Exhibit H

Geologic and Soil Stability

Nolin Hills Wind Power Project

January 2022

Prepared for

d/b/a Nolin Hills Wind, LLC

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Acronyms and Abbreviations

Applicant	Nolin Hills Wind, LLC
ASC	Application for Site Certificate
BMP	Best Management Practice
BPA	Bonneville Power Administration
DOGAMI	Oregon Department of Geology and Mineral Industries
ESCP	Erosion and Sediment Control Plan
FEMA	Federal Emergency Management Agency
g	acceleration from gravity
IBC	International Building Code
IEEE	Institute of Electrical and Electronics Engineers
kV	kilovolt
LiDAR	light detection and ranging
MMI	Modified Mercalli Intensity
NRCS	Natural Resources Conservation Service
O&M	operations and maintenance
OAR	Oregon Administrative Rules
ODOE	Oregon Department of Energy
OSSC	Oregon Structural Specialty Code
PGA	peak ground acceleration
Project	Nolin Hills Wind Power Project
SLIDO	Statewide Landslide Inventory Database
UEC	Umatilla Electric Cooperative
USGS	U.S. Geological Survey

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1.0 Introduction

Nolin Hills Wind, LLC (the Applicant) proposes to construct the Nolin Hills Wind Power Project (Project), a wind energy project with a nominal generating capacity of up to approximately 600 megawatts, and up to 373 megawatts of average energy, in Umatilla County, Oregon. The Project comprises up to 112 wind turbine generators and up to 1,700 acres of solar panels, depending on the turbine model selected as well as final mix of energy generating technologies based on engineering optimization and offtake market trends. The Project will interconnect to the regional grid via either a transmission line leading from the northern Project substation northwest to Cottonwood Substation in Hermiston, or a new 230-kilovolt (kV) transmission line to the proposed Bonneville Power Administration (BPA) Stanfield Substation, north of the town of Nolin. Other Project components include electrical collection lines, substations, a battery energy storage system, site access roads, one operations and maintenance (O&M) building, meteorological data collection towers, and temporary construction yards. These facilities are all described in greater detail in Exhibit B.

Exhibit H provides an analysis of geologic hazards and soil stability for the Project as required to meet the structural standard in Oregon Administrative Rule (OAR) 345-022-0020 and the submittal requirements in OAR 345-021-0010(1)(h) paragraphs (A) through (I).

2.0 Analysis Area

The Analysis Area for geologic and soil stability is the area within the proposed Site Boundary. The Analysis Area for historical seismic and potentially active faults included a 50-mile buffer around the proposed Site Boundary. The Site Boundary is defined in detail in Exhibits B and C and is shown on Figure H-1.

3.0 Geologic Report – OAR 345-021-0010(1)(A)

> *OAR 345-021-0010(1)(h) Information from reasonably available sources regarding the geological and soil stability within the analysis area, providing evidence to support findings by the Council as required by OAR 345-022-0020, including:*
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> > *OAR 345-021-0010(1)(h)(A) A geologic report meeting the Oregon State Board of Geologist Examiners geologic report guidelines. Current guidelines must be determined based on consultation with the Oregon Department of Geology and Mineral Industries, as described in paragraph (B) of this subsection;*

OAR 345-021-0010(1)(h)(A) requires submission of a geological report meeting the Oregon State Board of Geologist Examiners geologic report guidelines. The Applicant consulted with the Oregon Department of Geology and Mineral Industries (DOGAMI) on August 24, 2018 at the DOGAMI office with the Oregon Department of Energy (ODOE) in attendance, to verify current guidelines to be the 2014 Oregon State Board of Engineering Geology Reports (Oregon State Board of Geologist Examiners 2014) as discussed in Section 5.0.

To prepare this exhibit, existing published information was reviewed and used to characterize the current geologic conditions and potential seismic hazards in the vicinity of the Project site. These materials included local, state, and federal government aerial photography, site photographs, published geologic maps, and geotechnical data reports. The findings are described in the following sections. Subsurface explorations, testing, and engineering analysis will be conducted prior to design and construction as described in Section 5.0. When site-specific geotechnical exploration is complete, a report meeting the 2014 Oregon State Board of Engineering Geology Reports guidelines will be submitted to DOGAMI and ODOE.

3.1 Topographic Setting

The Project is located in north-central Oregon, an area of rolling hills covered in grasslands and desert vegetation. The major topographic features in the area are controlled by the structure of the Columbia River Basalt (USGS 1964). Elevations at the Project range from approximately 502 feet to 2,711 feet (USGS 2018a).

The basin as a whole is a westward-plunging syclinorium bounded on the southeast by the northeastward-trending anticlinal crest of the Blue Mountains, and on the northeast by the northwestward-trending crest of the Horse Heaven anticlinal ridge (USGS 1964).

3.2 Geological Setting

The Project is located within the Blue Mountain geologic province of Oregon. The Umatilla River Basin is part of the Columbia Plateau, a broad area underlain by volcanic flood basalts (the Columbia River Basalts Group), overlain by sediments ranging from windblown clay and silt to water-lain sand and gravel (USGS 1964). The oldest rocks of the Umatilla River Basin are pre-Tertiary in age, and consist of amphibolite schist and gneiss, which are intruded by a composite igneous body of norite and quartz diorite. This pre-Tertiary material is overlain unconformably by a fairly thick deposit of lavas and continental sediments of the Eocene age (Clarno formation). The lavas are of acidic to intermediate composition, and the sediments are sandstone, silt, and shale, some of which are highly carbonaceous. The pre-Tertiary rocks and the Clarno formation crop out only in the Blue Mountain uplands and the higher parts of the Blue Mountain slope (USGS 1964). The Eocene rocks, in turn, are overlain by the Columbia River basalt of the Miocene age. On the basis of extent, thickness, and structural control of the topography, this series of accordantly layered basaltic lava flows is the most important rock unit in the basin (USGS 1964).

In places, the basalt is overlain by one or more of five types of terrestrial sediments. The oldest of these is fanglomerate, containing lenses of sand and silt. The gravel of this fanglomerate is composed of basalt pebbles, cobbles, and boulders. The fanglomerate was deposited during the Pliocene, after deformation of the basalt had started. Below an altitude of 1,150 feet, the basalt (and in places the fanglomerate of the Pliocene age) is overlain by Pleistocene glacial-lake beds and, below 750 feet, by glaciofluvial deposits (USGS 1964).

All the pre-Pleistocene rock units of the area are mantled in places by a veneer of loess that was derived in part from the glacial-lake deposits. Thin ribbons of recent alluvium border the larger streams. These alluvial deposits are composed mostly of basaltic gravels in the Blue Mountains, and of reworked loess in the lowland districts. In some places, small deposits of white volcanic ash occur in the alluvium (USGS 1964).

Figure H-1 is a geologic map of the Project's vicinity, adapted using USGS Geographic Information System data and DOGAMI resources (Ma et al. 2009). The lithology throughout the portion of the proposed Site Boundary where the substations, wind turbines, solar array, and transportation routes will be located is dominantly basalt, with the southern part of this area located on middle Miocene Grande Ronde Basalt of the Middle and Lower Miocene age, and the northern part transitioning to Wanapum Basalt of the Middle Miocene age. The northwestern portion of the proposed Site Boundary is located on glaciofluvial, lacustrian, and pediment sedimentary deposits of the Pleistocene age, and on Quaternary alluvial deposits. A site reconnaissance was conducted on July 19, 2018 to verify to the information obtained during the literature review. The results of the site reconnaissance indicate that the geology of the Project Site Boundary is represented on the geologic map (Figure H-1), and that no geologic hazards, such as landslides, were evident.

Groundwater in the area ranges from 9 feet to 61 feet below ground surface in the northern part of the Project Site Boundary along the Umatilla River and 230 feet to 612 feet below ground surface in the southeasternmost part of the Project Site Boundary; no data were available for the majority of the Project Site Boundary (OWRD 2019).

Shallow groundwater is generally found along rivers such as the Umatilla River in flood zones. The proposed 230-kV line to the Stanfield Substation will span the floodway and 500-year flood zones (see Section 8.4 below). In addition, Exhibit J states that waters of the State will not be impacted.

The site-specific geotechnical investigation will identify if and where shallow groundwater is encountered, which will inform the final design. At that stage, mitigation options to address potential shallow groundwater (although not anticipated) will be determined by the design engineer and incorporated into final design. An example of a mitigation option is that the foundations would be designed for buoyant conditions, which means that the foundations will be made larger where required in order to offset the buoyant forces.

Exhibit I describes properties of the site surficial soils based on Natural Resources Conservation Service (NRCS) data within the Project Site Boundary, as well as the approximate thickness, formation setting, permeability, runoff potential, and potential hazard for erosion.

4.0 Evidence of Consultation with DOGAMI – OAR 345-021-0010(1)(h)(B)

OAR 345-021-0010(1)(h)(B) A summary of consultation with the Oregon Department of Geology and Mineral Industries regarding the appropriate methodology and scope of the seismic hazards and geology and soil-related hazards assessments, and the appropriate site-specific geotechnical work that must be performed before submitting the application for the Department to determine that the application is complete.

The Applicant communicated with Yumei Wang at DOGAMI (Y. Wang, pers. com. July 17, 2018) to discuss the general details of the Project. In addition, the Applicant consulted with DOGAMI on August 24, 2018 at the DOGAMI office with ODOE in attendance, to verify that the current guidelines are the 2014 Oregon State Board of Engineering Geology Reports. The results of the DOGAMI consultation discussions are included as Attachment H-1.

Discussion results are summarized as follows:

- DOGAMI was provided general, proposed Project information, including the location, acreage, and major Project components, structures, and systems.
- DOGAMI requested additional information, such as site-specific geotechnical work on geological hazards (e.g., site-specific seismic hazards analyses, site-specific landslide hazard evaluation, and other hazards) relating to public safety issues. In addition, DOGAMI asked the Applicant to provide planning and design information on disaster resilience and future climate conditions that may impact public safety, including a prompt recovery after any disasters. They also indicated that as part of this work, all relevant codes, standards, guidelines (e.g., the Oregon Structural Specialty Code [OSSC], ASCE 7, National Electric Safety Code, National Fire Protection Association, National Electrical Code) should be considered, and that all methods should be current state-of-practice or otherwise acceptable, clearly documented, and explained.
- DOGAMI also notified that they consider Quaternary faults as active and should be included in the site-specific seismic hazard analyses. DOGAMI also considers the use of light detection and ranging (LiDAR) as standard practice when evaluating landslide hazards, although given that this area in eastern Oregon does not have the vegetation as found in western Oregon, high-resolution imagery for landslide hazards could be used.

5.0 Site-Specific Geotechnical Investigation – OAR 345-021-0010(1)(h)(C)

OAR 345-021-0010(1)(h)(C) A description and schedule of site-specific geotechnical work that will be performed before construction for inclusion in the site certificate as conditions;

A detailed literature review of the local and regional geology in the vicinity of the Site Boundary was completed for this Preliminary Application for Site Certificate (ASC). This included searching for existing reports at adjacent sites, as well as reviewing other published literature and geologic mapping. The literature review included a detailed evaluation of seismic hazards at the Project (Section 7). A site reconnaissance review was conducted to verify to the extent possible the literature review performed in July 2018.

At an appropriate stage in the development, a site-specific geotechnical investigation will be conducted by a qualified engineer using current code requirements and state-of-practice methods to inform final design and will be reported to DOGAMI and ODOE following the 2014 Oregon State Board of Engineering Geology Reports guidelines. The site-specific geotechnical investigation will be conducted using current code requirements and state-of-practice methods at the time it is conducted. It will also rely on current geologic information at the time the investigation occurs.

Work to be conducted during site-specific geotechnical investigation, meeting the recommendations of DOGAMI, will include:

- Test pits, soil borings, and rock cores advanced at turbine foundation locations, solar array tracking foundations, foundations of meteorological towers, the O&M Building, and along access road alignments in order to determine soil strength and rock mass properties, and to evaluate foundation conditions. Seismic refraction surveys may also be used to evaluate the depth to suitable foundation materials. The final layout of the structures and associated roads will dictate the locations of the site-specific geotechnical investigations. A probabilistic and deterministic seismic hazard analysis with peak ground and spectral acceleration will be conducted by a qualified engineer of record.
- Drilling and sampling will be done in accordance with ASTM (formerly American Society for Testing and Materials) Method D1586 for advance to refusal or specified minimum depth, with identification and description of changes in strata, joints, discontinuity, and the extent of any weathering in accordance with ASTM D5878. A boring log for each boring location will be completed. Testing of materials will include electrical resistivity testing (Institute of Electrical and Electronics Engineers [IEEE] Standard 81), thermal resistivity testing (IEEE Standard 442), shear wave velocity testing, and California bearing ratio testing. Lab testing to be conducted will include: moisture content, density determination, Atterberg limit and sieve analysis, direct shear unconfined compression, unconfined compression soil, organic context, triaxial compression test and consolidation test, modified proctor compaction testing, chemical testing, and bond strength, at a minimum.
- Landslide hazard mapping will be conducted using the best available resources, including stereo pairs of aerial photographs, available LiDAR coverage or high-resolution aerial imagery, and field mapping. Drilling will be used to evaluate unstable areas and the characteristics of landslide-prone areas in order to avoid placing structures or facilities on existing landslides or potentially unstable areas.

- Based on the results of the site-specific geotechnical investigation, the structures will be sited to avoid or minimize geologic hazards and areas of poor foundation conditions, and foundations will be designed to appropriate factors of safety. They will be sited to minimize or avoid geologic impacts on the environment (for example, causing accelerated erosion or reconfiguring the landscape), and to minimize or avoid any geologic impacts of the environment on the structures.
- Data and design reports will summarize the geologic hazards and geotechnical conditions, describe soil and rock properties and foundation conditions, present laboratory testing results of soils and rock, and provide detailed foundation recommendations for structural designers.

Geotechnical analyses will be used to calculate the bearing capacity of the soils, conduct stability analyses, and provide engineering recommendations for construction of the structures. A qualified engineer will provide oversight and inspection during construction, including foundation inspections by a qualified engineering geologist or geotechnical engineer, to ensure that the Project is built according to plans and specifications, and the stability of the transmission line structures is not compromised.

6.0 Transmission Lines and Pipelines – OAR 345-021-0010(1)(h)(D)

OAR 345-021-0010(1)(h)(D) For all transmission lines, and for all pipelines that would carry explosive, flammable or hazardous materials, a description of locations along the proposed route where the applicant proposes to perform site specific geotechnical work, including but not limited to railroad crossings, major road crossings, river crossings, dead ends (for transmission lines), corners (for transmission lines), and portions of the proposed route where geologic reconnaissance and other site specific studies provide evidence of existing landslides, marginally stable slopes or potentially liquefiable soils that could be made unstable by the planned construction or experience impacts during the facility's operation;

As identified in Exhibit B, a single circuit 230-kV transmission line primarily supported by H-frame or monopole structures will run approximately 6.8 miles between the two Project substations. In addition, the current primary transmission line option being considered, the Umatilla Electric Cooperative (UEC) Cottonwood route, will be approximately 25.3 miles in length including 8.4 miles of new overhead 230-kV transmission line, 9.6 miles of 230-kV with existing 12.47-kV underbuild, and 7.3 miles of upgrade of an existing 115-kV UEC transmission line to carry 230 kV north to the UEC Cottonwood Substation. The overhead transmission line will be supported by H-frame or monopole structures.

Along the transmission line route, the Applicant will perform the site-specific geotechnical work where geologic reconnaissance and other site specific studies provide evidence of existing landslides, marginally stable slopes, or potentially liquefiable soils that could be made unstable by the planned construction of the Project. The site-specific geotechnical work will inform the final design.

