Appendix I

Probabilistic Site-Specific Tsunami Hazard Analysis (PTHA)

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Subject: **Nordic Aquafarms, Inc. Probabilistic Site-Specific Tsunami Hazard Analysis (PTHA)**

This report is a summary of the Site-Specific Tsunami Inundation Analysis conducted in accordance with the requirements of Chapter 6, Tsunami Loads and Effects, of ASCE 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, which is being updated for its ASCE 7-22 version. This site-specific high-resolution probabilistic tsunami hazard inundation analysis generated a time history of flow depth and velocities for the project site. The site-specific inundation analysis defines the tsunami inundation levels that could impact the proposed facility, shown in Figure 1.

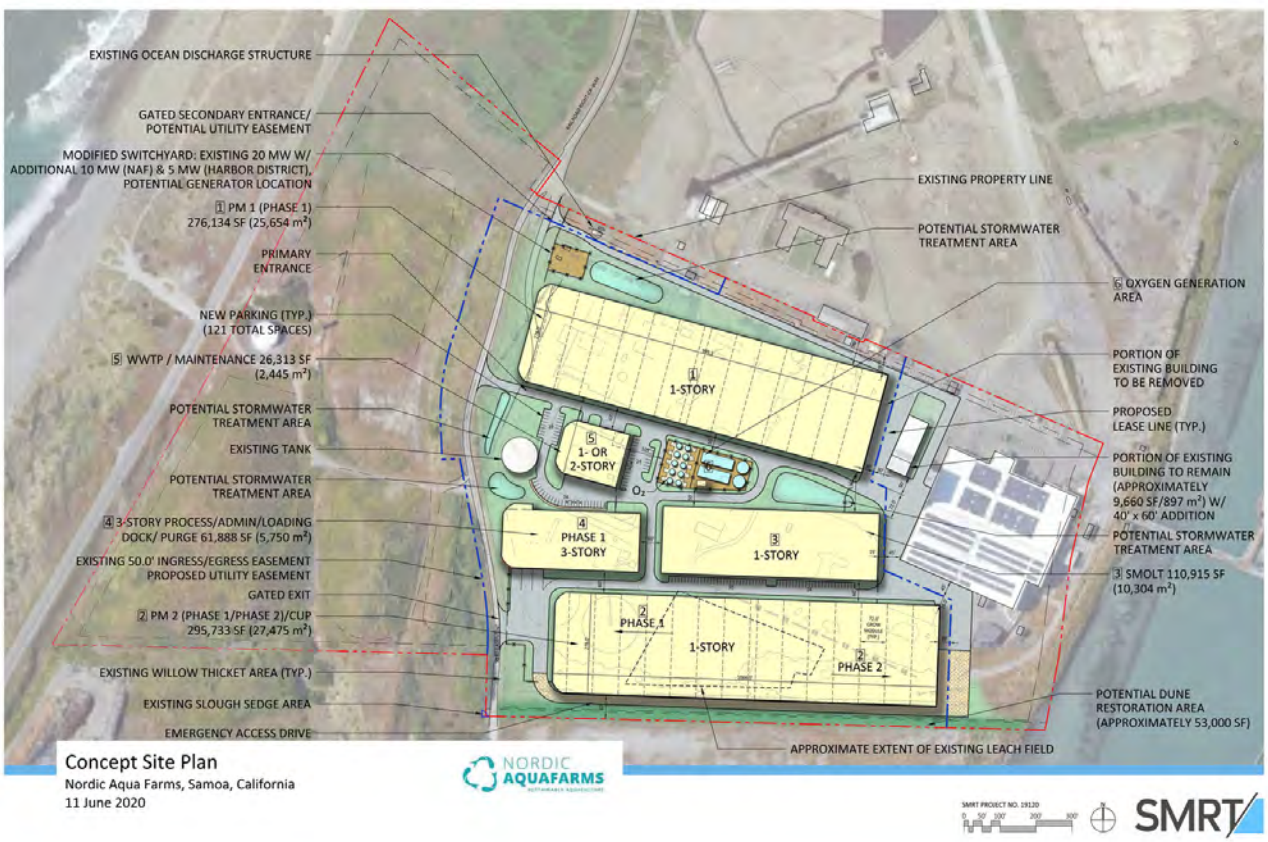

Figure 1. Proposed Facility Site Plan (configuration subject to minor modifications/alignment)

Background note:
This analysis supersedes an August 23, 2019 report, in which we provided an initial tsunami risk assessment for the proposed development based on an Energy Grade Line Analysis referenced to Inundation Depth Points given in the ASCE Tsunami Design Geodatabase.

