APPENDIX H

COASTAL HAZARDS MEMORANDUM

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Memorandum

February 20, 2025

To: Anthony Wrzosek, R.D. Olson Development

From: Alyssa Cannon, Anchor QEA

cc: Josh Burnam, MPH, D.Env; Adam Gale; Megan Collins, PE, Anchor QEA

Re: Final Dana Point Harbor Hotels Development Coastal Hazards

Anchor QEA has prepared this updated memorandum to address additional coastal hazards comments on the Dana Point Harbor Revitalization Plan provided by the City of Dana Point specific to the hotel development. This technical memorandum presents the analysis and results of the additional coastal hazards evaluation conducted for the proposed development at the hotel Site, including the following:

- Tidal levels
- Extreme stormwater levels
- Sea level rise (SLR): California Coastal Commission (CCC) 2024 SLR guidance
- Coastal Storm Modeling System (CoSMoS) wave data and flood depths
- Wave run-up and overtopping
- Tsunami hazards
- Groundwater hazards
- Summary of coastal hazards and proposed mitigations

Based on the latest hotel development site plans (dated August 26, 2024), the proposed finished floor elevation of the development is +15 feet North American Vertical Datum of 1988 (NAVD88) for Surf Lodge, and +12.8 feet NAVD88 for the lowest occupied level at Dana House (i.e. the basement). For the purposes of this evaluation, a design life of 75 years for the development has been assumed.

Tidal Levels

Tidal datums for the area (Table 1) were sourced from the National Oceanic and Atmospheric Administration (NOAA) Tides and Currents database, tidal station 9410660: Los Angeles, California (NOAA 2019a).

Table 1
Tidal Datums: Los Angeles NOAA Station No. 9410660

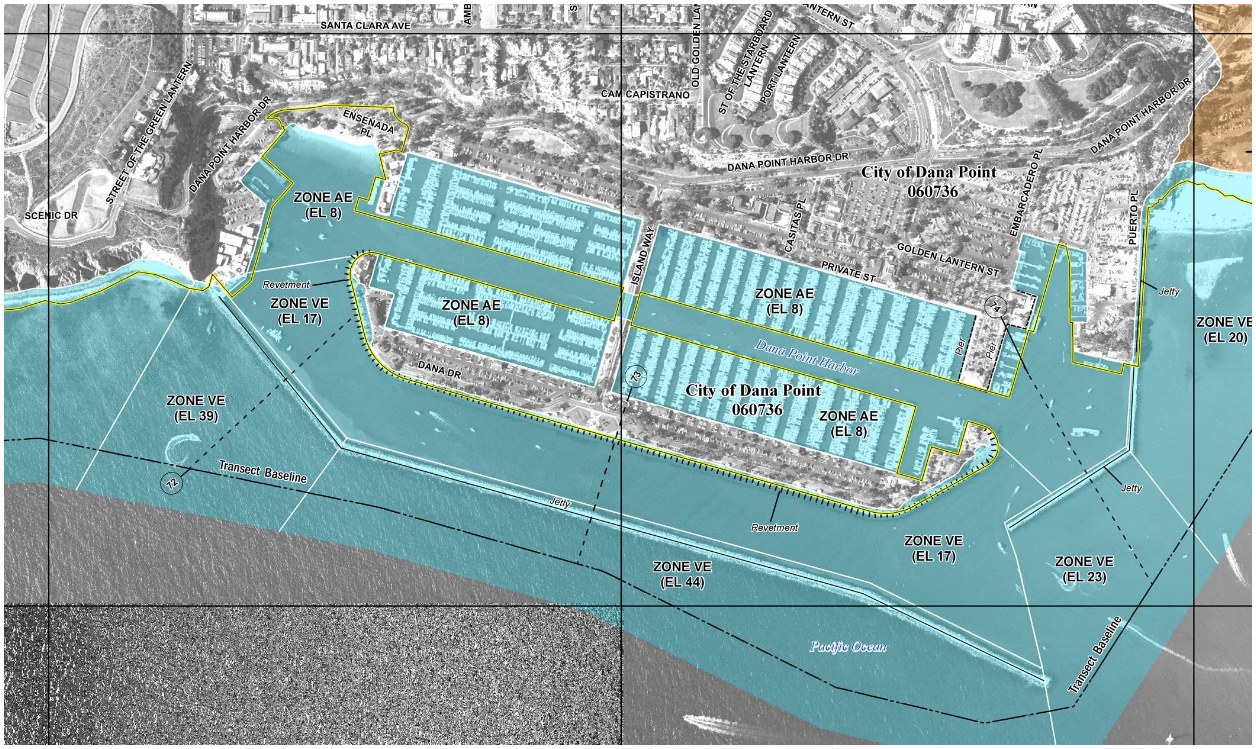
Tidal Datum	Elevation Relative to MLLW at Gage Location (feet)	Elevations Relative to NAVD88 (feet)
HOT	7.9	7.7
HAT	7.3	7.1
MHHW	5.5	5.3
Mean High Water	4.8	4.6
MSL	2.8	2.6
Mean Low Water	0.9	0.7
NAVD88	0.2	0.0
MLLW	0.0	-0.2
LAT	-2.0	-2.2