The Applicant plans to conduct geotechnical borings at transmission line dead-end and turning structures, plus borings approximately every 1 mile of straight section of transmission line. Geotechnical borings will also occur at locations where the transmission line to the BPA Substation will cross the Umatilla River and the Union Pacific Railroad and where the UEC transmission line will cross Interstate Highway 84, Butter Creek, and the Union Pacific Railroad (see Figure C-4 in Exhibit C). The actual number of borings will be based on final design of the transmission line route.

On the basis of review of aerial photography, existing geologic mapping, and site reconnaissance, structure foundations can be located in the Project micrositing corridors without adversely affecting slope stability or long-term erosion. The site-specific investigation will consist of soil and rock borings at locations where structures will be placed, and any other locations that appear to have weak soils, soils prone to liquefaction, or poor foundation conditions.

The Project does not have a pipeline. Therefore, this provision is not applicable.

7.0 Seismic Hazard Assessment – OAR 345-021-0010(1)(h)(E)

> *OAR 345-021-0010(1)(h)(F) An assessment of seismic hazards, in accordance with standard-of-practice methods and best practices, that addresses all issues relating to the consultation with the Oregon Department of Geology and Mineral Industries as described in paragraph (B) of this subsection, and an explanation of how the applicant will design, engineer, construct, and operate the facility to avoid dangers to human safety and the environment from these seismic hazards. Furthermore, an explanation of how the applicant will design, engineer, construct and operate the facility to integrate disaster resilience design to ensure recovery of operations after major disasters. The applicant must include proposed design and engineering features, applicable construction codes, and any monitoring and emergency measures for seismic hazards, including tsunami safety measures if the site is located in the DOGAMI-defined tsunami evacuation zone;*

7.1 Methods

Available reference materials were reviewed and a desktop seismic hazard assessment was performed for the ASC. Topographic and geologic conditions and hazards within the Project Site Boundary were evaluated by reviewing topographic and geologic maps, aerial photographs, existing geologic reports, and data provided by DOGAMI, the Oregon Water Resources Department, the U.S. Geological Survey (USGS), and NRCS.

A desktop seismic hazard analysis was performed to characterize seismicity in the vicinity of the Project, and to evaluate potential seismic impacts. This work was based on the potential for regional and local seismic activity as described in the existing scientific literature, and on subsurface soil and groundwater conditions within the Project Site Boundary–based desktop evaluations. The seismic hazard analysis consisted of the following tasks:

1. Detailed review of USGS, National Geophysical Data Center, and DOGAMI literature and databases.
2. Identification of potential seismic events for their site characterization in terms of a series of design events.
3. Evaluation of seismic hazards, including the potential for fault rupture, earthquake-induced landslides, liquefaction and lateral spread, settlement, and subsidence.
4. Mitigation recommendations based on the characteristics of the subsurface soils and design earthquakes, including specific seismic events that might have a significant effect on the site, potential for seismic energy amplification at the site, and the site-specific acceleration response spectrum for the site.

As described in Section 5.0, a future site-specific geotechnical investigation will be conducted by a qualified engineer using current code requirements and state-of-practice methods to inform final design and will be reported to DOGAMI and ODOE following the 2014 Oregon State Board of Engineering Geology Reports guidelines.

7.2 Maximum Considered Earthquake Ground Motion under IBC 2015

The USGS Seismic Hazard Mapping project (USGS 2019a) developed ground motions using a probabilistic seismic hazard analysis that covered the area within the Site Boundary. Though these motions are not considered site-specific, they provide a reasonable estimate of the ground motions within the Site Boundary. For new construction, the site should be designed for the maximum considered earthquake, according to the most recently updated International Building Code (IBC; IBC 2018) supplemented by the OSSC (State of Oregon 2019). The USGS unified hazard tool analysis was run for the Site Boundary and the design event has a 2 percent probability of exceedance in 50 years (or a 2,475-year return period). This event has a peak ground acceleration (PGA) of 0.0898 acceleration from gravity (g) at the bedrock surface. The values of PGA on rock are an average representation of the acceleration most likely to occur at the Project for all seismic events (crustal, intraplate, or subduction; USGS 2018a).

For this desktop analysis, seismic design parameters were developed in accordance with the IBC (IBC 2015). Using the subsurface information currently available, the Project will be designed for a Site Class D (stiff soil profile), according to current 2014 Oregon Structural Specialty Code, which relies on ASCE 7-10. The current recommended seismic design parameters are summarized in Table H-1.

Table H-1. Seismic Design Parameters—Maximum Considered Earthquake

Location	Site Class	Earthquake Magnitude	Peak Horizontal Ground Acceleration on Bedrock	Soil Amplification Factor, F_a	Peak Horizontal Ground Acceleration at Ground Surface
Project Site Boundary	S_D	9.0	0.587g	1.2	0.70g
g = acceleration from gravity.					

The design spectral response acceleration parameters, S_{DS} and S_{D1}, for both short period and 1-second period, are determined by multiplying the Maximum Considered Earthquake spectral response accelerations (S_{MS} and S_{M1}) by a factor of 2/3. However, as stated in Section 5.0, the site-specific geotechnical investigation, which will be conducted prior to construction as a condition to the Site Certificate, will indicate which seismic design parameters to use in the final Project layout and design.

7.2.1 Earthquake Sources

Seismicity in northern Oregon is generated from the convergence of the Juan de Fuca Plate and the North American Plate at the Cascadia Subduction Zone. These plates converge at a rate between 1 and 2 inches per year and accumulate large amounts of stress that are released abruptly in earthquake events. The four sources of earthquakes and seismic activity in this region are crustal, intraplate, volcanic, and the deep subduction zone (DOGAMI 2010).

Regionally, seismicity has been attributed to crustal deformation resulting from the Cascadia Subduction Zone and volcanism. Faults are considered active if there has been displacement in the last 10,000 years, and potentially active if there has been movement over the last Quaternary period (1.6 million years). Overall, earthquakes in Oregon are associated with active faults in four regional zones of seismicity: Cascade seismic zone, Portland Hills (the Portland, Oregon–Vancouver, Washington metropolitan area) zone, south-central (Klamath Falls) zone, and northeastern Oregon zone (Niewendorp and Neuhaus 2003).

Earthquakes caused by movements along crustal faults, generally in the upper 10 to 15 miles of the earth's crust, result in the third seismic source mechanism. In the vicinity of the Project site, earthquakes occur within the crust of the North American tectonic plate when built-up stresses near the surface are released through fault rupture.

There are no known or active faults mapped within the Project Site Boundary (USGS 2019b; Figure H-2). A number of undifferentiated Quaternary-age faults are mapped within 50 miles of the Site Boundary, as shown on Figure H-2. The DOGAMI Oregon HazVu: Statewide Geohazards Viewer earthquake hazard layer (DOGAMI 2019) and the USGS Geologic Hazards Science Center (USGS 2019b; Figure H-2) show active faults near the Project area. The faults depicted on Figure H-2, which are mapped within 50 miles of the Project Site Boundary, present the largest potential for seismic contribution to the Project. An investigation of potentially active faults within the Site Boundary will be conducted as part of the site-specific geotechnical investigation for the Project as described in Section 5.0. The investigation will include a description of the potentially active faults, their potential risk to the Project, and any additional mitigation that will be undertaken by the Applicant to ensure safe design, construction, and operation of the Project.

The 2013 Oregon Resilience Plan by the Oregon Seismic Safety Policy Advisory Commission (OSSPAC 2013) identified simulated shaking for a magnitude 9.0 Cascadia scenario. This plan identifies the Project site area as falling into the "very light" category, meaning that a magnitude 9.0 Cascadia scenario earthquake would produce a very light shaking event that would be felt outdoors and during which sleepers might be wakened, liquids disturbed or spilled, small unstable objects upset, doors might swing, and pictures might move (OSSPAC 2013).

Probabilistic seismic hazard deaggregation at 475-year intervals are shown in Attachment H-2, and at 2,475-year intervals in Attachment H-3.

7.2.2 Recorded Earthquakes

Attachment H-4 and Figure H-2 provide a summary of all recorded earthquakes known to have caused Modified Mercalli Intensity (MMI) III shaking intensity or greater within 50 miles of the Project, regardless of epicentral origin. These data from the National Earthquake Information Center show that no earthquakes have occurred within the Site Boundary. The historical seismic events are grouped by magnitude and are displayed with differently-sized symbols based on the strength of event. For reference, an intensity of MMI III is associated with shaking that is "noticeable indoors but may not be recognized as an earthquake." An intensity of MMI V is "felt by nearly everyone; many awakened" (USGS 2019c).

The Ground Response Spectra Assessments in Attachments H-5 and H-6 compare the design response spectrum given in the 2012/2015 IBC with the 2014 OSSC (USGS 2019a). Response spectra are provided for the maximum considered earthquake at the Project location. For the maximum considered earthquake, separate response spectra modified by the amplification factors for Site Class D (S_D) and Site Class C (S_C) are provided. On the basis of the current subsurface information available, it is recommended that the Project be designed for Site Class D. However, examination of the geology mapped for the site suggests that shallow bedrock formations may exist at certain locations, where the S_C response spectra would apply.

As stated in Section 5.0, the site-specific geotechnical investigation, which will be conducted as a condition to the Site Certificate, will indicate which seismic design parameters to use in the final Project layout and design.

7.2.3 Hazards Resulting from Seismic Events

Potential seismic hazards associated with a design seismic event for this Project include seismic shaking or ground motion, fault displacement, instability from landslides or subsurface movement, and adverse effects from groundwater or surface water. These hazard risks are anticipated to be low, as discussed below. The Project is located well away from the Oregon coastline and is not within a DOGAMI-defined tsunami evacuation zone (DOGAMI 2018a), so tsunami inundation is not considered a hazard.

7.2.4 Seismic Shaking or Ground Motion

The design seismic event will have a 2,475-year recurrence interval. The Project's structures will be designed to withstand the maximum risk-based design earthquake ground motions developed for the Project site. The State of Oregon has adopted the IBC 2018 code for structural design. Specifically, this is Section 1613 (Earthquake Loads) of the 2019 OSSC, which is in Chapter 16. It should be noted that building codes are frequently updated; the IBC specifically is updated every 3 years. The Applicant will design, engineer, and construct the Project in accordance with the current version of the latest IBC, OSSC, and building codes adopted by the State of Oregon at the time of construction. Therefore, it is incumbent on the design engineers to ensure that the designs are in accordance with the current versions of the latest codes as adopted by the State of Oregon at the time of construction.

Based on geotechnical and geological information, a Site Class for the soil/bedrock at the site is assigned. In this case, as described previously in Section 7.2.2, Site Class D (stiff soil) is appropriate for the Project.

Based on site-specific analyses, the original equipment manufacturer will provide the structural engineer with site-specific foundation loads and requirements. The structural engineer then completes the foundation analyses based on the design site-specific parameters. Generally, these include the following loads for turbine foundation design: extreme loads, load cases for up-lift, shear failure, tension loads (for pile foundations), earthquake loads, fatigue loads, subsoil properties, spring constants, verification procedures, and maximum allowable inclination.

The geotechnical studies and analyses provide site-specific parameters including but not necessarily limited to: moisture content and density, soil/bedrock bearing capacity, bedrock depth, settlement characteristics, structural backfill characteristics, soil improvement (if required), and dynamic soil/bedrock properties including shear modulus and Poisson's Ratio of the subgrade. The foundation design engineer uses these parameters to design a foundation suitable for the Project and verifies that the foundation/soil interaction meets or exceeds the minimum requirements stated by the original equipment manufacturer for the Project.

7.2.5 Fault Rupture

The probability of a fault displacement at the Project is considered to be low because of the distance of known or mapped potentially active faults from the Site Boundary and the absence of faults within the Site Boundary (Figure H-2). Unknown faults could exist, or new fault ruptures could form during a significant seismic event such as the Cascadia event discussed above in Section 7.2.1. As a part of the desktop evaluation and a review of historical fault lines and landslides, there are no apparent landslides or faults in the Site Boundary. If faults are identified during the site-specific geotechnical investigation, they will be used to inform final design and layout of the Project.

7.2.6 Liquefaction

Liquefaction is a phenomenon in which saturated, cohesionless soils temporarily lose their strength and liquefy when subjected to dynamic forces such as intense and prolonged ground shaking and seismic activity. The soils at the Project are not saturated, due to the deep groundwater depth, and appear to be generally cohesive in nature. Combined with the relatively low seismic event potential, this indicates that liquefaction of soils within the Site Boundary is considered very unlikely, so the risk to human safety and the environment will be minimal.

7.2.7 Seismically Induced Landslides

Seismicity in the region has the potential to trigger landslides and mass wasting processes within the Site Boundary; although the potential is considered low to moderate for expected shaking based on a Cascadia 9.0 magnitude event (DOGAMI 2020). As seen on Figure H-1, there are no known historic landslides in the Site Boundary. As discussed above, a review of historical fault lines and landslides, and a review during the geologic reconnaissance of the site, there are no apparent landslides or faults in the Project area. The site-specific geotechnical investigation will include review for evidence of active faults and landslides, which will help inform final design and layout of the Project facilities. More detailed discussion on the location and type of landslides is included in Section 8.1.

7.2.8 Subsidence

Subsidence is the sudden sinking or the gradual downward settling of the land surface, and is often related to groundwater drawdown, compaction, tectonic movements, mining, or explosive activity. Subsidence due to a seismic event is highly unlikely. In most areas, the bedrock is relatively shallow, and as noted above, the overlying soils are not saturated.

7.2.9 Seismic Hazard Mitigation

The State of Oregon uses the 2018 IBC, with current amendments by the OSSC (State of Oregon 2019). Pertinent design codes as they relate to geology, seismicity, and near-surface soil are contained in IBC Chapter 16, Section 1613, with slight modifications by the current amendments of the State of Oregon. The Project facilities will be designed to meet or exceed the minimum standards required by these design codes. Wind turbines are designed for large wind loads, which for a region of moderate seismicity potential like the site vicinity, results in ample capacity to resist seismic loads. Substation equipment will be specified in accordance with the latest version of IEEE 693.

As discussed in Section 5.0, site-specific geotechnical exploration will be conducted to collect pertinent data for the design of the Project facilities to mitigate potential hazards that could be created during a seismic event. The hazard of a surficial rupture along a fault trace is anticipated to be low, given the seismic history of the site displayed in geologic mapping, and the low probability that a fault rupture would actually displace the ground surface at the location of one of the wind turbine structures. No mitigation for potential fault rupture is anticipated; the risk to human safety and the environment will be minimal because the Project will be located in a sparsely populated area. No structures will be built on steep slopes that could be prone to instability, thus avoiding potential impacts. Design guidelines related to disaster resilience are further described in Section 9.0.

8.0 Non-Seismic Geological Hazards – OAR 345-021-0010(1)(h)(F)

OAR 345-021-0010(1)(h)(F) An assessment of geology and soil-related hazards which could, in the absence of a seismic event, adversely affect or be aggravated by the construction or operation of the facility, in accordance with standard-of-practice methods and best practices, that addresses all issues relating to the consultation with the Oregon Department of Geology and Mineral Industries as described in (B) of this subsection. An explanation of how the applicant will design, engineer, construct and operate the facility to adequately avoid dangers to human safety and the environment presented by these hazards, as well as:

(i) An explanation of how the applicant will design, engineer, construct and operate the facility to integrate disaster resilience design to ensure recovery of operations after major disasters; and

(ii) An assessment of future climate conditions for the expected life span of the proposed facility and the potential impacts of those conditions on the proposed facility;

Nonseismic geologic hazards in the Columbia Plateau region typically include landslides, volcanic eruptions, collapsing soils, and erosion potential. The area within the Project Site Boundary consists of relatively flat-lying basalt with a cover of loess. The Project will be constructed on the flat-lying part within the Project Site Boundary and will avoid steep side slopes and drainages that could potentially be subject to landslides and soil creep. A discussion of potential nonseismic geologic hazards is presented below.

