Commission's Draft Sea-Level Rise Policy Guidance parameters; this study should be updated at such time as regulatory requirements are adopted by state and/or Federal agencies.

6. Closure

We have completed the wave uprush analyses for the Commercial Core Project at the Dana Point Harbor. Please feel free to contact me if you have any questions or comments about this report.

Sincerely,
Everest International Consultants, Inc.

Ying Poon, P.E., D.Sc.
Vice President/Principal Engineer

REFERENCES

California Coastal Commission (CCC), 2013. Draft Sea-Level Rise Policy Guidance. Public Draft Version.

ERDC and Nobles (US Army Engineering Research & Development Center and Noble Consultants, Inc.), 2011. Comprehensive Condition Survey and Storm Waves, Circulation, and Sedimentation Study, Dana Point Harbor, California. Draft Report prepared for the US Army Corps of Engineers, Los Angeles District, March 2011.

Everest International Consultants, Inc., 2008. Dana Point Harbor Revitalization Coastal Engineering Services – Progress Report. Prepared for URS/Cash & Associates, March 18, 2008.

National Research Council (NRC), 2012. Sea-Level Rise for the Coasts of California, Oregon and Washington: Past, Present and Future.

USACE 1965. Design Memorandum No. 1, General Design for Dana Point Harbor, Dana Point, California. September 1965.

USACE 1986. Lessons Learned Study, Dana Point Harbor, Dana Point, California. Los Angeles District, February 1986.

USACE 1996. Coast of California Storm and Tidal Wave Study, South Coast Region, Orange County, Nearshore Hydrodynamic Factors and Wave Study of the Orange County Coast. Final Report. Report 96-3, January 1996.

Veri-Tech Inc. 2010. Automated Coastal Engineering System (ACES) Version 4.03, Coastal Engineering Design & Analysis System (CEDAS) Version 4.0.

Wilson, R. I., A.R. Admire, J.C. Borrero, L.A. Dengler, M.R. Legg, P. Lynett, T.P. McCrink, K.M. Miller, A. Ritchie, K. Sterling, and P.M. Whitmore, 2012. Observations and Impacts from the 2010 Chilean and 2011 Japanese Tsunamis in California (USA). Proc. Appl. Geophys. 170 (2013), 1127-1147.