Discussion of the Site-Specific Tsunami Inundation Analysis
The tsunami hazard basis used in the ASCE 7 Standard is a Maximum Considered Tsunami (MCT) with a 2% probability of being exceeded in a 50-year period, or a ~2500-year average return period.
The Maximum Considered Tsunami is the design basis flooding event, characterized by the inundation depths and flow velocities most critical to the structure. The method of Probabilistic Tsunami Hazard Analysis (PTHA) is consistent with probabilistic seismic hazard analysis in the precautionary treatment of uncertainties. The International Code Council adopted these tsunami design requirements by reference into the International Building Code, IBC 2018, without alteration. Similarly, the California State Building Code adopted the IBC 2018 with these requirements without alteration. Chapter 6 of ASCE 7-16 is therefore an engineering standard practice for design of buildings and other structures. Note that the application of tsunami-resilient design to Risk Category II buildings and structures is left to the local county or city jurisdiction's building code.

The requirements for performing a high-resolution site-specific tsunami analysis is specified in ASCE 7 Chapter 6, Section 6.7. First, a tsunami inundation software model validated by the certification criteria set by the National Tsunami Hazard Mitigation Program under NOAA. We have used the same certified model software that was utilized by the California Geological Survey for its high-resolution tsunami mapping being incorporated in the 2022 version of the ASCE 7-22 Standard. This choice reduces model variability.

The probabilistic criteria for this analysis are embodied in Offshore Tsunami Amplitude points given in the ASCE Tsunami Design Geodatabase. That is, the ASCE Offshore Tsunami Amplitudes are the probabilistic compilation of all Pacific Basin tsunami sources of significant influence on this region (Figure 2). A Hazard Consistent Tsunami scenario is qualified if:

- its tsunami amplitudes closely match the ASCE-specified Offshore Tsunami Amplitudes, averaged over at least 40 miles but not exceeding 50 miles of projected length along the coastline, centered within a tolerance of plus or minus 6 miles on the site, such that
    - the average of the design scenario waveform is at least 100% of the ASCE average, and
    - no waveform amplitude point of the design scenario is less than 80% of any ASCE Offshore Tsunami Amplitude at the corresponding location.

Probabilistic information for the seismic source to be used to generate a proper Hazard Consistent Tsunami scenario is provided in seismic source disaggregation figures in the ASCE 7 Tsunami Design Geodatabase. For this site, the Cascadia Subduction Zone (CSZ) is the dominant tsunami-genic seismic source (Figure 3). A subsequent inundation analysis confirmed that an Alaskan Hazard Consistent Tsunami would not govern over the inundation levels resulting from the CSZ. Some relatively small ground subsidence due to the local fault rupture is to be included in the analysis results per Figure 4, as well as the specified allowance for relative sea level rise of 4.1 ft. (See Figure 5).