8.1 Landslides

In 2017, DOGAMI released an update of the Statewide Landslide Information Database for Oregon (SLIDO-3.3; DOGAMI 2018b). SLIDO is a compilation of known landslides that have been identified on published maps and entered into this statewide database. Features included in the database include landslides, debris flows, alluvial fans, and colluvium or talus. The primary sources of this historical landslide information are published geologic reports and geologic hazard studies by the USGS and DOGAMI. The SLIDO-3.3 landslide database was used to overlay landslide areas or landslide-related features on Figure H-1. As seen on Figure H-1, there are no landslides identified in the Project Area. In addition, no existing landslides were observed during the site reconnaissance.

If slope stability issues are identified during the final design geotechnical investigations, the structures will either be relocated during the micrositing process, or else remedial measures to improve slope stability will be implemented.

8.2 Volcanic Activity

Volcanic activity in the Cascade Range is driven by the subduction of the Juan de Fuca Plate beneath the North American Plate. Approximately 120 miles to the north, Mt. Adams is the closest volcano to the Project (USGS 2018b). Most of the volcanic hazard impacts will occur within a 50-mile radius of the erupting volcano. Depending on the prevailing wind direction at the time of the eruption and the source of the eruption, ash fallout in the region surrounding the Project may occur. Because of the distance to the nearest volcanoes, impacts to the Project from volcanic activity will be indirect, and will likely be limited to ash fallout. In addition, the Project is not located near any streams that will likely be subject to pyroclastic flows from a volcanic eruption from these volcanoes. It is unlikely that there would be any adverse effects to volcanic activity by the construction or operation of the Project. A volcanic eruption, even though unlikely, could damage or affect Project structures including the wind turbines and solar array. If an event similar to the 1980 Mt. St. Helens eruption were to occur, the turbines will be shut down until safe operating conditions return. If an eruption should occur during construction, a temporary shutdown would most likely be required to protect equipment and human health.

8.3 Erosion

As discussed in Exhibit I, erosion can be caused by increasing exposure to wind or water. Wind erosion is influenced by the wind intensity, vegetative cover, soil texture, soil moisture, grain size of unprotected soil surface, topography, and the frequency of soil disturbance. Wind erosion will be addressed through erosion control measures that will be implemented to mitigate erosion potential as identified in Exhibit I. Water erosion is a function of primarily soil type, vegetative cover, precipitation, and slope inclination. If left unmitigated, erosion from rainfall would be a hazard during construction. The runoff potential and water erosion hazard for the identified soils at the site range from low to high with higher erosion potential associated with steeper slopes, especially on slopes exceeding 25 percent (see Exhibit I). U.S. Climate Data (2019) reports that the site vicinity receives approximately 13 inches of rainfall per year. The erosion potential and available precipitation make site soils sensitive to water erosion during winter and springs months when most of the precipitation occurs, particularly where slopes are steep.

To reduce the potential for soil erosion, a construction Erosion and Sediment Control Plan (ESCP) has been developed for the Project. The ESCP includes both structural and nonstructural Best Management Practices (BMP). Examples of structural BMPs include the installation of silt fences or other physical controls to divert flows from exposed soils, or otherwise limit runoff and pollutants from exposed areas within the Project Site Boundary. Examples of nonstructural BMPs include management practices such as implementation of materials handling, disposal requirements, and spill prevention methods.

The Applicant's application for a National Pollutant Discharge Elimination System stormwater construction permit is attached to Exhibit I and includes the ESCP. In addition, Exhibit I contains a comprehensive list of mitigation measures to avoid wind and water erosion and soil impacts.

8.4 Flooding

To evaluate flood hazards, the Federal Emergency Management Agency (FEMA) National Flood Hazard data (FEMA 2018) were compared to the temporary and permanent disturbance areas in the Site Boundary. As shown on Figure H-3, the transmission line to the planned BPA Stanfield Substation will cross an identified FEMA floodway and the 500-year flood zone. The proposed 230-kV line to the Stanfield Substation will span the floodway and 500-year flood zones, avoiding flood zone impacts.

Seasonal thunderstorms can result in concentrated stormwater runoff and localized flooding. The engineered access roads and drainages will direct stormwater runoff away from structures and into drainage ditches and culverts as required in the ESCP. The Project will be designed and engineered to comply with zoning ordinances and building codes that establish flood protection standards for all construction to avoid dangers to the infrastructure, as well as human safety and the environment, including criteria to ensure that the foundation will withstand flood forces. Therefore, the risks and potential impacts to the Project as well as human safety and the environment from flood hazards are expected to be low.

8.5 Shrinking and Swelling Soils

Shrinking and swelling properties are generally indicative of clayey soils, and based on soil data, these soils are not anticipated along the majority of the Project (see Exhibit I). As part of the final design, the shrink-swell potential of the soils will be evaluated during the site-specific geotechnical investigations and laboratory testing and analysis. If shrinking or swelling soils are present at the site, foundation locations, or along road alignments, soil improvement will be necessary. Soil improvement include reworking and compacting onsite soils, over-excavating soils with shrink-swell potential and replacing with compacted structural fill, constructing an impermeable barrier to prevent saturation, or mixing with other soils to reduce the potential for shrinking and swelling.

8.6 Collapsing Soils

Subsurface soil conditions, such as loess or collapsing soils, will be identified during the site-specific geotechnical investigation to inform final design of turbine foundations and solar array tracking foundations. Soil properties will be evaluated by laboratory testing and analysis. If collapsible soils are present at the site, collapse potential will be mitigated by construction techniques (over-excavating and replacing with structural fill, wetting, compacting) during subgrade preparation.

9.0 Disaster Resilience

The State of Oregon uses IBC 2018, with current amendments by the OSSC and local agencies. Pertinent design codes as they relate to geology, seismicity, and near-surface soils are contained in IBC Chapter 16, Section 1613, with slight modifications by the current amendments of the State of Oregon and local agencies. The Project will be designed to meet or exceed the minimum standards required by these design codes. The Applicant acknowledges that DOGAMI encourages, but does not require, applicants to design and build for disaster resilience and future climate conditions using science, data and community wisdom to protect against and adapt to risks. With this in mind, the Applicant has extensive experience building energy facilities and from a structural perspective, designs projects to withstand nonseismic geologic hazards.

A qualified engineer will assess and review the seismic, geologic, and soil hazards associated with the construction of Project facilities. Construction requirements will be modified, as needed, based on the site-specific characterization of seismic, geologic, and soil hazards. The Project will be designed, engineered, and constructed to meet all current standards to adequately avoid potential dangers to human safety presented by seismic hazards. Substation and O&M Building structures will be designed in accordance with the current version of the OSSC. Substation, transmission lines, and collector line equipment will be specified in accordance with the latest version of the Institute of Electrical and Electronics Engineers. The Project facilities will be located in sparsely populated areas; therefore, the risks to human safety and the environment due to seismic hazards will be minimal.

The Project facilities will be designed, engineered, and constructed to meet or exceed all current standards. The Applicant proposes to design, engineer, and construct the Project to avoid dangers to human safety related and nonseismic hazards in many ways, including conducting site-specific geotechnical evaluations for the facilities (see Section 5.0). Typical mitigation measures for nonseismic hazards include avoiding potential hazards, conducting subsurface investigations to characterize the soils to adequately plan and design appropriate mitigation measures, creating detailed geologic hazard maps to aid in laying out facilities, providing warnings in the event of hazards, and purchasing insurance to cover the Project in the event of hazards. In addition, as described in Exhibit B, structures meeting height limits will have lighting according to FAA standards, and each turbine and substation and the solar array will be monitored by a Supervisory Control and Data Acquisition system for the Project to come back online in the event of a disaster. Should Project elements like the access roads be damaged, they will be assessed, and repairs made quickly to ensure recovery of operations after a major storm event.

The Applicant is a member of the North American Electrical Reliability Corporation and follows its standards for critical infrastructure protection, emergency preparedness and operations, and facility design. Similarly, BPA confirmed that it has system recovery plans for the Stanfield Substation and its associated transmission lines, and UEC confirmed that it has system recovery plans for the Cottonwood Substation and its associated transmission lines.

10.0 Climate Change

The University of Washington conducted a study to assess climate vulnerability and adaptation in the Columbia River Plateau, the region where the Project is located (Michalak et al. 2014). The study involved downscaling five climate models (CCM3, CGM3.1, GISS-ER, MIROC3.2, and Hadley). Climate projections were downscaled to approximately a 1-kilometer resolution for over 40 different direct (mean annual temperature/precipitation) and derived (number of growing-degree days, actual and potential evapotranspiration) climate variables (Michalak et al. 2014). The downscaling of the climate models for this area led to future projections of greater annual average and summer temperatures, and more severe storm events and wildfires, among other changes. These specific changes are expected to increase stress to power lines in the region.

Reinforcing the local electric grid with wind power and new transmission lines also provides resilience to the overall energy grid in this part of Oregon. This reinforcement will be direct, by upgrading a system that is anticipated to experience higher loads under rising temperatures and related increases in power demand for summer cooling. It is also indirect, by supporting delivery of power generated through a variety of sources, minimizing the potential reduction in hydro power's role under future conditions. All aspects of this Project support resiliency in the face of future climate change. In addition, the Project will be designed to withstand extreme events as explained above in Section 8.0.

11.0 Conclusions

The risk of seismic hazards to human safety at the Project is considered low. The Applicant reviewed regional geologic information and performed a site-specific desktop characterization of potential seismic, geologic, and soils hazards. In addition to this desktop characterization, a site-specific geotechnical investigation will be conducted, which will allow the Applicant to design, engineer, and construct the Project to the most current standards at the time of construction. The Applicant anticipates that EFSC will make this site-specific geotechnical investigation a pre-construction requirement attached to the site certificate. This exhibit reflects input from DOGAMI and demonstrates that the Applicant can design, engineer, and construct the Project to avoid dangers to human safety. The following supporting evidence is provided, with the remaining evidence to be provided prior to construction:

- The risk of seismic hazards to human safety at the proposed Project is considered low. The Applicant has adequately characterized the seismic hazard risk of the site in accordance with OAR 345-022-0020(1)(a) and considered seismic events and amplification for the Project's site-specific subsurface profile. Project components include wind turbine generators, solar array, site access roads, transmission line structures, an O&M Building, meteorological data collection towers, battery energy storage system, and two substations with equipment. The O&M Building will be staffed; however, the probability of a large seismic event occurring while the Project O&M Building is occupied is much lower than for a normal building or facility. This very low probability results in minimal risk to human safety.

- The Applicant has demonstrated that the Project can be designed, engineered, and constructed to avoid dangers to human safety and the environment in case of a design seismic event by adhering to most recently updated IBC requirements, in accordance with OAR 345- 022-0020(1)(b). These standards require that for the design seismic event, the factors of safety used in the Project design exceed certain values. For example, in the case of slope design, a factor of safety of at least 1.1 is normally required during the evaluation of seismic stability. This factor of safety is introduced to account for uncertainties in the design process and to ensure that performance is acceptable. In the event that factors of safety for slope stability are not met, the Project components will either be relocated during the micrositing process or else remedial measures to improve slope stability will be implemented. For slope stability, the remedial measures could include use of ground improvement methods (such as retaining structures) to limit the movement to acceptable levels. Given the relatively low level of risk for the Project, adherence to the IBC requirements will ensure that appropriate protection measures for human safety are taken.
- The Applicant has provided appropriate site-specific information and demonstrated (in accordance with OAR 345-022-0020(1)(c)) that the construction and operation of the proposed Project, in the absence of a seismic event, will not adversely affect or aggravate the geological or soil conditions of the Project site or vicinity. The risks posed by nonseismic geologic hazards are generally considered to be low because the Project can be designed to minimize or avoid the hazards of landslides and soil erosion. Landslide and slope stability issues will be identified during final design and mitigated. Erosion hazard resulting from soil and wind action will be minimized with the implementation of an engineered erosion control plan.
- The Applicant has demonstrated that the Project can be designed, engineered, and constructed to avoid dangers to human safety and the environment resulting from the geological and soil hazards of the site, pursuant to OAR 345-022-0020(1)(d). Site-specific studies will be conducted, additional geotechnical work will be completed once the final locations of the structures are selected, and adequate measures will be implemented to control erosion. Accordingly, given the relatively small risks these hazards pose to human safety, standard methods of practice (including implementation of the current IBC) will be adequate for the design and construction of the Project.
- Finally, the Applicant has conducted an assessment of future climate conditions for the expected life span of the Project, and the potential impacts of those conditions on the Project.

Therefore, for the reasons set forth in this Exhibit, the construction and operation of the Project will comply with EFSC's structural standard as set forth in OAR 345-022-0020.

12.0 References

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Figures

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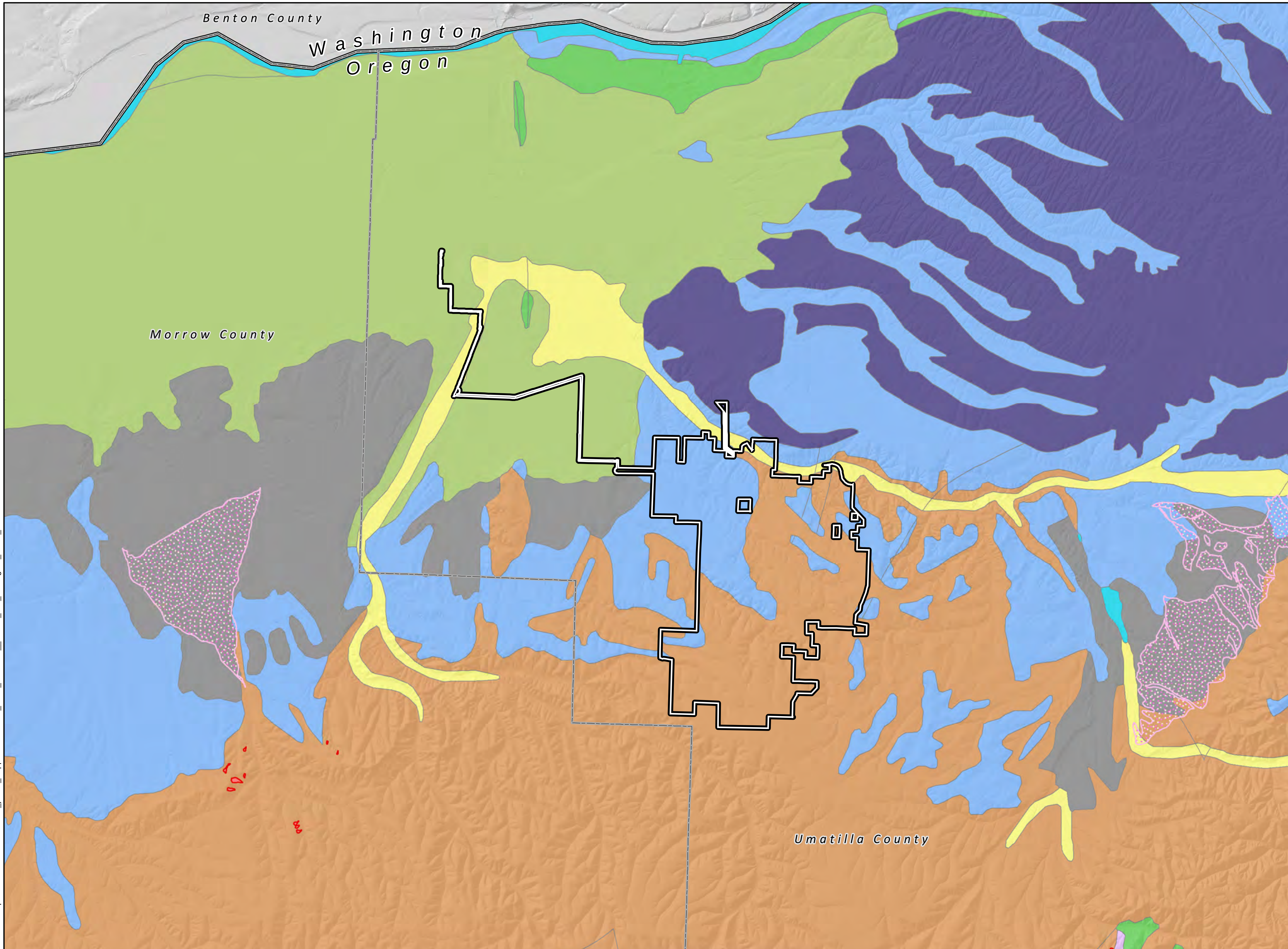
Nolin Hills Wind Power Project