Notes:
HOT: highest observed tide (January 10, 2005)
HAT: highest astronomical tide
LAT: lowest astronomical tide
MHHW: mean higher high water
MLLW: mean lower low water
MSL: mean sea level

Extreme Stormwater Levels

In addition to normal tide water elevations, existing and future storms can result in increased water levels and flooding. The Federal Emergency Management Agency's (FEMA's) Flood Insurance Study for Orange County (FEMA 2019) divides Dana Point Harbor into various zones. Figure 1 shows the Dana Point Harbor portion of the flood insurance rate map (FIRM; FEMA 2019). Just within the breakwaters, the 100-year total water elevation (including wave impacts) is +17 feet NAVD88. Within the marina, wave impacts are not directly included in the FEMA 100-year base flood elevation of +8.0 feet NAVD88, which was calculated using an extreme analysis of measured tides, including storm setup, from the Los Angeles NOAA tidal station No. 9410660 (FEMA 2019).

Figure 1
Portion of Dana Point FEMA FIRM



Note: Orange County FIRM Number 06059C0504K

Sea Level Rise

SLR estimates for the original 2019 Dana Point Harbor Revitalization Coastal Hazards assessment were taken from CCC's *Sea Level Rise Policy Guidance* (CCC 2018) for Los Angeles (the closest station). As of 2024, CCC guidance has been updated based on the Ocean Protection Council's updated State of California Sea Level Rise Guidance, and those updates have been included here for the hotel Site. CCC guidance recommends the intermediate-high scenario[1] from the Ocean Protection Council's (OPC's) SLR guidance (OPC 2024) be used based on the project type. The intermediate-high scenario should be used for projects with greater consequences and/or a lower ability to adapt, such as residential and commercial structures (CCC 2024). The time frame used to evaluate impacts to the Site due to predicted SLR is based on the design life of the proposed structures (CCC 2024). As stated previously, the design life of the development is expected to be approximately 75 years. Therefore, an intermediate-high scenario SLR estimate for 2100 should be

[1] From OPC's Sea Level Rise Guidance, for the intermediate-high scenario, at a warming level of 3°C in 2100, the probability of exceeding this scenario is 0.1% when not considering the low-confidence processes (e.g., rapid ice sheet melt), emphasizing the degree to which these processes are needed to reach this level of SLR. With the low-confidence processes, the probability of exceeding this scenario is approximately 20% for very high warming levels (OPC 2024).

used for design, +4.5 feet. The projected tidal elevations at the Site based on the projected SLR estimate for 2100 are summarized in Table 2.

Table 2
Potential 2100 Water Levels at the Site

Tidal Level	Current Conditions[1]	2100 Conditions[2]
FEMA 100-year still water	8.0	12.5
HOT	7.7	12.2
HAT	7.1	11.6
MHHW	5.3	9.8
MSL	2.6	7.1
NAVD88	0.0	4.5
MLLW	-0.2	4.3

Notes:
All elevations are in feet, relative to NAVD88.
1. Existing tidal datums are provided in Table 1.
2. 2100 conditions are based on the intermediate-high SLR scenario (+4.5 feet).

Because the finished floor elevation for Surf Lodge is to be +15 feet NAVD88, and the lowest finished floor elevation of occupied areas (i.e. the basement) of Dana House is to be +12.8 feet NAVD88, neither existing nor future 2100 still water-level flood elevations are expected to directly impact the occupied areas.