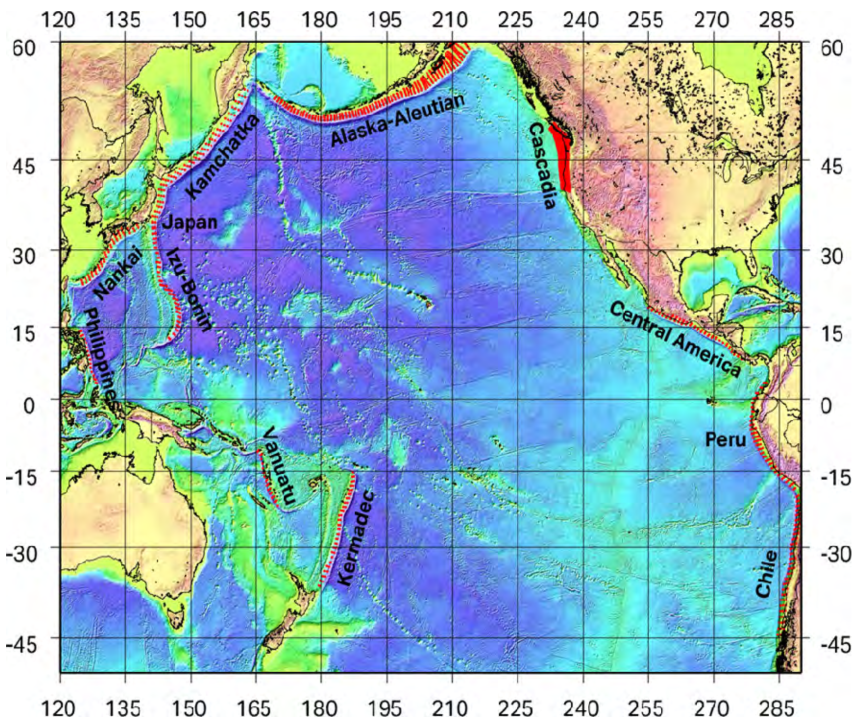

Figure 2. Pacific Basin Tsunami-genic Subduction Zones

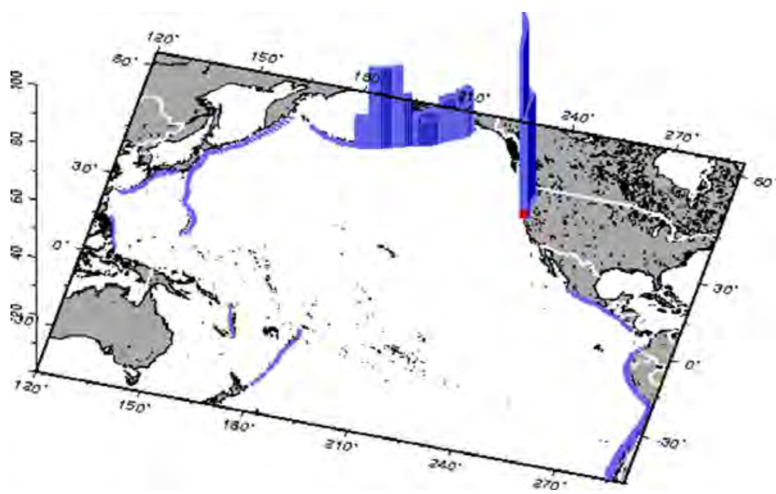

Figure 3. Example Disaggregated Tsunami-genic Seismic Sources for 40.85300 and -124.36400

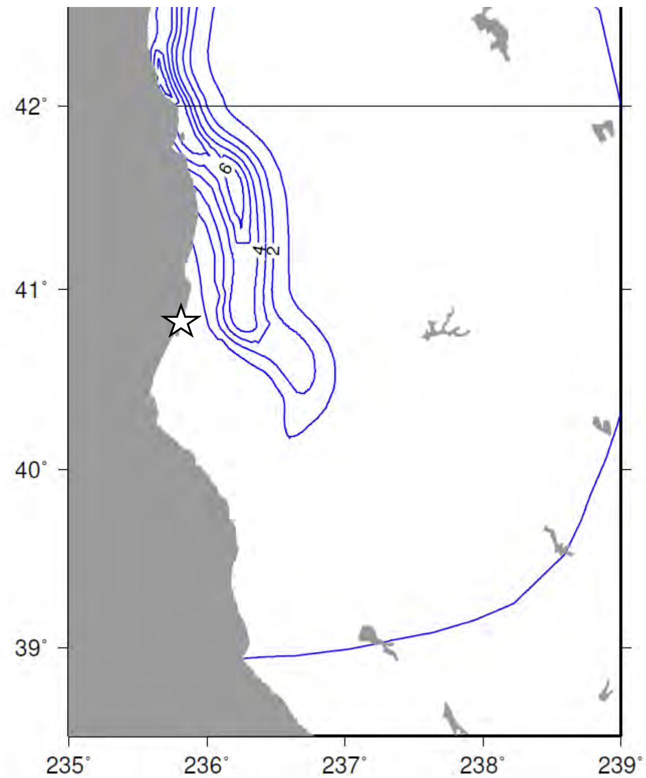

Figure 4. Probabilistic Regional Seismic Subsidence due to Tsunami-genic Earthquakes (feet)