Figure H-1
Geological Map

UMATILLA COUNTY, OREGON



1:250,000 WGS 1984 UTM Zone 11N

0 2.5 5 10 15 20 Miles

NOT FOR CONSTRUCTION

- Proposed Site Boundary
- State Boundary
- County Boundary
- Fan
- Landslide

Surface Geology

Qal	*Alluvial Deposits*
Qgs	*Glaciofluvial, Lacustrine, and Pediment Sedimentary Deposits (Pleistocene)*
Ql	*Loess (Holocene and Pleistocene)*
TRPsv	*Sedimentary and Volcanic Rocks, Partly Metamorphosed (Triassic and Permian)*
Tcg	*Grande Ronde Basalt (Middle and Lower Miocene)*
Tcs	*Saddle Mountains Basalt (Upper and Middle Miocene)*
Tcw	*Wanapum Basalt (Middle Miocene)*
Ts	*Tuffaceous Sedimentary Rocks and Tuff (Pliocene and Miocene)*
Water	*Water Bodies*

TETRA TECH

Capital Power
RESPONSIBLE ENERGY FOR TOMORROW

Data Sources

Capital Power-Project Infrastructure; USDA-Aerial Imagery; USGS U.S. Geological Survey-Surface Geology; DOGAMI-Landslide, Fan

Reference Map

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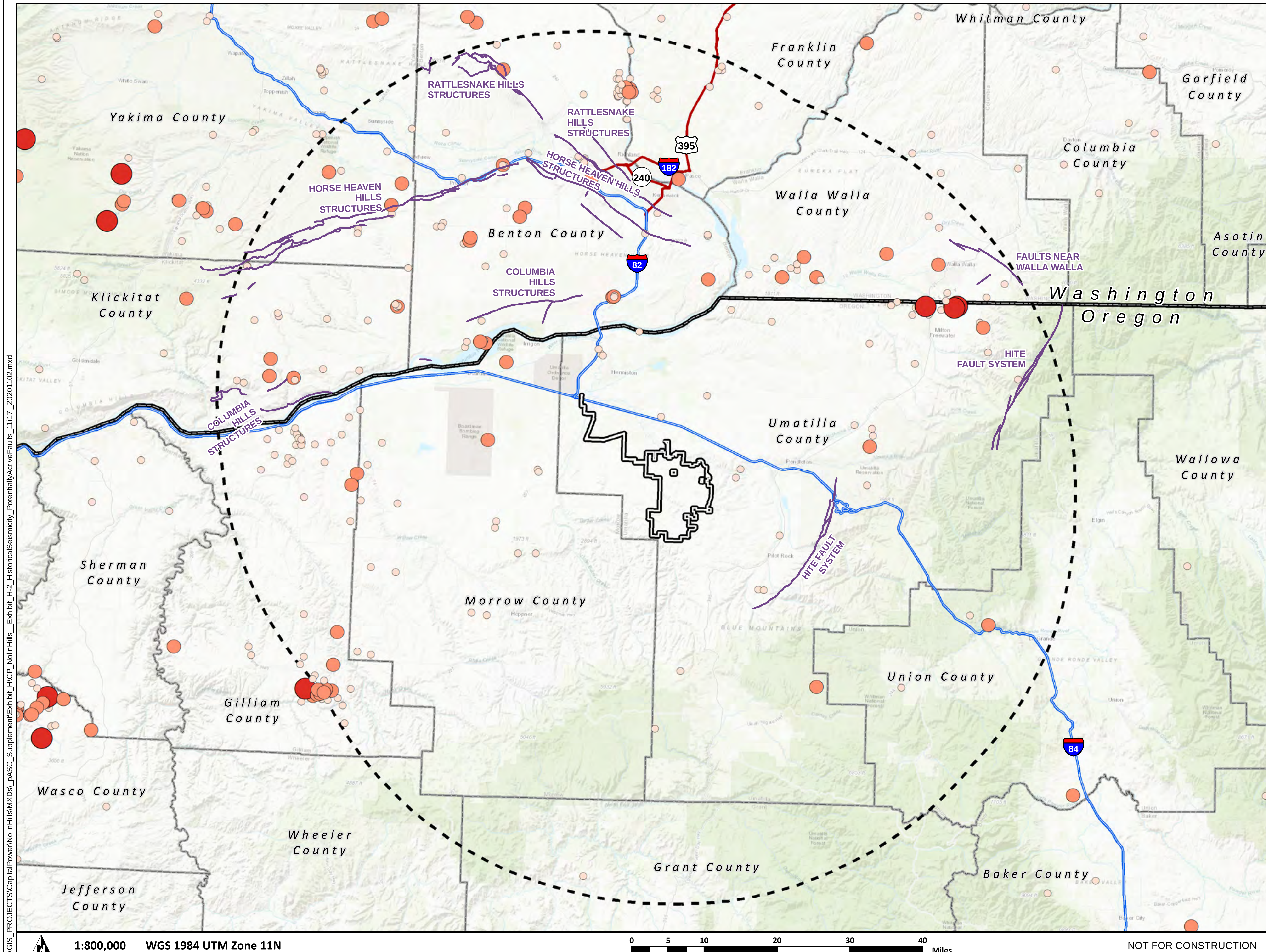


Nolin Hills Wind Power Project

Figure H-2
Historical Seismicity and Potentially Active Faults

UMATILLA COUNTY, OREGON

- Proposed Site Boundary
- Analysis Area (50-mile Buffer)
- Interstate Highway
- Primary Highway
- State Boundary
- County Boundary
- Undifferentiated Quaternary Fault

Earthquakes by Magnitude
- 2.5 - 2.9
- 3.0 - 3.9
- 4.0 - 4.9

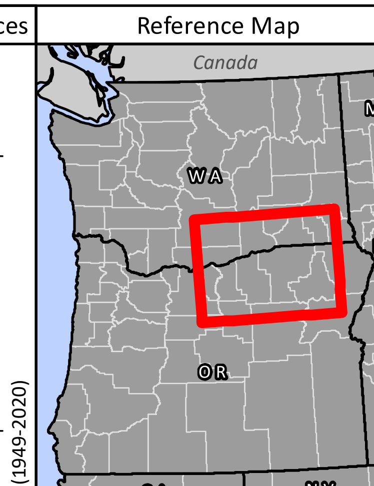
TETRA TECH

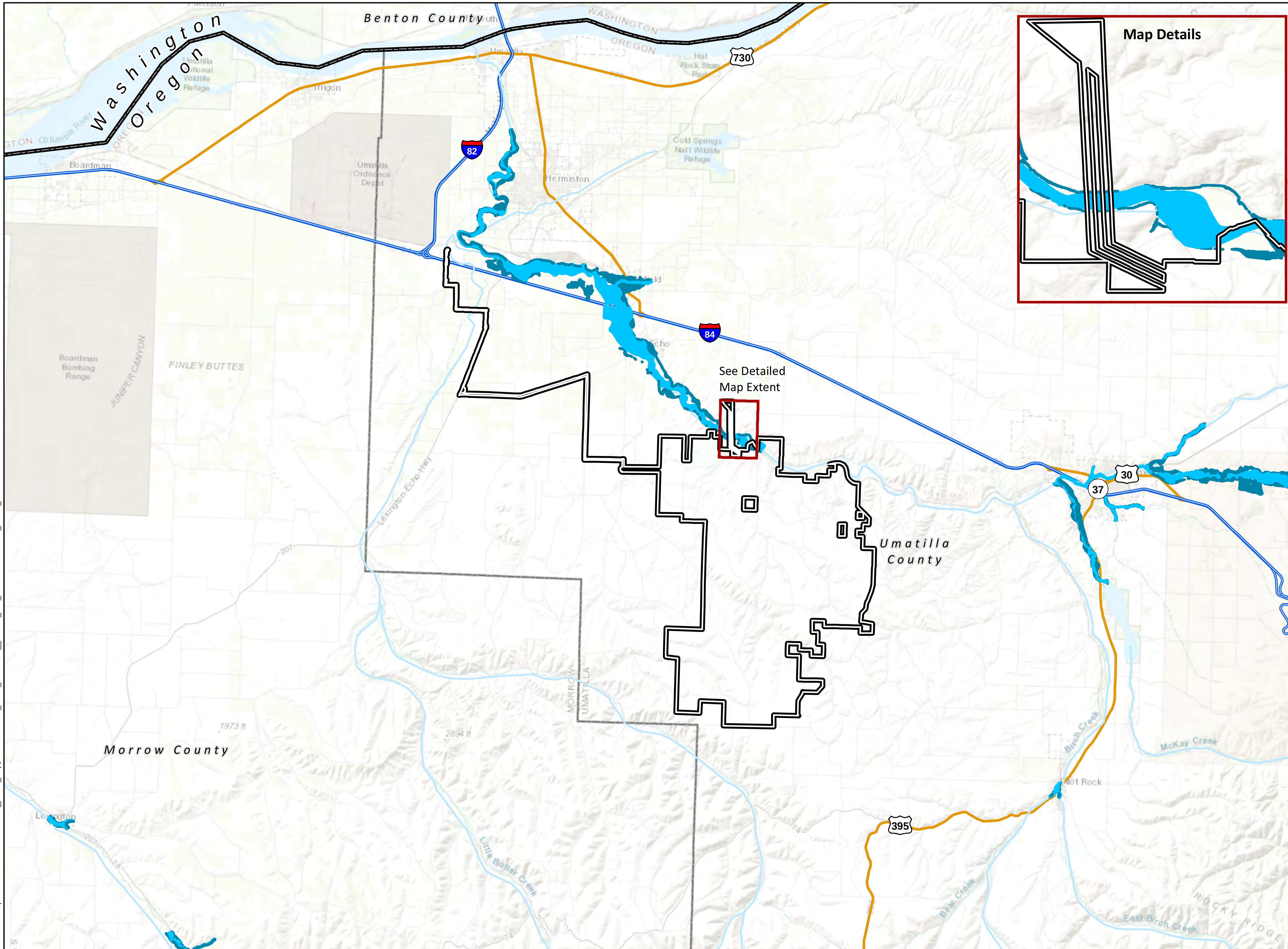
Capital Power
RESPONSIBLE ENERGY FOR TOMORROW

Data Sources

Capital Power-Project Infrastructure; USDA-Aerial Imagery; USGS Geologic Hazard Science Center-U.S. Quaternary Faults; National Earthquake Information Center-Earthquakes (1949-2020)

Reference Map





Nolin Hills
Wind Power Project

Figure H-3
Special Flood Hazard Areas

UMATILLA COUNTY, OREGON

- Proposed Site Boundary
- River/Stream
- Interstate Highway
- Secondary Highway
- State Boundary
- County Boundary

Special Flood Hazard Areas

- 500-year Flood Zone
- Floodway

TETRA TECH

Capital Power
RESPONSIBLE ENERGY FOR TOMORROW

Data Sources

Capital Power-Project Infrastructure; USDA-Aerial Imagery; ESRI-Rivers; FEMA National Flood Hazard-Flood Hazard

Reference Map

1:250,000 WGS 1984 UTM Zone 11N

0 2.5 5 10 15 20 Miles

NOT FOR CONSTRUCTION

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Attachment H-1. DOGAMI Consultation

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Cavanagh, Suzy

From: WANG Yumei * DGMI <Yumei.WANG@oregon.gov>
Sent: Tuesday, July 17, 2018 7:16 PM
To: Cavanagh, Suzy
Cc: Fossum, Linnea; Huelse, Kaitlin; WANG Yumei * DGMI
Subject: RE: Nolin Hills wind project EFSC preliminary application for site certificate
Attachments: DOGAMI EFSC Scope of Review ASC_Nov2017.pdf

Hi Suzy,

I'm confirming that I rec'd your VM and below email with an overview of the proposed project.

Are you requesting a DOGAMI consultation? Or simply providing some basic information at this point? If you are requesting a consultation, then please provide a few meeting options on 7/25, 8/1 morning, and 8/15. If those don't work out, we can revisit possible dates. Also, I have attached information on DOGAMI's scope of review.

As far as additional information, when you are ready with it, DOGAMI would like to obtain information on the site-specific geotechnical work, including on geological hazards (e.g., site-specific seismic hazards analyses; site-specific landslide hazard evaluation, other hazards) and relating to public safety issues. In addition, please provide information (e.g., planning, design) on disaster resilience and future climate conditions that may impact public safety, including a prompt recovery after any disasters. As part of this work, all relevant codes, standards, guidelines (OSSC, ASCE 7, NESC, NFPA, NEC, etc) should be considered, and all methods should be current state-of-practice or otherwise acceptable, clearly documented and explained.

Please note that DOGAMI considers Quaternary faults as active and should be included in the site-specific seismic hazard analyses. DOGAMI considers the use of lidar as standard practice when evaluating landslide hazards. If you have not completed specific work but plan at a future stage (e.g., subsurface exploration of the site), then please explain what you plan to do and when.

If you do not require a consultation at this time, just let me know. Thanks.

Yumei

Yumei Wang, P.E. | Geotechnical Engineer
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From: Cavanagh, Suzy [mailto:Suzy.Cavanagh@tetratech.com]
Sent: Monday, July 16, 2018 12:38 PM
To: WANG Yumei * DGMI <Yumei.WANG@oregon.gov>
Cc: Fossum, Linnea <Linnea.Fossum@tetratech.com>; Huelse, Kaitlin <Kaitlin.Huelse@tetratech.com>
Subject: Nolin Hills wind project EFSC preliminary application for site certificate

Hi Yumei,
I left a message for you last Friday about the Nolin Hills Wind Power Project. Tetra Tech is preparing the EFSC preliminary Application for Site Certificate (pASC) on behalf of the Applicant.

As part of the EFSC process, I am initiating consultation with DOGAMI by sending this email to you with project information so that we can start communicating to inform Exhibit H of the pASC.

Project Information:
Nolin Hills Wind, LLC (the Applicant) proposes to construct the Nolin Hills Wind Power Project (Project), a wind energy Project with a nominal generating capacity of approximately 350 megawatts (MW), and up to 117 average MW of energy, in Umatilla County, Oregon. The Project is comprised of up to 127 turbines. Power generated by the Project will be transmitted by 34.5-kilovolt (kV) underground and overhead electrical collector lines, up to approximately 67.5 miles in length. The Applicant proposes to construct two on-site collector substations to increase the voltage from the 34.5-kV collection system to 230 kV for transmission through the proposed overhead transmission line that will connect the Project to the proposed Hermiston Generating Station. The Project Site Boundary encompasses approximately 44,900 acres, and is located entirely on private land.