The unoccupied garage (e.g. parking, drive aisles, and storage areas), will have an elevation of +12.3 feet NAVD88, which could be flooded by the FEMA 100-year still water elevation (+12.5 feet NAVD88). To reduce the risk of flooding in the garage and basement of the Dana House, a multitude of perimeter trench drains, and area floor drains directed to sump pumps, are included in the design. The basement of Dana House will be designed with special flood-proof doors and window systems and constructed of concrete masonry units and/or on 8 inches high concrete curbs adding additional vertical height above the surrounding garage. Supporting consultants and adaptive management of the flood protection system will reduce future flood risk as water level rise in the future.

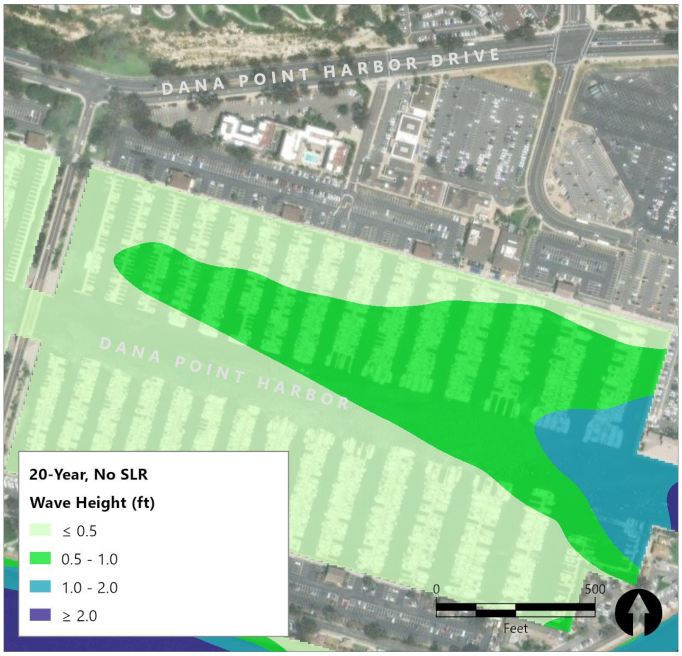
CoSMoS Wave Data and Flood Depths

In addition to the water levels outlined previously, localized waves within the marina have the potential to cause increased flooding. The U.S. Geological Survey CoSMoS (Barnard et al. 2018) was used to further evaluate potential local flooding and wave impacts at the Site. CoSMoS makes detailed predictions over large geographic scales of storm-induced coastal flooding and erosion for both current and future SLR scenarios. The future SLR scenarios ranged from 0 to 2 meters at 0.25-meter increments (0 to 6.6 feet at 0.82-foot increments), and an additional 5 meter (16.4 feet) extreme scenario. As Dana

Point Harbor has a hard shoreline (i.e., seawall), there are no estimates for shoreline erosion at the Site. However, there are flood depth and wave height estimates for Dana Point Harbor (see Figures 2 through 7). Conditions for both the 20-year and 100-year wave events are summarized as follows:

- With no SLR, wave heights are less than 0.5 feet along the seawall in front of the Site (Figures 2 and 3).
- No flooding is expected without SLR.
- With 4.9 feet (1.5 meters) of SLR, wave heights are 0.5 to 1 foot along the seawall in front of the Site (Figures 4 and 5). This is a slightly more conservative estimate than the 2024 OPC intermediate-high estimate of +4.5 feet of SLR by 2100, but it is the closest scenario available from the CoSMoS modeling effort.
- With 4.9 feet of SLR, flooding is expected for existing Site conditions, with depths predominately between 2 and 3 feet; however, flood depths could exceed 3 feet in areas near the seawall, based on Light Detection and Ranging data used by CoSMoS for the area (Figures 6 and 7).