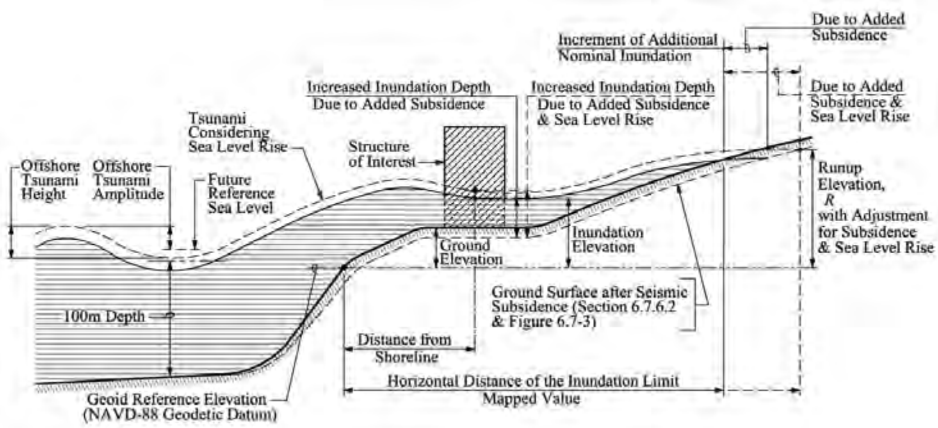

Figure 5. Incorporation of Ground Subsidence and Relative Sea Level Rise

The 2022 update to ASCE 7 Chapter 6 will include California Geological Survey (CGS) tsunami inundation data based on a digital elevation model of 10-meter resolution that is more refined than the present ASCE 7 Tsunami Design Geodatabase; the CGS results indicate significantly lower Inundation Depth Points in this overwashed area. The Digital Elevation Model used in our analysis for Nordic Aquafarms is at an even more refined 1 m grid resolution, and it includes the proposed structures that affect the flow across the site.

In this region, the tsunami flows across the overwashed Samoa Peninsula and discharges into the Eureka Channel. Therefore, the digital elevation model input also incorporated erosion around the perimeters of the dunes to the west of the site. Because the large dunes are not overwashed by the flow that passes through the gaps between them, the duration of flow and the erodibility of the dune material beneath the vegetated cover was evaluated, and the edges of the dunes were trimmed and steepened to reflect the loss of material due to erosion by the tsunami flow.

The site-specific tsunami inundation analysis is performed to generate the time history of flow depth and velocities over the greater area encompassing the site, over several hours of cyclic inundation due to the Hazard Consistent Tsunami scenario. A map of maximum inundation depth is shown below in Figure 6. It is apparent that overland flow with a northwestern component impacts the northern Building 1 more directly, which if appropriately designed for tsunami would then provide mitigation to reduce the flow depths and velocities experienced by the other structures to its south on this site.

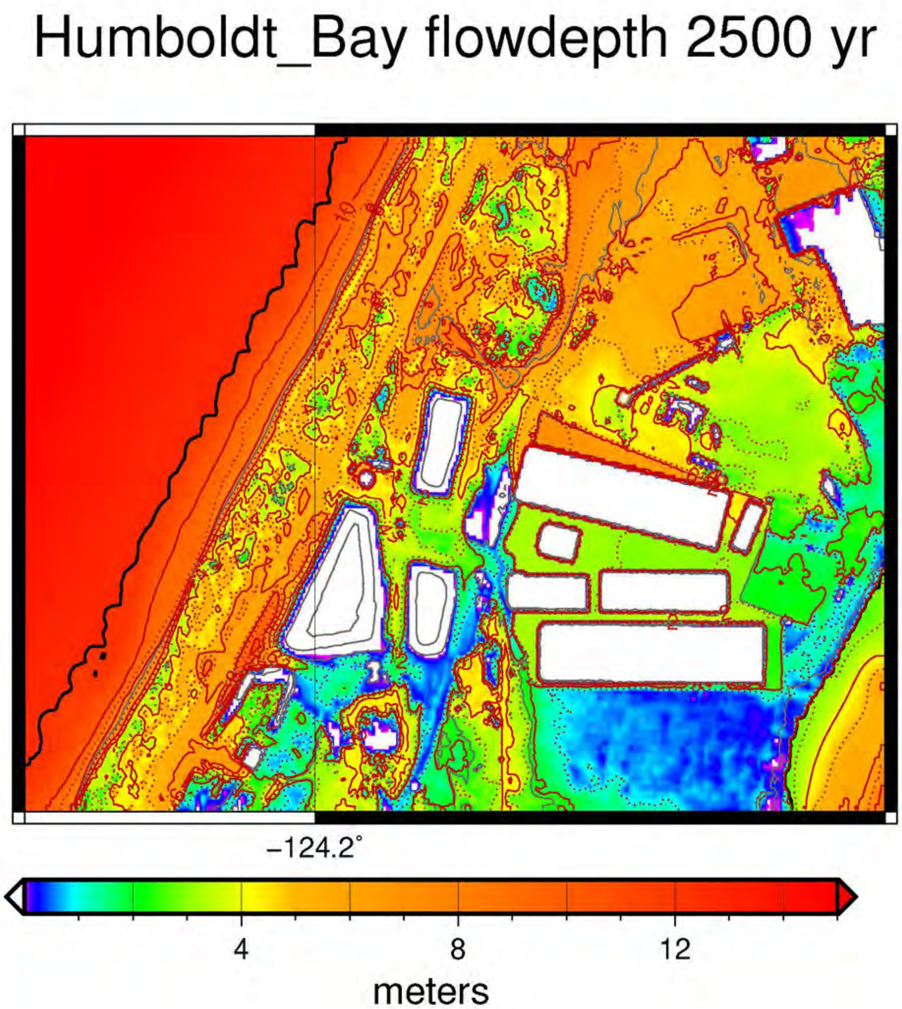

Figure 6. Spatially Averaged Maximum Inundation Depths at the Site

From the site-specific modeling, site-specific design conditions are being processed for use by the structural engineers of the design team for the design of the individual buildings and their structural systems as well as nonstructural systems. Per ASCE 7, the model raw results for flow speed are also subject to certain minimum prescriptive design values based on observational data from large recent tsunamis. Debris impacts and scour are also being evaluated per ASCE 7 analysis procedures.