Major components, structures, and systems associated with the proposed Project are:
- Turbines, including the nacelle, blades, rotor, and tower;
- Turbine foundations; and
- Generator Step-Up (GSU) transformers and transformer foundations.

Other Project components include site access roads, an electrical collection and control system, operations and maintenance buildings (O&M buildings), meteorological data collection towers (met towers), and temporary construction yards.

The project area is located in northeastern Oregon south of Interstate 84 and the Umatilla River in the foothills. Please see the attached vicinity map.

Please let me know if there is any other information I can provide to you at this time.

Thank you,
Suzy

Suzy Cavanagh, P.G. | **Project Manager**
Direct: 208.489.2868 | Cell: 208.871.0720
suzy.cavanagh@tetratech.com

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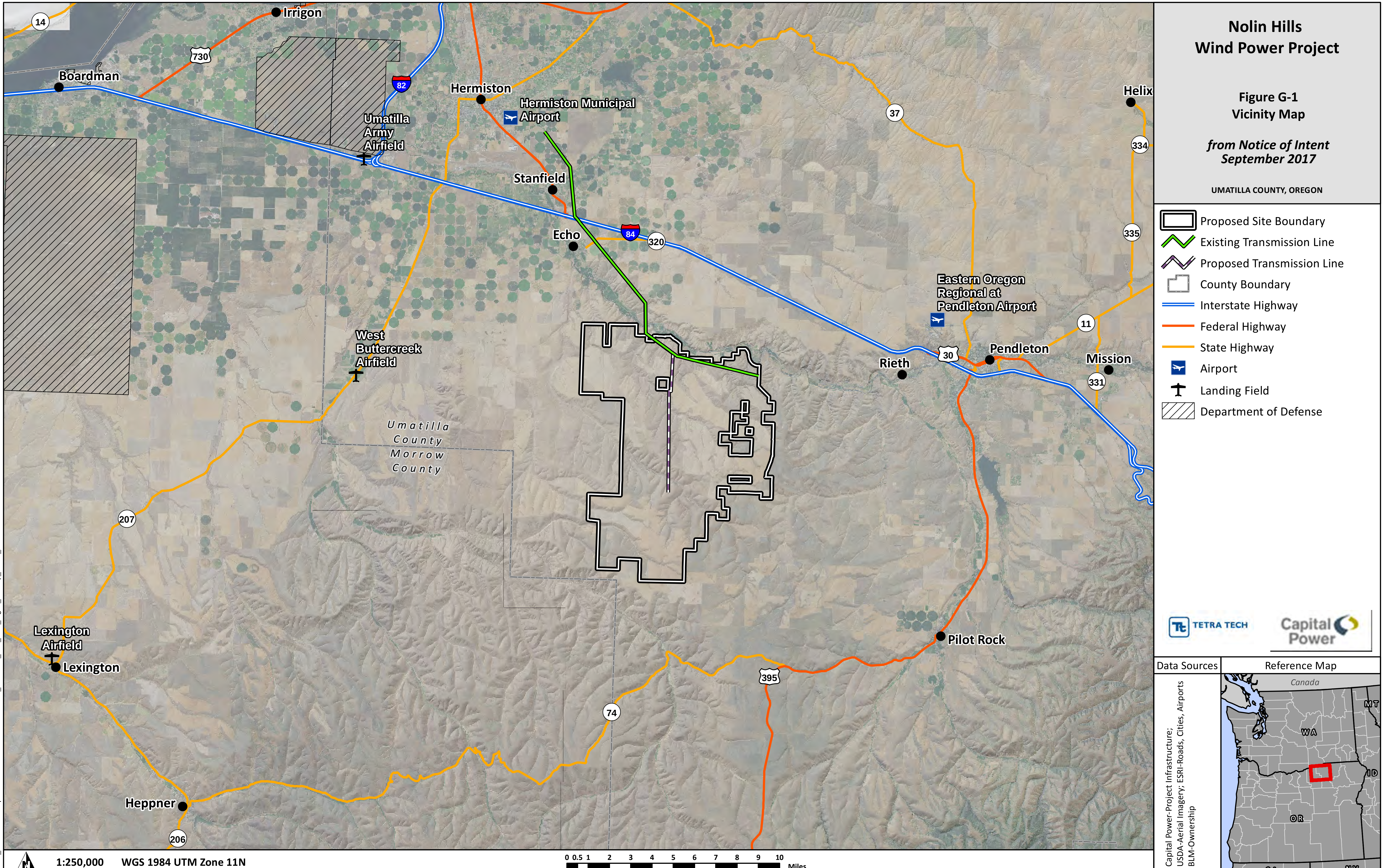

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DOGAMI SCOPE OF REVIEW
FOR ENERGY FACILITY SITING COUNCIL

The scope of review by Department of Geology and Mineral Industries (DOGAMI) for the Energy Facility Siting Council (EFSC) is:

- DOGAMI is a “reviewing agency” and provides comments to the Oregon Department of Energy (ODOE), which serves as staff to EFSC.

- DOGAMI’s area of responsibility in this review involves public safety surrounding geologic and seismic hazards as described in Oregon Administrative Rules (OAR) 345-021-0010(1)(h) and OAR 345-022-0020 (see below), and in OAR 345-050-0060 (radioactive waste disposal facility site suitability) when applicable.

- DOGAMI’s charge to address these concerns are in accordance with the general terms and budget of an Interagency Agreement between DOGAMI and the Oregon Department of Energy (ODOE). Tasks typically involve commenting on the Notice of Intent, reviewing the Application for Site Certificate, and commenting on the Draft Proposed Order. Other tasks are possible upon specific request from the Council.

- Prior to DOGAMI’s review, the Applicant must consult with DOGAMI regarding the appropriate site-specific geotechnical work that must be performed before submitting their application. This consultation occurs after the Notice of Intent has been filed with EFSC, and ODOE has requested DOGAMI’s assistance.

- DOGAMI’s review is limited to the documents provided by the Applicant. DOGAMI’s comments are not based on site-specific evaluations by DOGAMI. For example, DOGAMI does not conduct any new exploration and/or analysis. The intended depth of DOGAMI’s review is at an overview and/or regional level of detail. For example, DOGAMI reviews the documents to make sure the applicant has answered questions in the OARs and that the answers seem reasonable.

- DOGAMI may also propose site certificate conditions for ODOE to consider recommending to EFSC for adoption, and may provide feedback on ODOE’s recommendations to EFSC regarding finding the facility compliant or noncompliant with the Structural Standard (OAR 345-022-0020).

- DOGAMI is one of the entities notified when a site certificate holder’s site investigations or trenching reveal that conditions in the foundation rocks differ significantly from those described in the Application for Site Certificate Exhibit H, and when shear zones, artesian aquifers, deformations or clastic dikes are found at or in the vicinity of the site [OAR 345-027-0020(13) and (14)]. In these instances, DOGAMI responds to requests for consultation and helps the applicant and ODOE identify corrective or mitigation actions.

- DOGAMI has regulatory authority on these activities that may involve EFSC projects:
  1. Tsunami regulations. See Section 1803.2.1 Tsunami Inundation Zone of the Oregon Structural Specially Code (Oregon Revised Statutes [ORS] 455.446 and 455.447 https://www.oregonlegislature.gov/bills_laws/ors/ors455.html), where the focus is on the safety of occupants from tsunami events. DOGAMI and ODOE should closely coordinate on EFSC projects in the tsunami inundation zone.
  2. Surface mining operations. See ORS 517.750(15) https://www.oregonlegislature.gov/bills_laws/ors/ors517.html. A DOGAMI surface mining operating permit is required for material extraction activity that exceeds one acre of disturbance and/or 5,000 cubic yards of material in any 12-month period.
  3. Oil and gas well permits. See ORS 520, which provides DOGAMI authority to issue permits https://www.oregonlegislature.gov/bills_laws/ors/ors520.html
  4. Geothermal well permits. See ORS 522, which provides DOGAMI authority to issue permits https://www.oregonlegislature.gov/bills_laws/ors/ors522.html
     As one example, DOGAMI maintains regulatory authority over the individual wells and wellhead equipment of the NW Natural Mist Underground Natural Gas Storage Facility, as these components are not considered part of the EFSC-jurisdictional energy facility. In addition, DOGAMI serves as a reviewing agency for the surface components of the underground gas storage facility, over which EFSC has jurisdiction.

Division 21
OAR 345-021-0010(1)(h): Contents of an Application
(Accessed from: https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=234447)

(1) The project order described in OAR 345-015-0160(1) identifies the provisions of this rule applicable to the application for the proposed facility, including any appropriate modifications to applicable provisions of this rule. The applicant shall include in its application for a site certificate information that addresses each provision of this rule identified in the project order. The applicant shall designate the information with the appropriate exhibit label identified in the following subsections. If the same information is required in each of several exhibits the applicant may provide the required information in one exhibit and include appropriate references in the others. For the purpose of submitting an application for a site certificate in an expedited review granted under 345-015-0300 or 345-015-0310, the applicant shall include information that addresses all provisions of this rule. In such expedited reviews, analysis areas addressed in this rule are the study areas defined in 345-001-0010, subject to later modification in the project order.

(h) Exhibit H. Information from reasonably available sources regarding the geological and soil stability within the analysis area, providing evidence to support findings by the Council as required by OAR 345-022-0020, including:

(A) A geologic report meeting the Oregon State Board of Geologist Examiners geologic report guidelines. Current guidelines shall be determined based on consultation with the Oregon Department of Geology and Mineral Industries, as described in paragraph (B) of this subsection.

(B) A summary of consultation with the Oregon Department of Geology and Mineral Industries regarding the appropriate methodology and scope of the seismic hazards and geology and soil-related hazards assessments, and the appropriate site-specific geotechnical work that must be performed before submitting the application for the Department to determine that the application is complete.

(C) A description and schedule of site-specific geotechnical work that will be performed before construction for inclusion in the site certificate as conditions.

(D) For all transmission lines, and for all pipelines that would carry explosive, flammable or hazardous materials, a description of locations along the proposed route where the applicant proposes to perform site specific geotechnical work, including but not limited to railroad crossings, major road crossings, river crossings, dead ends (for transmission lines), corners (for transmission lines), and portions of the proposed route where geologic reconnaissance and other site specific studies provide evidence of existing landslides, marginally stable slopes or potentially liquefiable soils that could be made unstable by the planned construction or experience impacts during the facility's operation.

(E) An assessment of seismic hazards, in accordance with standard-of-practice methods and best practices, that addresses all issues relating to the consultation with the Oregon Department of Geology and Mineral Industries described in paragraph (B) of this subsection, and an explanation of how the applicant will design, engineer, construct, and operate the facility to avoid dangers to human safety and the environment from these seismic hazards. Furthermore, an explanation of how the applicant will design, engineer, construct and operate the facility to integrate disaster resilience design to ensure recovery of operations after major disasters. The applicant shall include proposed design and engineering features, applicable construction codes, and any monitoring and emergency measures for seismic hazards, including tsunami safety measures if the site is located in the DOGAMI-defined tsunami evacuation zone.

(F) An assessment of geology and soil-related hazards which could, in the absence of a seismic event, adversely affect or be aggravated by the construction or operation of the facility, in accordance with standard-of-practice methods and best practices, that address all issues relating to the consultation with the Oregon Department of Geology and Mineral Industries described in paragraph (B) of this subsection. An explanation of how the applicant will design, engineer, construct and operate the facility to adequately avoid dangers to human safety and the environment presented by these hazards, as well as:

(i) An explanation of how the applicant will design, engineer, construct and operate the facility to integrate disaster resilience design to ensure recovery of operations after major disasters.

(ii) An assessment of future climate conditions for the expected life span of the proposed facility and the potential impacts of those conditions on the proposed facility.

Division 22
OAR 345-022-0020: Structural Standard
(Accessed from: https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=234450)

(1) Except for facilities described in sections (2) and (3), to issue a site certificate, the Council must find that:

(a) The applicant, through appropriate site-specific study, has adequately characterized the seismic hazard risk of the site; and

(b) The applicant can design, engineer, and construct the facility to avoid dangers to human safety and the environment presented by seismic hazards affecting the site, as identified in subsection (1)(a);

(c) The applicant, through appropriate site-specific study, has adequately characterized the potential geological and soils hazards of the site and its vicinity that could, in the absence of a seismic event, adversely affect, or be aggravated by, the construction and operation of the proposed facility; and
(d) The applicant can design, engineer and construct the facility to avoid dangers to human safety and the environment presented by the hazards identified in subsection (c).

(2) The Council may not impose the Structural Standard in section (1) to approve or deny an application for an energy facility that would produce power from wind, solar or geothermal energy. However, the Council may, to the extent it determines appropriate, apply the requirements of section (1) to impose conditions on a site certificate issued for such a facility.

(3) The Council may not impose the Structural Standard in section (1) to deny an application for a special criteria facility under OAR 345-015-0310. However, the Council may, to the extent it determines appropriate, apply the requirements of section (1) to impose conditions on a site certificate issued for such a facility

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Guidelines for Resilience and Future Climate
Per Division 21, OAR 345-021-0010(1)(h)(F)(i-ii)

DOGAMI encourages, but does not require, Applicants to design and build for disaster resilience and future climate using science, data and community wisdom to protect against and adapt to risks. Applicants may address hazards by avoidance or through appropriate analyses, design, and construction methods. This will allow people, communities and systems to be better prepared to withstand catastrophic events and future climate—both natural and human-caused—and be able to bounce back more quickly and emerge stronger from shocks and stresses.

DOGAMI encourages Applicants to adopt:

- A long-term view to protect citizens, property, environment, and a high standard of living;
- Best practices in order to build resilience not only for the proposed facility but also for the local community and stakeholders; and
- Higher performance standards than may be required by building codes and regulations.

By taking such actions, facilities will incur less damage, which will improve continuity of operations, and Oregonians will feel less of a negative impact and faster recovery after future disasters. A goal is to increase resilience from future disasters and future climate conditions to improve the operations of energy facilities that impact community activities. This is consistent with the State of Oregon's efforts to prepare for future Cascadia earthquakes and tsunamis and other hazards (refer to *State of Oregon References*).

Applicants may include a separate section in Exhibit H (or as an appendix to Exhibit H) of the Application materials on proposed actions to address disaster resilience and future climate conditions.