Figure 2
20-Year Wave Heights, No SLR



Note:
ft: foot

Figure 3
100-Year Wave Heights, No SLR

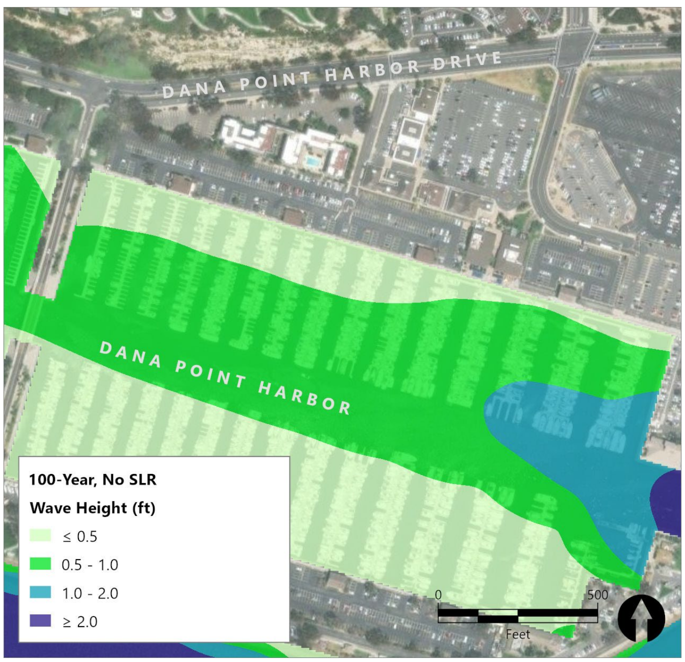


Figure 4
20-Year Wave Heights, 4.9 Feet SLR (conservatively above the anticipated +4.5 Feet SLR by 2100)

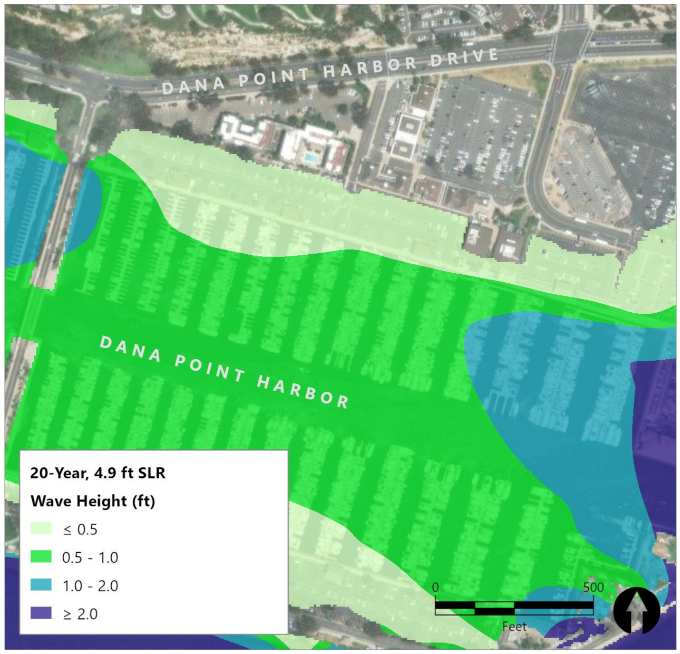


Figure 5
100-Year Wave Heights, 4.9 Feet SLR (conservatively above the anticipated +4.5 Feet SLR by 2100)

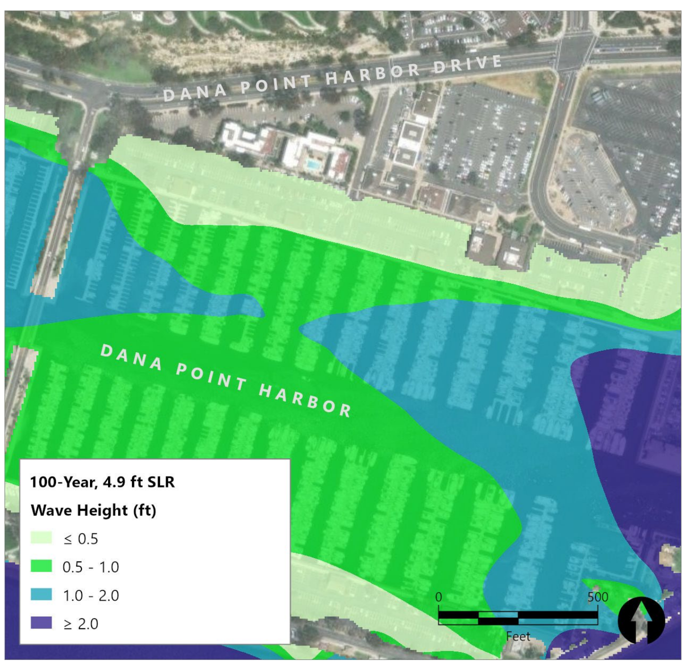


Figure 6
Flood Depths for 20-Year Waves, 4.9 Feet SLR (conservatively above the anticipated +4.5 Feet SLR by 2100)