It is our understanding that the three-story-tall Building 4 is anticipated to be designed as a Tsunami Vertical Evacuation Refuge Structure. Per ASCE 7-16, such buildings are to be designed in accordance with ASCE 7 Section 6.14, Tsunami Vertical Evacuation Refuge Structures, for a greater depth of flow to achieve much greater tsunami resilience and very high reliability for safe occupancy, in accordance with an ASCE 7 target reliabilities of 99% confidence for structural performance during the Maximum Considered Tsunami. ASCE 7 Section 6.14 requires that tsunami refuge floors shall be located not less than the greater of 10 ft or one-story height above 1.3 times the Maximum Considered Tsunami inundation elevation at the site with respect to mean high water, as determined by the site-specific inundation analysis(Figure 7). In the case of the three-story-tall Building 4, the floor height for the refuge level would be at 22.5 ft. + 10 ft, or 32.5 above grade, including the effects of the tsunami inundation, associated seismic subsidence, and 4.1 ft of long-term sea level rise.

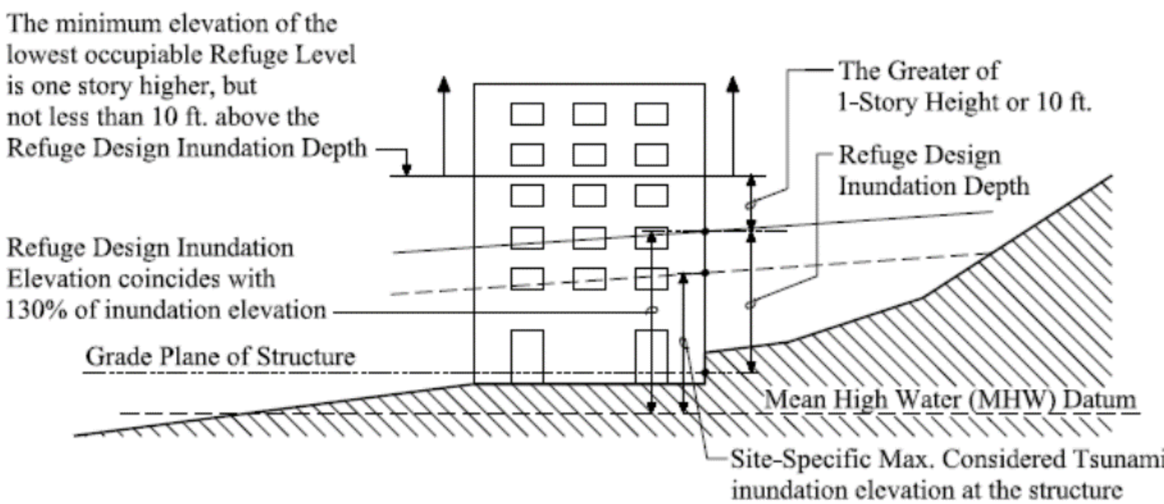

Figure 7. Minimum Refuge Elevation per ASCE 7-22 Figure 6.14-1

Summary:

1. We have conducted a high-resolution Site-Specific Probabilistic Tsunami Inundation Analysis to generate a time history of tsunami flow depth and velocities for the proposed development's site plan. This site-specific inundation analysis defines the tsunami inundation levels that could impact the proposed facility.
2. The analysis complies with the requirements of the national ASCE 7 Standard, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, Chapter 6, Tsunami Loads and Effects.
3. The probabilistic hazard level for the analysis using a Hazard Consistent Tsunami was verified against Offshore Tsunami Amplitudes specified in the ASCE Tsunami Design Geodatabase.
4. Overland flow has a northwestern component that impacts the northern Building 1 more directly, which if appropriately designed for tsunami would then provide mitigation to reduce the flow depths and velocities experienced by the other structures to its south on this site.
5. From the site-specific modeling, site-specific design conditions are processed for use in tsunami-resilient design to prevent failure of structural systems and principal structural components of individual buildings, per procedures given by Chapter 6 of the ASCE 7 Standard.

Very truly yours,
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