State of Oregon References

1. Office of the Governor's Resilience Office
   www.oregon.gov/gov/policy/Pages/resilience.aspx
   www.oregon.gov/gov/policy/orr/pages/index.aspx

2. 2013 Oregon Resilience Plan by Oregon Seismic Safety Policy Advisory Commission (OSSPAC)
   www.oregon.gov/oem/Documents/Oregon_Resilience_Plan_Final.pdf

3. State of Oregon National Hazard Mitigation Plan (NHMP). Contact county for county NHMPs
   www.oregon.gov/LCD/HAZ/Pages/nhmp.aspx

4. Oregon Department of Administrative Services Hazards Guidelines
   www.oregon.gov/das/Financial/Facplan/Documents/DAS hazard guideline.pdf

Example Actions

- Build in lower risk areas and avoid building in higher risk areas, such as in an ancient landslide or 500 year flood zone

- Relocate existing facilities situated in high risk areas that would be critical to the proposed facility, such as a control building in a tsunami hazard zone or a 100 year flood zone

- Evaluate and, if needed, mitigate existing potentially vulnerable facilities that the proposed facility would rely on, such as older control buildings that may be seismically vulnerable to collapse during future earthquakes

- Opt to design for higher seismic performance than required by building "above code" for any new facility, such as control buildings, and certain equipment, such as emergency generators. A higher than required building code risk category may be voluntarily selected to better protect occupants, lessen earthquake damage and quicken recovery time

  As an example, Beaverton School District built several new schools "above code" in order to better protect students as well as the local community during a future Cascadia earthquake. See https://www.beaverton.k12.or.us/depts/facilities/Documents/150710_Beaverton%20School%20Report.pdf

- Install emergency power systems for control equipment and other critical functions with seismically certified emergency generators where not mandated

- Design new transmission lines for higher than required ice and wind loads to withstand future climate conditions

- Incorporate effective technologies, such as geofoam (e.g., pipeline fault crossings), seismic base isolation for buildings and equipment (e.g., power transformers), automatic seismic shut off valves, and flexible connections to lower seismic risk

- Install protective systems, such as a landslide warning system for facilities, roads and transmission lines with landslide risks or landslide monitoring system for pipelines in landslide prone areas

- Design new access roads in flood zones for higher than AASHTO requirements to withstand future worsening flood and scouring conditions and allow for use soon after disaster conditions

- Avoid building in a potential channel migration hazard zone with a 100 year outlook. Adopt large setbacks in expected channel migration hazard zones and create green space

Nolin Hills Wind Power Project Consultation with Oregon Department of Geology and Mineral Industries (DOGAMI)

August 24, 2018
Meeting in Portland, OR at the DOGAMI office

In Attendance	Yumei Wang, P.E. – DOGAMI; Katie Clifford – ODOE; Suzy Cavanagh – Tetra Tech/Capital Power
On Phone	Linnea Fossum – Tetra Tech/Capital Power; Kevin Victoor – Capital Power; Brad Heintz – Capital Power

Project Description and Schedule

The Nolin Hills Wind Project, located in Umatilla County, Oregon, will be a 350-MW wind facility with up to 127 turbines. Extensive studies have already been conducted to site turbines and supporting facilities to avoid impacts to biological and cultural resources; additional studies will be conducted associated with final design. Specific turbines have not yet been selected for the project and the preliminary Application for Site Certification (pASC) will describe a range of turbine options that may be selected. Tetra Tech has been hired by Capital Power (Applicant) to prepare the Oregon Department of Energy, Energy Facility Siting Council pASC. As identified in the Notice of Intent (NOI), the site boundary is identified on Figure G-1 Vicinity Map from the Notice of Intent (provided to DOGAMI in hard copy and via email). The timing of the submittal of the pASC is being pushed out after the end of September 2018.

Capital Power's construction timing is to begin construction in late 2019/early 2020. The grid interconnection is currently being worked out and the transmission piece has not been determined. Capital Power anticipates conducting geotechnical investigation later this year to feed into the design.

There are two powering options being considered, a 2.3 MW turbine design and a 4.0 MW turbine design. Micrositing corridors are being addressed in the pASC, these are areas that have had cultural and biological resource surveys conducted so that the turbines and related facilities can be located within the micrositing corridors. Generally, the micro-siting corridors are 150 feet on either side of roadways and 250 feet on either side of turbine strings. Exhibit B of the pASC contains additional detail regarding turbine size, anticipated foundation options, road construction, transmission line support structures, and other related or supporting facilities.

Turbine model options were discussed. DOGAMI asked about the weight and height of the turbines. Weight and height of the turbines will be included in the pASC; generally, the maximum height at the blade tip is up to 590 feet above ground and the tower height to hub is up to 344 feet above ground. Discussion of foundation design type; spread footing versus rock anchors in bedrock. Subsurface exploration should be conducted to inform foundation design. References to the project description in Exhibit B will be incorporated into Exhibit H to point the reader to details about the project. Geotechnical investigation will assist with determining the foundation design. Capital Power will acquire loading information from the turbine manufacturer to provide to DOGAMI and/or incorporate into Exhibit H.

Yumei asked about the transmission line and how they plan to design for the dead-end structures, substation and the collector system. Discussion around a 40 to 50-year design life. DOGAMI requested to know what standards are used and how they are different than turbines (IEEE standards).

Information needed for the pASC

DOGAMI discussed Lidar as a standard of practice tool/base map to study existing landslides and to assist in the analysis of slope stability conditions. Capital Power generally will exclude a certain percent slope grade for constraint. Most of the turbine strings are aligned near the tops of ridges. DOGAMI looks at things from a disaster resilience perspective, so doesn't consider slope grade the only standard of practice to use.

Yumei discussed Lidar coverage on the DOGAMI webpage and the standards on how to use for the landslide analysis. This area in eastern Oregon doesn't have the vegetation like western Oregon, so high resolution imagery for landslide hazards could be justified. The DOGAMI standards are DOGAMI special papers #42 – existing landslides; #45 – shallow susceptibility; and #48 – deep susceptibility (see additional notes below). If there are no existing landslides, then #45 and #48 are not warranted for this site.

Jake Edwards is DOGAMI's Lidar guy and could answer any questions that we might have.

DOGAMI will require a probabilistic seismic hazard analysis with peak ground and spectral acceleration. DOGAMI asked how Capital Power will know if the seismic design has been done appropriately and requested this be explained in Exhibit H.

DOGAMI would like the Applicant to explain how they are meeting building codes while considering seismic hazard analysis. Over 0.5 seconds response spectrum envelope that exceeds the design response spectrum. DOGAMI would like to be ensured that seismic hazard analysis is incorporated into design (they want to know that happened). Exhibit H needs assumptions that go along with the supporting material.

DOGAMI would like to know what codes the project is being built to (structural, building, NESC, etc.). What is being used for design and design considerations. DOGAMI mentioned that the state of Oregon Structural Specialty code is likely going to be changing next year and they are likely adopting the new 2018 IBC code. ASCE7-7 (new structures) versus ASCE7-13 codes discussed.

DOGAMI considers ALL Quaternary faults as active. Suzy showed a preliminary geologic map (Figure H-2) which shows the nearest largest control evaluation of fault hazards at the site from that fault (probable seismic hazard). For landslide hazards -include site reconnaissance and address where facilities could be impacted (to minimize risk). Soils analysis was discussed, DOGAMI requested to look for collapsing soils and shallow groundwater/perched groundwater. Suzy made a note to include reference to Exhibit I (Soils) in Exhibit H.

DOGAMI requires disaster resilience to be addressed. Not just safety hazards, but what plans are in place to show how the project will to recover after a disaster. Such as how the facility will be kept safe after a disaster and how/what plans are in place to get it back up and running to provide power to residents of Oregon. It would be helpful to know if emergency lighting (think of low flying emergency surveyors and responders) and backup generators, SCADA for monitoring, etc. are being included. Suzy noted that a reference to Exhibit B would help explain how they are lighting the turbines in accordance with FAA requirements. The transmission intertie was discussed, DOGAMI would like to see how disaster resilience in incorporated into all aspects of the facility.

DOGAMI requires a discussion of future climate and that the acknowledgement that there are increasing extreme weather conditions occurring, including an explanation that Capital Power understands the hazards, how it might impact the facility, and how they plan on recovering from it.

Studies to be conducted prior to construction

The geotechnical investigation report for the project will need to conform to the 2014 Oregon State Board of Engineering Geologists Report as identified in the standard. DOGAMI would like future geotechnical work explained to ensure that Capital Power is not moving forward on a simple geotechnical investigation where a more thorough investigation is warranted.

Next Steps

DOGAMI requested that the consultation meeting held on August 24, 2018 be summarized and emailed to DOGAMI and ODOE for review so that we are all on the same page as to what is expected to be analyzed. The final summary of consultation should be included as an attachment to Exhibit H. Geotechnical report(s) for any studies that have been completed at the time of ASC submittal should also be attached to Exhibit H.

Additional information provided by DOGAMI after meeting

- Special Paper 42, Protocol for Inventory Mapping of Landslide Deposits from Light Detection and Ranging (Lidar) Imagery, 2009, by William J. Burns and Ian P. Madin. https://www.oregongeology.org/pubs/sp/p-SP-42.htm
- Special Paper 45, Protocol for Shallow-Landslide Susceptibility Mapping, 2012, by William J. Burns, Ian P. Madin, and Katherine A. Mickelson. https://www.oregongeology.org/pubs/sp/p-SP-45.htm

- Special Paper 48, Protocol for deep landslide susceptibility mapping, 2016, by William J. Burns and Katherine A. Mickelson. https://www.oregongeology.org/pubs/sp/p-SP-48.htm
- And, Statewide Landslide Information Database for Oregon (SLIDO) should be viewed and referenced. https://www.oregongeology.org/slido/index.htm
- Also, ASCE 7-16 is the latest currently available version.

Attachment H-2. Probabilistic Seismic Hazard Deaggregation – 475-Year Return Time

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Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

^ Input

Edition

Dynamic: Conterminous U.S. 2014 (update) (v4.2.0)

Latitude

Decimal degrees

45.344279

Longitude

Decimal degrees, negative values for western longitudes

-119.014782

Site Class

259 m/s (Site class D)

Spectral Period

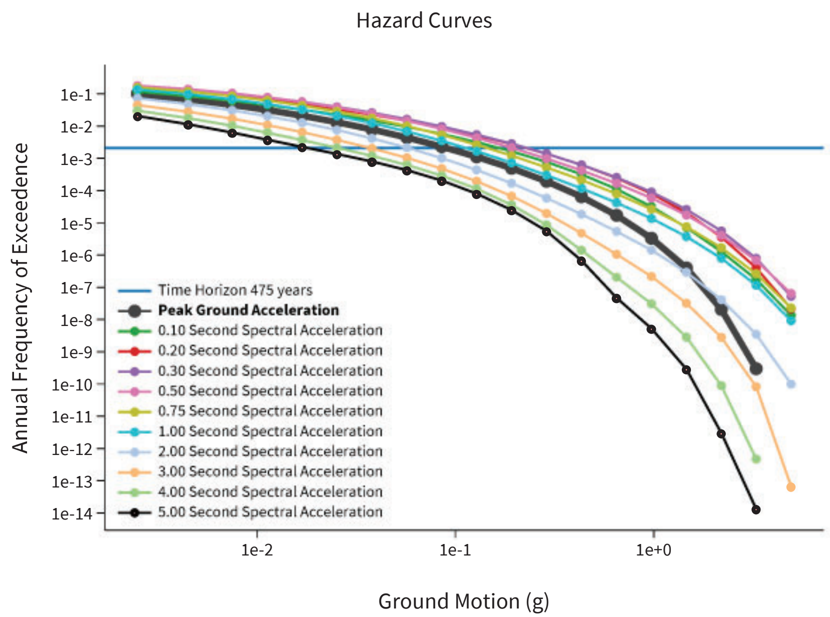
Peak Ground Acceleration

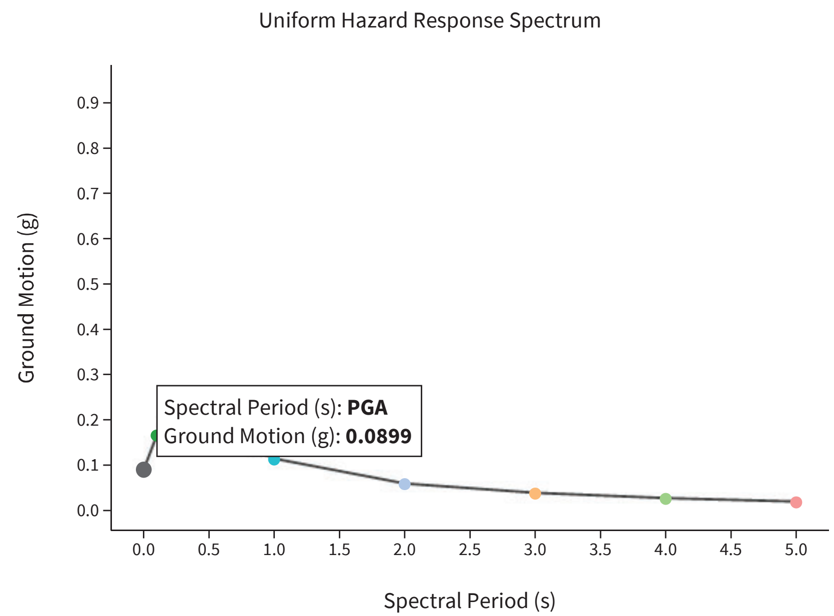
Time Horizon

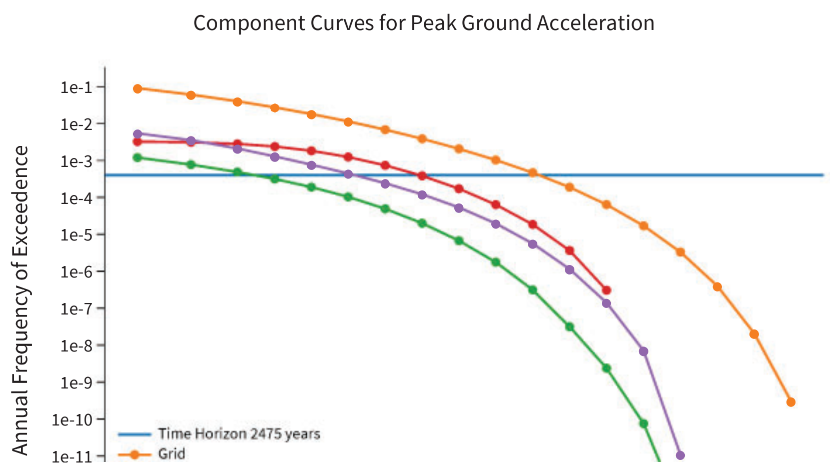
Return period in years

475

^ Hazard Curve



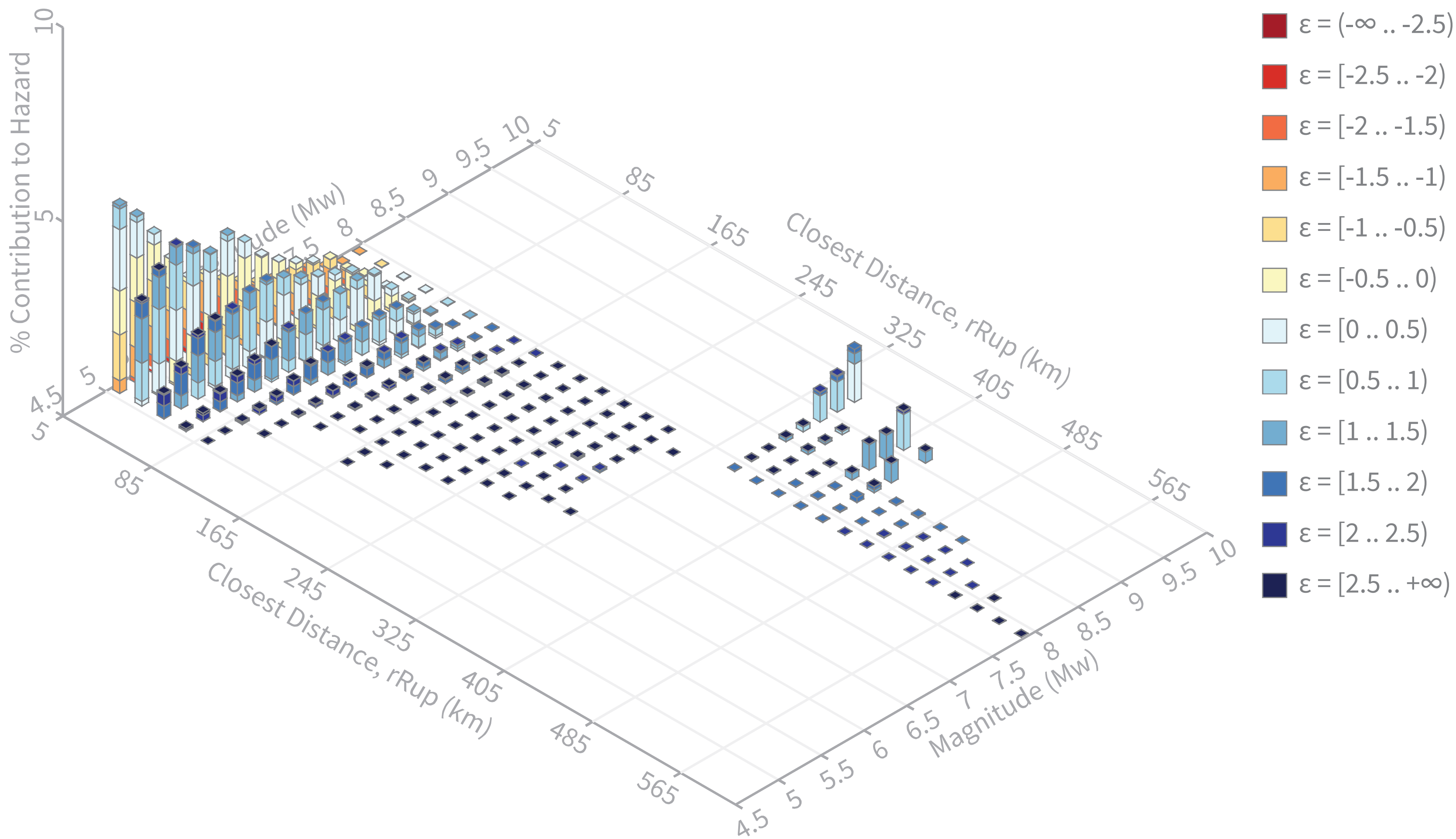




^ Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 475 yrs
Exceedance rate: 0.0021052632 yr^{-1}
PGA ground motion: 0.089854585 g