Figure 7
Flood Depths for 100-Year Waves, 4.9 Feet SLR (conservatively above the anticipated +4.5 Feet SLR by 2100)

Wave Run-up and Overtopping

Wave run-up and overtopping was estimated using the *EurOtop: Manual on Wave Overtopping of Sea Defences and Related Structures* (Van der Meer et al. 2018). The existing seawall has a top elevation of +9.8 feet NAVD88 and was approximated as a plain vertical wall. Orange County is anticipated to maintain and repair the seawall as needed in the future; however, no plans to raise the seawall by the County are known at this time therefore for this analysis it is assumed that the seawall top elevation will be +9.8 feet NAVD88 for existing conditions and future SLR conditions. It is also assumed that the Dana Point Harbor jetties will be maintained at their current elevations during future SLR conditions.

The wave run-up height is defined as the vertical difference between the highest point of wave run-up and the still water level. The wave run-up height reported here corresponds to the value exceeded by 2% of incoming waves in accordance with the methodology outlined in the *EurOtop* manual. The “design and assessment” approach was applied using Equation 1 (Equation 5.7 in *EurOtop*), which includes a safety factor of one standard deviation from the mean run-up prediction. In the case of a vertical wall, the ratio of run-up to wave height would become 1.93.

$$\frac{R_{u2\%}}{H_{m0}} = 0.86cot\alpha + 1.71 \qquad (1)$$

Wave overtopping is described by an average wave overtopping discharge (q) given in units of volume of water per second. Overtopping is dependent both on the incident wave height and on freeboard of the structure (R_c). The *EurOtop* manual suggests different methodologies for estimating wave overtopping on vertical walls based on the foreshore influence on incident waves. A practical definition of an influencing foreshore offered by the *EurOtop* manual is a sloping foreshore (1:50 and steeper) and relatively shallow or intermediate depth water (i.e. not deep) at the structure toe. According to the most recent NOAA chart, the bottom of the East Basin is dredged to -10.2 feet NAVD88 (–10 feet MLLW), and this depth was assumed to be constant throughout the marina and up to the seawall’s toe (NOAA 2025). In this case, the horizontal foreshore would not influence overtopping and at this depth the waves reported in the CoSMoS data would not break. The overtopping design and assessment approach for a plain vertical wall without the influence of foreshore was applied using Equation 2 (Equation 7.2 in the *EurOtop* manual):

$$\frac{q}{\sqrt{g \times {H_{m0}}^3}} = 0.054 * \exp\left[-\left(2.12 \times \frac{R_C}{H_{m0}}\right)^{1.3}\right] \qquad (2)$$

Table 5 outlines the results of the run-up and overtopping analysis. Equations 1 and 2 were applied to the seawall for the 100-year wave conditions with and without the effects of sea level rise. The initial still water elevation was set to the FEMA 100-year level of +8 feet NAVD88 and a SLR projection of +4.5 feet was assessed. The results show that for existing SLR conditions, the wave run-up would not surpass the crest of the seawall, and the overtopping rate would be insignificant. With an added 4.5 feet of SLR, the seawall will be inundated, as the SWL of 12.5 feet NAVD88 exceeds the seawall crest at 9.8 feet NAVD88. Figure 5 shows a wave height of up to 0.5 feet occurring in the parking lot landward of the seawall, where the wave will travel inland along the existing topography until the wave hits the natural topography or the building's vertical walls. For this analysis it is assumed that the wave would travel and impact the parking garage, at which point adaptive measures such as floodproofing would be implemented.

Table 5
Wave Run-up and Overtopping of the Seawall and Building

Scenario	SWL (ft NAVD88)	Wave Height (ft)	Freeboard (ft)	Wave Run-up on a vertical wall (ft)	SWL + Wave Run-up (ft NAVD88)	Overtopping Rate (ft^3/s)
100-yr wave, no SLR	8	0.5	1.8	1.0	9.0	0.0
100-yr wave, +4.5 ft SLR	12.5	0.5	>>1	1.0	13.5	0.0

