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6 can be used to effectively design structures for vertical evacuation as is evidenced by the existing Ocosta Elementary School in Westport Washington and OSU's Marine Science building to be completed soon in Newport, Oregon.

I recommend that Oregon adopt ASCE 7-16 Chapter 6 in its entirety, including the Tsunami Design Geodatabase and associate methods described in the chapter to establish the hazard for engineering design. Although I was not directly involved in the tsunami hazard analysis or creation of the ASCE maps, I have been participated in discussions during the committee process and voted in favor of this methodology. My rationale for recommending this probabilistic method is that the hazard level is defined based on a recurrence interval consistent with the seismic code used in other parts of the standard. Independently, I conducted my own probabilistic tsunami hazard analysis for two sites in Oregon – Newport and Seaside – and compared my work to that of ASCE for the 2500 year recurrent interval. Although there were some discrepancies due, in part, to the differences in the resolution of the digital elevation models, the comparisons reaffirmed to me that the ASCE work provided a useful definition of the tsunami hazard for engineering design.

I cannot recommend DOGAMI's tsunami modeling as a replacement for the ASCE 7 hazard definition for engineering design. The tsunami work of DOGAMI has high value as a community planning tool, for evacuation planning, and for public outreach and education, and I use it for some of my own research. However, the DOGAMI tsunami maps are essentially a set of scenarios described as small, medium, large and extra-large without a quantified recurrence interval. As a minimum standard of engineering design and to be consistent with other chapters in ASCE 7, a well-defined recurrence interval must be used. Currently, only the ASCE 7 provisions provides this standard for the 5 western states (AK, CA, HI, OR, WA). It is noteworthy that Chapter 6 allows engineers to conduct site specific hazard analysis for tsunamis in keeping with other chapters. This would allow a designer to account for the flow disturbances that might be caused, for example, by elevated roadways or levees that were not modeled originally.

The intensity and destructive potential of a tsunami will vary throughout the inundation zone. The ASCE 7 Chapter 6 methodology incorporates this varying tsunami intensity throughout the inundation zone, leading to safer and more cost effective design. For example, a building site located near the landward most point of inundation (or "just inside the tsunami zone") will be subjected to a lower tsunami intensity than a site located near the shoreline, and, therefore, will have a lower structural demand. This is in contrast to a regulatory approach in which buildings and other facilities are designated as either inside or outside the tsunami zone without any recognition of the varying intensity of the tsunami.

In summary, I recommend that Oregon adopt ASCE 7-16 Chapter 6 in its entirety, including the Tsunami Design Geodatabase, as a basis for the safe design of critical structures, including vertical evacuation structures, within the tsunami inundation zone. I am willing to provide the commission with more information and answer questions they might have.

Sincerely,

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Re: Adoption of ASCE 7-16 Chapter 6 Tsunami Loads and Effects in Oregon

Members of OSSPAC,

Thank you for the opportunity to speak today on ASCE 7-16 Chapter 6 Tsunami Loads and Effects. I encourage the Commission to recommend the adoption of Chapter 6 in Oregon in its entirety, including the ASCE Tsunami Design Geodatabase. In my testimony today, I will provide some of my background and expertise in tsunami engineering and a rationale for my recommendation

Background and Expertise in Tsunami Engineering: Currently, I am the CH2M-Hill Professor of Civil Engineering at Oregon State University. I have over 30 years of research experience in coastal engineering, and I have been teaching engineering students for 25 years. Since 2002, I have been at OSU and my research focus has emphasized tsunami engineering. From 2002 to 2010, I served as the director of the O.H. Hinsdale Wave Research Laboratory, the Nation's leading tsunami engineering research facility. Some of the research conducted at this facility has been used to inform the new ASCE tsunami standard. From 2010 to 2011, I took a sabbatical leave to work at the Disaster Prevention Research Institute at Kyoto University in Japan. Coincidentally during my time there, the Tohoku Earthquake and Tsunami occurred. This provided me with a first-hand understanding of the devastating power of tsunamis. I conducted two disaster reconnaissance deployments with teams of researchers to investigate the tsunami impacts, particularly to understand damage of civil infrastructure including buildings, bridges and other lifeline infrastructure. I have returned to Japan several times to observe the recovery process. Since 2014, I have served as an associate director of the Center for Risk-Based Community Resilience, headquartered at Colorado State University and supported through the National Institute for Standards and Technology. This center has supported me and other researchers to investigate earthquake and tsunami hazards originating from the Cascadia Subduction Zone and the community-wide damage and loss, using Seaside, Oregon, as a testbed. In our approach, we use state-of-the-art Probabilistic Tsunami Hazard Analysis (or PTHA), similar to what is currently used in ASCE 7 Chapter 6. I have been a member of the American Society of Civil Engineers (ASCE) for my entire career. In 2011, I was asked to join the ASCE 7-16 Chapter 6 subcommittee, and I was directly involved in the writing of this new chapter. I am currently a member of the ASCE 7-22 Chapter 6 subcommittee working to improve the chapter for the next code cycle. In 2013, I was also asked to serve on Chapter 5 subcommittee for Flood Loads arising from riverine flooding and hurricane surge. I am currently the chair that committee for the 7-22 code cycle, and I serve as a voting member of the Main committee. Through this involvement, I understand not only the details of Chapter 6 on Tsunami Loads but also how this chapter is consistent with the rest of the chapters in the engineering standard. As a researcher, I have co-authored over 200 peer-reviewed papers and conference proceedings with my collaborators. Tsunami research topics include: probabilistic hazard assessment, structural damages to building and lifelines, economic loss, community recovery, tsunami debris modeling, and evacuation planning. This work has provided me with the understand of tsunami hazard, their impacts on our community, and how we can mitigate these impacts through better planning, engineering design for new construction, retrofit strategies, evacuation drills and consideration for vertical evacuation alternatives, and debris management.

Rationale for Adoption of ASCE 7-16 Chapter 6: I encourage the adoption of ASCE 7-16 Chapter 6 in Oregon because it gives communities the means to have higher risk category structures to be built within a tsunami inundation zone safety and in a manner consistent with the other hazards considered in ASCE 7. When I first came to Oregon in 2002, the use of vertical evacuation structures to provide a safe refuge from tsunami were not being considered in Oregon as a viable alternative to horizontal evacuation. Over the past decade, particularly after the 2011 Tohoku event which saw thousands of lives saved through vertical evacuation, the views on vertical evacuation have changed here in Oregon and neighboring states of Washington and California. ASCE 7-16 Chapter