Recovered targets

Return period: 483.50703 yrs
Exceedance rate: 0.0020682223 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.67 %

Mean (over all sources)

m: 6.35
r: 68.44 km
ε_0: 0.18 σ

Mode (largest m-r bin)

m: 5.1
r: 13.27 km
ε_0: -0.14 σ
Contribution: 4.82 %

Mode (largest m-r-ε_0 bin)

m: 5.1
r: 16.9 km
ε_0: 0.24 σ

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUSmap_2014_fixSm.ch.in (opt)	Grid							11.15
noPuget_2014_fixSm.ch.in (opt)	Grid							11.15
WUSmap_2014_fixSm.gr.in (opt)	Grid							10.94
noPuget_2014_fixSm.gr.in (opt)	Grid							10.94
noPuget_2014_adSm.ch.in (opt)	Grid							8.96
WUSmap_2014_adSm.ch.in (opt)	Grid							8.96
noPuget_2014_adSm.gr.in (opt)	Grid							8.86
WUSmap_2014_adSm.gr.in (opt)	Grid							8.85
sub0_ch_bot.in	Interface							2.96
Cascadia Megathrust - whole CSZ Characteristic		357.49	9.12	0.85	123.413°W	46.300°N	288.89	2.96
WUSmap_2014_fixSm_M8.in (opt)	Grid							2.75
noPuget_2014_fixSm_M8.in (opt)	Grid							2.75
sub0_ch_mid.in	Interface							2.22
Cascadia Megathrust - whole CSZ Characteristic		411.24	8.92	1.13	124.137°W	46.300°N	286.82	2.22
noPuget_2014_adSm_M8.in (opt)	Grid							2.18
WUSmap_2014_adSm_M8.in (opt)	Grid							2.18

Attachment H-3. Probabilistic Seismic Hazard Deaggregation – 2,475-Year Return Time

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Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (update) (v4.2.0)

Latitude

Decimal degrees

45.344279

Longitude

Decimal degrees, negative values for western longitudes

-119.014782

Site Class

259 m/s (Site class D)

Spectral Period

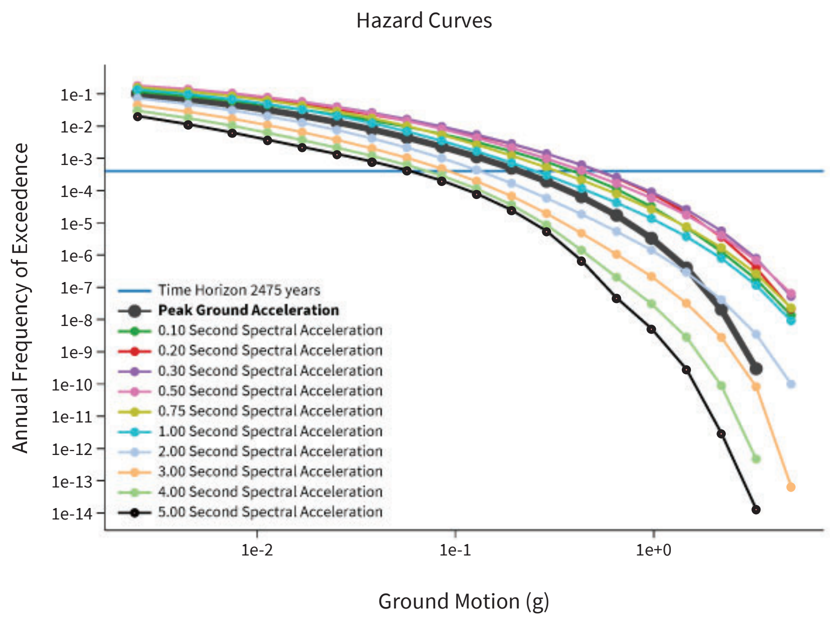
Peak Ground Acceleration

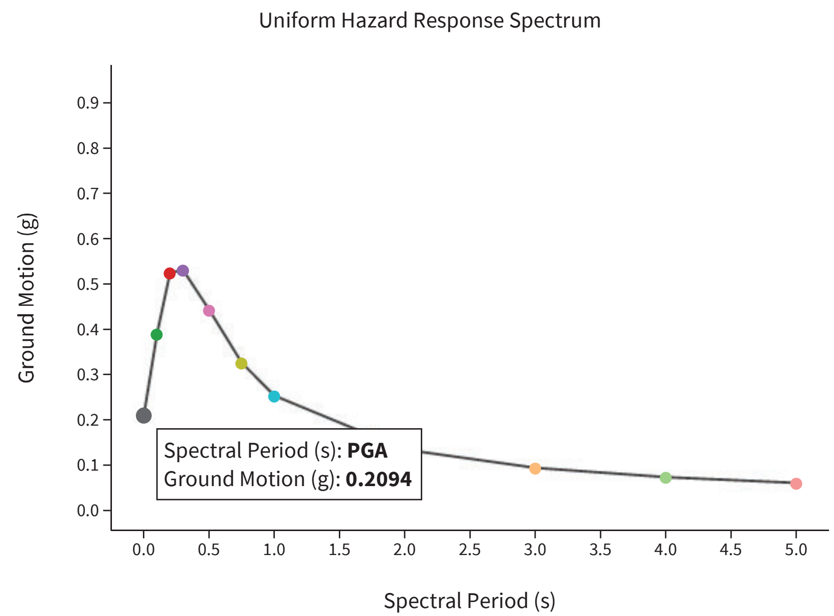
Time Horizon

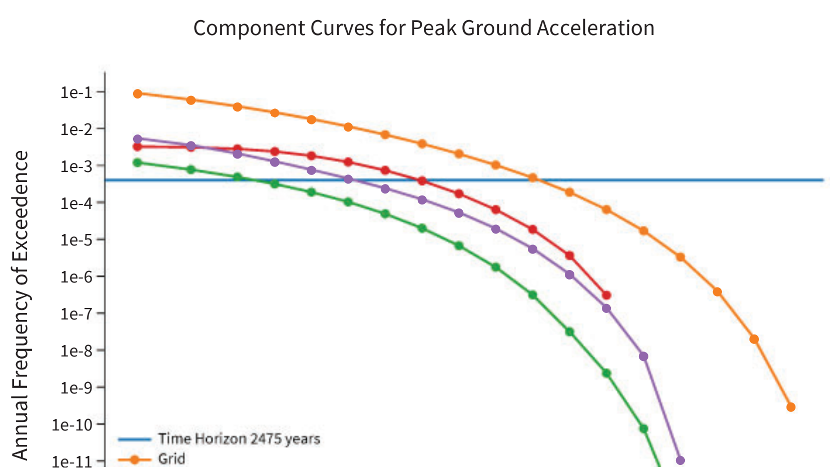
Return period in years

2475

^ Hazard Curve



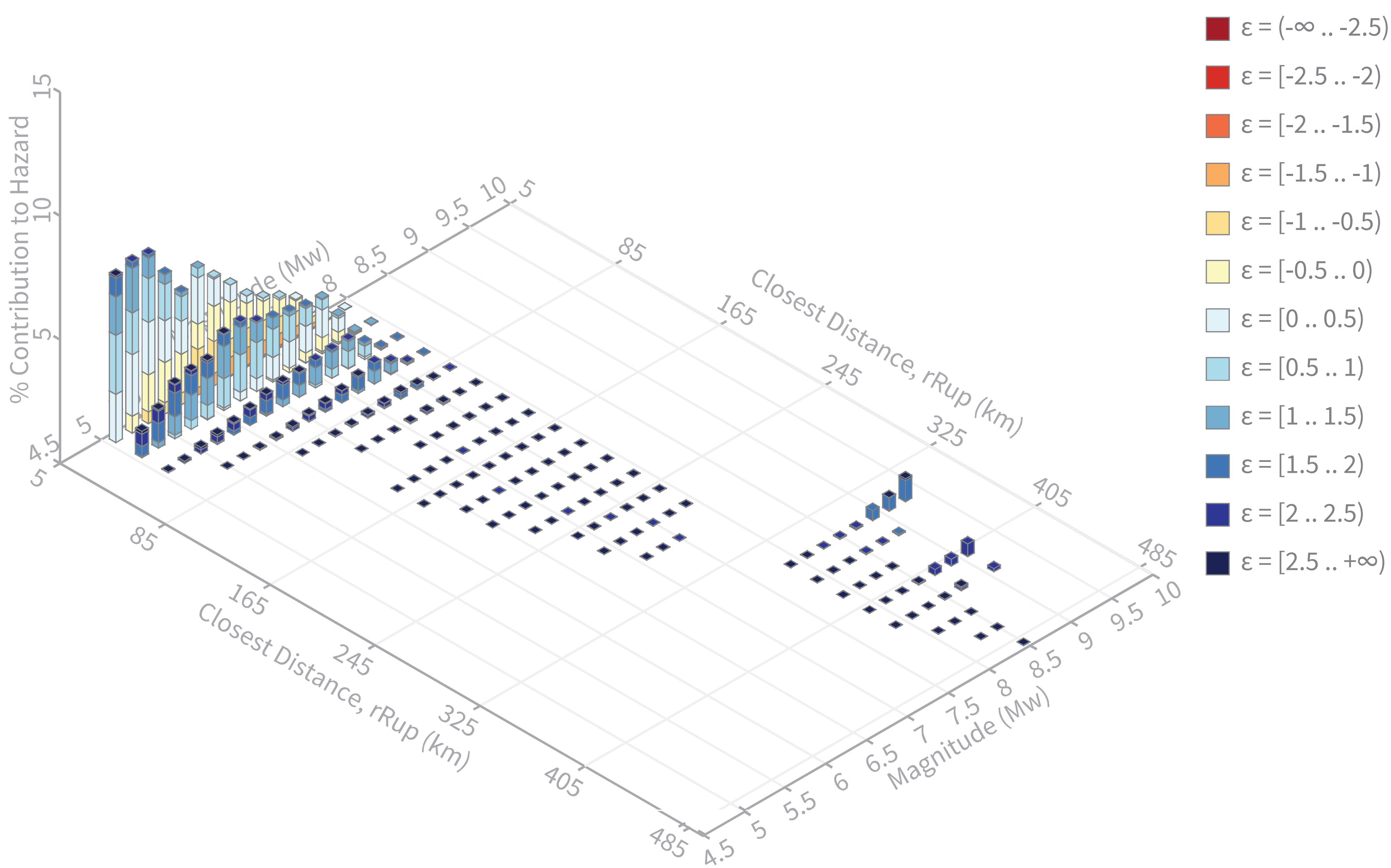




^ Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
PGA ground motion: 0.2094104 g

Recovered targets

Return period: 2554.1915 yrs
Exceedance rate: 0.00039151332 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.37 %

Mean (over all sources)

m: 6.28
r: 36.33 km
ε_0: 0.61 σ

Mode (largest m-r bin)

m: 5.3
r: 12.16 km
ε_0: 0.62 σ
Contribution: 6.91 %

Mode (largest m-r-ε_0 bin)

m: 5.3
r: 9.45 km
ε_0: 0.25 σ

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
WUSmap_2014_fixSm.ch.in (opt)	Grid							11.28
noPuget_2014_fixSm.ch.in (opt)	Grid							11.28
WUSmap_2014_fixSm.gr.in (opt)	Grid							11.19
noPuget_2014_fixSm.gr.in (opt)	Grid							11.19
noPuget_2014_adSm.ch.in (opt)	Grid							9.97
WUSmap_2014_adSm.ch.in (opt)	Grid							9.96
noPuget_2014_adSm.gr.in (opt)	Grid							9.93
WUSmap_2014_adSm.gr.in (opt)	Grid							9.92
WUSmap_2014_fixSm_M8.in (opt)	Grid							2.83
noPuget_2014_fixSm_M8.in (opt)	Grid							2.83
noPuget_2014_adSm_M8.in (opt)	Grid							2.45
WUSmap_2014_adSm_M8.in (opt)	Grid							2.45
sub0_ch_bot.in	Interface							1.80
Cascadia Megathrust - whole CSZ Characteristic		357.49	9.15	1.79	123.413°W	46.300°N	288.89	1.80

Attachment H-4. Earthquakes within 50 miles of Project Boundary

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Earthquakes within 50 miles of Project Boundary

Magnitude	Location	Date	Depth	Latitude	Longitude	Proximity from Project Site Boundary (miles)
M 2.9	10km SW of Athena, Oregon	02/15/17		45.7528333	45.7528333	20.93
M 3.5	11km ENE of Mission, Oregon	01/23/15		45.711	45.711	22.16
M 3.0	10km WNW of La Grande, Oregon	12/23/13		45.3601667	45.3601667	41.15
M 3.2	13km NNE of West Richland, Washington	11/17/13		46.4115	46.4115	41.55
M 3.2	Washington	04/10/12		46.0455	46.0455	28.91
M 2.7	Washington	02/22/12	55.10 km (34.24 mi)	46.492	46.492	47.47
M 3.4	Washington	10/15/11		46.4083333	46.4083333	41.34
M 2.8	Washington	09/05/11		46.4071667	46.4071667	41.26
M 3.7	Washington	09/04/11		46.4108333	46.4108333	41.51
M 2.5	Washington	08/27/11		46.4073333	46.4073333	41.27
M 3.3	Washington	05/01/11		46.4045	46.4045	41.07
M 2.8	Oregon	05/16/10	20.16 km (12.53 mi)	45.7323333	45.7323333	22.89
M 2.7	Oregon	05/15/10	19.67 km (12.22 mi)	45.7461667	45.7461667	23.03
M 2.7	Washington	02/04/10		46.3993333	46.3993333	40.69
M 2.5	Washington	12/22/09	0.85 km (0.53 mi)	46.415	46.415	41.80
M 2.8	Washington	09/11/09		46.4155	46.4155	41.83
M 2.8	Washington	08/16/09	4.26 km (2.64 mi)	45.933	45.933	36.17
M 2.6	Washington	08/11/09	17.98 km (11.17 mi)	45.933	45.933	30.77
M 2.5	Washington	07/23/09	0.98 km (0.61 mi)	46.4133333	46.4133333	41.68