SWL = still water level

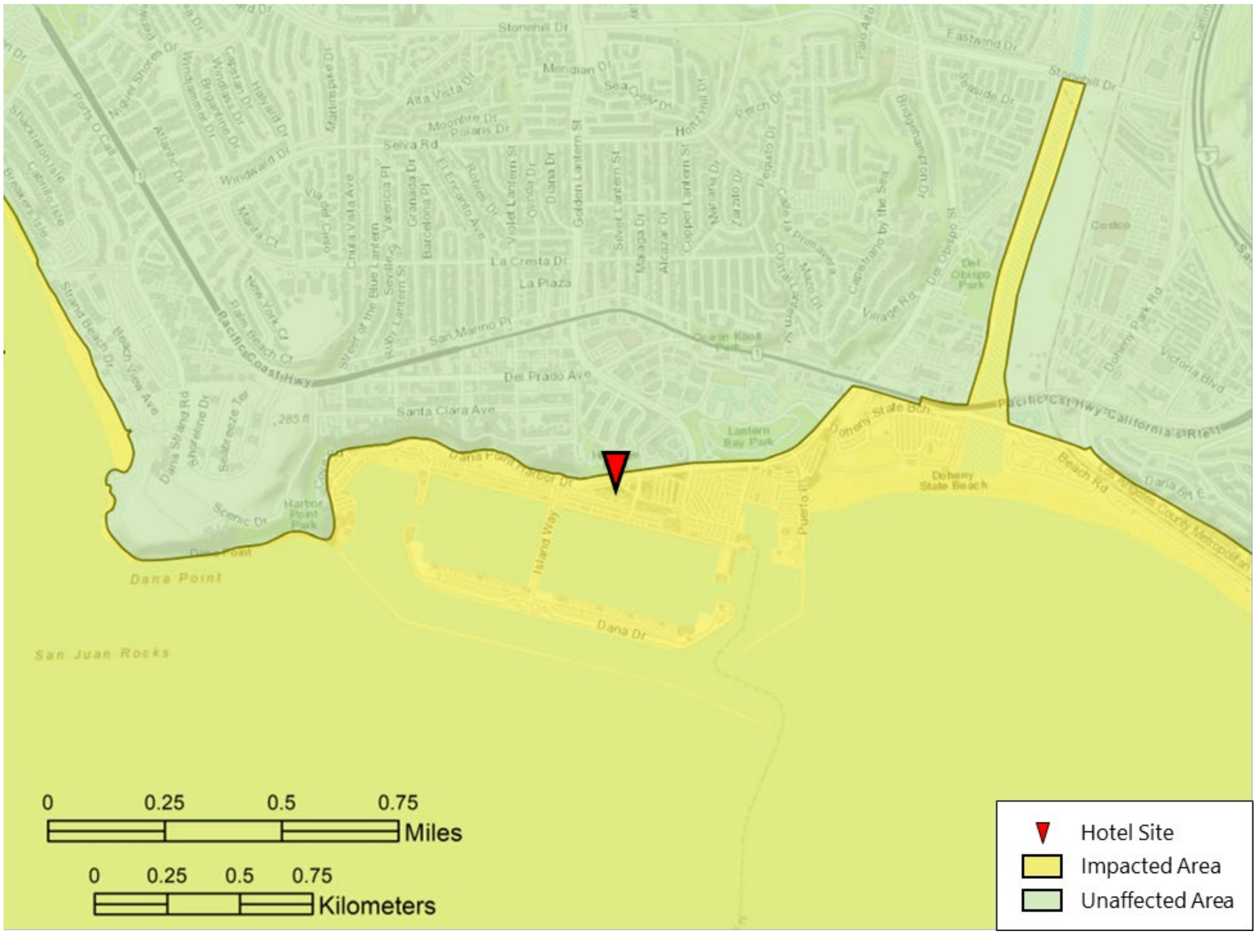
For computation of wave run-up and overtopping, linear wave theory dispersion relation was used to determine wave periods and it was assumed the bathymetry in the area of the seawall adjacent the hotel is a uniform flat bottom with a mudline elevation of -10.2 ft NAVD88. This classifies all incident wave conditions as relatively deep water. This methodology applied includes simplified assumptions regarding the geometry of the seawall or its foreshore.

Tsunami Hazard

The Department of Conservation California Geological Survey puts Dana Point Harbor and the project Site within the Tsunami Hazard zone (Figure 8). However, large magnitude tsunami waves have not been recorded at Dana Point because the area is somewhat protected from the more common northern tsunamis due to the coastline orientation, local headlands, and offshore islands (Project Dimensions 2014). The Site is more exposed to damage from an even more rare tsunami event originating from the south.

NOAA's National Centers for Environmental Information categorizes three tsunami events that have affected Dana Point (1960, 2010, and 2011); each resulted in water levels being increased by less than 2.5 feet, and limited damage was reported (NGDC & WDS 2024).

Figure 8
Tsunami Hazard Zone



Source: Excerpt from Tsunami Hazard Area Map, Orange County; produced by the California Geological Survey and the California Governor's Office of Emergency Services (State of California 2021)

Groundwater Hazards

The geotechnical investigations, conducted by GMU Geotechnical, Inc. (2019), estimated groundwater elevations to be approximately 5 to 10 feet below ground surface. At the marina promenade, the ground elevation is approximately +9.3 feet NAVD88, putting the highest groundwater, closest to the harbor, at approximately +4.3 feet NAVD88.

The geotechnical investigations also noted that the groundwater level was variable by tide level, and, therefore, is expected to rise with SLR along with tide levels. If the rise is equivalent for 2100 (+4.5 feet), groundwater is expected to reach approximately +8.8 feet NADV88, which is below the finished floor elevations of the hotels.

Summary of Coastal Hazards and Proposed Mitigations

A table of coastal hazards is included in Table 6. For the Surf Lodge, the lowest proposed finished floor elevation is +15 feet NAVD88, and for the basement of Dana House, the lowest occupied floor elevation is +12.8 feet NAVD88. During existing conditions, the proposed finished floor elevations are sufficiently above the existing still water level of +8.0 feet NAVD88, and the highest elevation reached by the 100-year wave run-up on a vertical wall (+9.0 feet NAVD88). This analysis assumes Orange County will maintain the seawall at +9.8 feet NAVD88 in the future; no plans to raise the seawall by the County are known at this time or included in this analysis. The existing Dana Point Harbor jetties are also assumed to be maintained at existing elevations into the future.

In the future (2100) with +4.5 feet of SLR, the still water level increases to +12.5 feet NAVD88 and the 100-year wave run-up on a vertical wall reaches a maximum elevation of +13.5 feet NAVD88. The finished floor elevation of the Surf Lodge (+15 feet NAVD88) is above both the still water inundation level and the potential wave run-up elevation. The lowest occupied floors of Dana House, residing at +12.8 feet NAVD88, are at a sufficient elevation to not be inundated during the 100-year still water event at +12.5 feet NAVD88, but the 100-year wave run-up elevation (+13.5 feet NAVD88) could result in inundation of the parking garage. It is anticipated that the lowest occupied floors of Dana House might experience inundation near 2085. The unoccupied parking garage, with a design elevation of +12.3 feet NAVD88, would also be inundated in the future.

To reduce the risk of flooding in the parking garage and basement of the Dana House, a multitude of perimeter trench drains, and area floor drains directed to sump pumps, are included in the design. The basement of Dana House will be designed with special flood-proof doors and window systems and constructed of concrete masonry units and/or on 8 inches high concrete curbs adding additional vertical height above the surrounding garage providing protection up to the future projected +12.5 feet NAVD88 still water level. Supporting consultants and adaptive management of the flood protection system will reduce future flood risk as water level rise in the future. As SLR is not expected to overtop the seawall earlier than about 2055 during a 100-year flood event, between 2050 and 2053 a new assessment of SLR impacts shall be made (which can be part of an overall harbor wide assessment) to determine if there are additional mitigation measures or construction adaptation necessary to protect against future impacts of SLR as may be predicted at such time.

Table 6
Coastal Hazards Summary Table

Coastal Hazard	Existing (2020) Conditions	Future (2100) Conditions[1]
MSL	+2.6 feet NAVD88	+7.1 feet NAVD88
MHHW	+5.3 feet NAVD88	+9.8 feet NAVD88
HAT	+7.1 feet NAVD88	+11.6 feet NAVD88
HOT	+7.7 feet NAVD88	+12.5 feet NAVD88
FEMA 100-year still water elevation	+8 feet NAVD88	+12.5 feet NAVD88
CoSMoS 100-year marina wave height	0.5 feet	0.5 feet
FEMA 100-year still water elevation with 100-year wave run-up on a vertical wall	+9.0 feet NAVD88	+13.5 feet NAVD88

Note:
1. An intermediate-high SLR scenario was used for "Future (2100) Conditions" (+4.5 feet).

References

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