Magnitude	Location	Date	Depth	Latitude	Longitude	Proximity from Project Site Boundary (miles)
M 2.8	Oregon	05/29/09	7.33 km (4.55 mi)	45.9155	45.9155	27.98
M 2.7	Washington	05/16/09	-0.18 km (-0.11 mi)	46.3946667	46.3946667	40.37
M 2.8	Washington	05/13/09	-0.11 km (-0.07 mi)	46.4035	46.4035	40.98
M 2.9	Washington	05/13/09		46.4073333	46.4073333	41.25
M 2.5	Washington	05/10/09	10.03 km (6.23 mi)	45.833	45.833	35.41
M 2.5	Washington	05/05/09	-0.09 km (-0.05 mi)	46.3866667	46.3866667	39.84
M 3.0	Washington	05/04/09		46.4135	46.4135	41.69
M 2.6	Washington	04/14/09		46.3956667	46.3956667	40.44
M 2.6	Washington	04/08/09	0.31 km (0.19 mi)	46.405	46.405	41.11
M 2.7	Washington	04/07/09	0.64 km (0.40 mi)	46.4015	46.4015	40.84
M 2.5	Washington	04/07/09	-0.05 km (-0.03 mi)	46.411	46.411	41.50
M 2.5	Washington	04/07/09	-0.03 km (-0.02 mi)	46.411	46.411	41.50
M 2.7	Washington	04/04/09	-0.11 km (-0.07 mi)	46.386	46.386	39.80
M 2.7	Washington	04/04/09		46.3958333	46.3958333	40.45
M 2.7	Washington	04/03/09		46.4073333	46.4073333	41.25
M 2.9	Washington	03/18/09	-0.13 km (-0.08 mi)	46.4056667	46.4056667	41.15
M 2.9	Washington	03/18/09		46.404	46.404	41.04
M 2.6	Washington	03/16/09	0.23 km (0.14 mi)	46.3996667	46.3996667	40.72
M 2.8	Washington	03/12/09		46.4031667	46.4031667	40.98
M 2.9	Washington	03/08/09		46.41	46.41	41.44
M 2.9	Washington	02/21/09		46.4076667	46.4076667	41.27
M 2.5	Washington	02/10/09	-0.18 km (-0.11 mi)	46.4078333	46.4078333	41.29
M 3.7	Washington	05/18/08		46.1676667	46.1676667	26.36
M 2.7	Washington	04/16/07	1.78 km (1.10 mi)	46.397	46.397	40.58

Magnitude	Location	Date	Depth	Latitude	Longitude	Proximity from Project Site Boundary (miles)
M 3.4	Washington	12/20/06		46.0948333	46.0948333	38.05
M 2.5	Washington	11/10/05	9.89 km (6.14 mi)	46.1463333	46.1463333	35.62
M 3.3	Washington	02/28/04		46.0363333	46.0363333	18.12
M 2.5	Oregon	12/01/03	16.13 km (10.02 mi)	45.4213333	45.4213333	12.54
M 2.8	Oregon	09/12/03	23.39 km (14.54 mi)	45.4206667	45.4206667	12.99
M 2.6	Washington	02/23/03	8.41 km (5.23 mi)	46.0621667	46.0621667	26.81
M 2.5	Oregon	10/25/02	3.98 km (2.47 mi)	45.1843333	45.1843333	49.70
M 2.7	Oregon	01/31/02	3.25 km (2.02 mi)	45.6851667	45.6851667	38.63
M 2.6	Washington	12/29/00	-0.55 km (-0.34 mi)	45.8868333	45.8868333	16.97
M 3.0	Washington	09/06/00		46.0755	46.0755	42.16
M 3.2	Oregon	08/17/00		45.312	45.312	42.91
M 2.8	Oregon	08/03/00	3.11 km (1.93 mi)	45.2086667	45.2086667	48.89
M 2.5	Oregon	02/21/00	9.32 km (5.79 mi)	45.6828333	45.6828333	36.69
M 2.6	Oregon	02/15/00	15.05 km (9.35 mi)	45.6876667	45.6876667	34.46
M 2.8	Oregon	01/05/00	4.98 km (3.10 mi)	45.7041667	45.7041667	32.85
M 3.1	Washington	09/19/99		46.4413333	46.4413333	45.48
M 2.9	Oregon	03/21/99	21.99 km (13.66 mi)	45.1803333	45.1803333	48.44
M 2.6	Oregon	03/10/99	4.71 km (2.93 mi)	45.9991667	45.9991667	34.50
M 2.9	Oregon	09/05/98	-0.55 km (-0.34 mi)	45.6481667	45.6481667	7.54
M 2.8	Oregon	08/12/98	7.16 km (4.45 mi)	45.1663333	45.1663333	48.34
M 2.5	Oregon	06/11/98	-0.61 km (-0.38 mi)	45.2321667	45.2321667	35.61
M 2.6	Oregon	04/14/98	-0.53 km (-0.33 mi)	45.4803333	45.4803333	18.00
M 2.7	Washington	03/23/98	19.63 km (12.19 mi)	46.3838333	46.3838333	42.53
M 3.1	Washington	02/03/98	15.65 km (9.73 mi)	45.8138333	45.8138333	39.32

Magnitude	Location	Date	Depth	Latitude	Longitude	Proximity from Project Site Boundary (miles)
M 2.7	Oregon	09/10/97	-0.61 km (-0.38 mi)	45.6543333	45.6543333	40.56
M 2.8	Oregon	08/17/97	-0.64 km (-0.40 mi)	45.6483333	45.6483333	40.08
M 2.7	Oregon	07/23/97	8.11 km (5.04 mi)	45.9923333	45.9923333	33.58
M 2.7	Oregon	05/13/97	1.88 km (1.17 mi)	45.5431667	45.5431667	16.39
M 2.6	Oregon	03/28/97	1.31 km (0.81 mi)	45.2005	45.2005	48.71
M 2.6	Oregon	03/26/97	4.38 km (2.72 mi)	45.9848333	45.9848333	38.68
M 3.1	Oregon	03/23/97	16.98 km (10.55 mi)	45.2463333	45.2463333	46.23
M 3.1	Oregon	03/23/97	-0.67 km (-0.41 mi)	45.1951667	45.1951667	48.73
M 3.9	Oregon	03/22/97	0.15 km (0.09 mi)	45.1973333	45.1973333	49.24
M 2.7	Oregon	03/22/97	-0.67 km (-0.41 mi)	45.214	45.214	48.64
M 2.5	Oregon	03/21/97	2.30 km (1.43 mi)	45.6435	45.6435	7.62
M 2.7	Oregon	01/02/97	9.45 km (5.87 mi)	45.8493333	45.8493333	44.22
M 2.9	Oregon	02/13/96	1.82 km (1.13 mi)	45.53	45.53	17.15
M 3.1	Washington	11/02/95	20.87 km (12.97 mi)	46.15	46.15	25.45
M 2.9	Oregon	09/03/95	12.57 km (7.81 mi)	45.902	45.902	41.65
M 3.1	Washington	08/29/95	14.72 km (9.15 mi)	46.2081667	46.2081667	37.73
M 3.3	Washington	06/12/95	0.56 km (0.35 mi)	46.4045	46.4045	41.07
M 2.7	Oregon	11/17/94	-0.63 km (-0.39 mi)	45.7011667	45.7011667	39.01
M 2.7	Oregon	10/06/94	0.65 km (0.41 mi)	45.6806667	45.6806667	38.56
M 2.6	Oregon	09/25/94	7.50 km (4.66 mi)	45.5305	45.5305	10.01
M 2.9	Oregon	09/22/94	-0.62 km (-0.38 mi)	45.6915	45.6915	38.43
M 2.6	Washington	05/27/94	15.01 km (9.32 mi)	46.1486667	46.1486667	45.62
M 2.9	Oregon	12/18/93	2.88 km (1.79 mi)	45.1918333	45.1918333	49.71
M 2.8	Oregon	09/23/92	5.51 km (3.42 mi)	45.975	45.975	36.90

Magnitude	Location	Date	Depth	Latitude	Longitude	Proximity from Project Site Boundary (miles)
M 3.9	Oregon	08/07/92	-0.03 km (-0.02 mi)	45.8603333	45.8603333	10.96
M 2.8	Oregon	08/06/92	-0.31 km (-0.19 mi)	46.0028333	46.0028333	37.42
M 4.1	Oregon	07/14/92	11.02 km (6.85 mi)	45.9926667	45.9926667	40.79
M 2.5	Oregon	03/10/92	21.62 km (13.43 mi)	44.843	44.843	47.51
M 3.3	Oregon	12/15/91	7.56 km (4.70 mi)	45.9945	45.9945	40.07
M 4.3	Oregon	11/28/91	9.05 km (5.63 mi)	45.9895	45.9895	40.35
M 2.5	Oregon	08/14/91	4.25 km (2.64 mi)	46.0031667	46.0031667	39.88
M 2.8	Oregon	04/20/91	12.63 km (7.84 mi)	45.3445	45.3445	45.30
M 2.5	Washington	04/04/91	9.36 km (5.81 mi)	46.0818333	46.0818333	26.09
M 2.5	Washington	03/25/91	20.85 km (12.95 mi)	46.1248333	46.1248333	30.10
M 2.5	Washington	12/17/90	-0.56 km (-0.35 mi)	46.0318333	46.0318333	48.83
M 2.5	Washington	08/18/90	1.37 km (0.85 mi)	46.0111667	46.0111667	44.87
M 2.6	Oregon	08/15/90	21.42 km (13.31 mi)	45.2555	45.2555	17.98
M 2.6	Oregon	08/10/90	6.31 km (3.92 mi)	45.961	45.961	42.36
M 2.5	Washington	06/18/90	4.72 km (2.93 mi)	46.0186667	46.0186667	40.67
M 2.7	Oregon	08/18/89	5.57 km (3.46 mi)	45.2745	45.2745	42.55
M 2.5	Washington	04/03/89	1.33 km (0.83 mi)	46.4868333	46.4868333	46.76
M 3.1	Washington	03/27/89	11.57 km (7.19 mi)	45.8158333	45.8158333	42.67
M 2.6	Oregon	02/21/89	-0.62 km (-0.38 mi)	45.7388333	45.7388333	31.66
M 2.6	Washington	02/10/89	-0.63 km (-0.39 mi)	46.1138333	46.1138333	37.80
M 2.8	Washington	01/27/89	9.70 km (6.03 mi)	46.0403333	46.0403333	29.18
M 2.5	Oregon	11/21/88	0.90 km (0.56 mi)	45.2696667	45.2696667	41.49
M 2.6	Oregon	10/19/88	19.40 km (12.05 mi)	45.1396667	45.1396667	25.97
M 3.5	Washington	09/29/88	13.25 km (8.23 mi)	45.8498333	45.8498333	42.69

Magnitude	Location	Date	Depth	Latitude	Longitude	Proximity from Project Site Boundary (miles)
M 2.8	Washington	08/26/88	2.83 km (1.76 mi)	46.0705	46.0705	27.81
M 2.7	Oregon	08/18/88	-0.67 km (-0.41 mi)	45.224	45.224	49.06
M 2.5	Oregon	08/06/88	-0.63 km (-0.39 mi)	45.435	45.435	31.56
M 2.6	Oregon	07/23/88	-0.66 km (-0.41 mi)	45.2601667	45.2601667	48.62
M 2.9	Oregon	07/11/88	-0.67 km (-0.42 mi)	45.2446667	45.2446667	49.66
M 2.5	Washington	03/18/88	-0.41 km (-0.26 mi)	46.3505	46.3505	37.35
M 2.6	Washington	03/18/88	0.14 km (0.09 mi)	46.3501667	46.3501667	37.32
M 2.7	Oregon	02/20/88	13.51 km (8.39 mi)	45.2163333	45.2163333	49.65
M 2.5	Oregon	02/14/88	16.02 km (9.96 mi)	45.577	45.577	39.19
M 2.7	Oregon	09/29/87	19.39 km (12.05 mi)	45.1761667	45.1761667	49.80
M 3.1	Oregon	09/08/87	12.46 km (7.74 mi)	45.1911667	45.1911667	49.71
M 2.6	Oregon	12/08/86	19.03 km (11.83 mi)	45.9766667	45.9766667	16.89
M 2.5	Oregon	11/10/86	14.55 km (9.04 mi)	45.1996667	45.1996667	46.29
M 3.2	Washington	02/04/86	7.47 km (4.64 mi)	46.044	46.044	25.12
M 2.6	Oregon	12/26/85	3.45 km (2.14 mi)	45.9885	45.9885	36.01
M 2.9	Washington	12/03/85	1.16 km (0.72 mi)	46.1655	46.1655	27.16
M 2.8	Washington	10/27/85	1.97 km (1.22 mi)	46.3988333	46.3988333	40.68
M 2.5	Washington	10/27/85	0.93 km (0.58 mi)	46.4095	46.4095	41.43
M 2.6	Oregon	08/02/85	-0.53 km (-0.33 mi)	45.443	45.443	34.07
M 3.9	Oregon	02/10/85	18.07 km (11.23 mi)	45.7045	45.7045	13.14
M 3.1	Oregon	06/18/84	9.75 km (6.06 mi)	45.2308333	45.2308333	27.41
M 2.7	Oregon	06/06/84	5.88 km (3.65 mi)	45.974	45.974	35.04
M 2.8	Washington	04/30/84	-0.51 km (-0.32 mi)	46.0405	46.0405	29.14
M 2.6	Washington	04/13/83	6.16 km (3.83 mi)	46.0386667	46.0386667	47.94

Magnitude	Location	Date	Depth	Latitude	Longitude	Proximity from Project Site Boundary (miles)
M 3.8	Oregon	03/22/83	7.20 km (4.47 mi)	45.992	45.992	37.07
M 2.6	Washington	07/10/81	2.05 km (1.28 mi)	46.2958333	46.2958333	49.75
M 2.8	Washington	12/18/80	-0.39 km (-0.24 mi)	45.833	45.833	30.46
M 2.6	Washington	03/12/80	2.76 km (1.72 mi)	46.1246667	46.1246667	23.50
M 2.6	Washington	03/04/80	-0.44 km (-0.28 mi)	45.94	45.94	16.72
M 2.5	Washington	09/08/79	3.79 km (2.35 mi)	46.4896667	46.4896667	48.96
M 4.3	Oregon	04/08/79	7.56 km (4.70 mi)	45.9913333	45.9913333	37.19
M 3.6	Washington	02/17/79	17.67 km (10.98 mi)	46.1641667	46.1641667	36.50
M 2.8	Washington	03/04/78	13.04 km (8.10 mi)	46.0603333	46.0603333	24.29
M 2.9	Washington	03/31/77	-0.48 km (-0.30 mi)	45.9018333	45.9018333	14.97
M 3.1	Washington	03/11/77	-0.51 km (-0.32 mi)	45.8991667	45.8991667	15.39
M 2.9	Oregon	07/26/76	3.45 km (2.14 mi)	45.6468333	45.6468333	29.89
M 3.1	Washington	07/23/76	-0.25 km (-0.16 mi)	46.0853333	46.0853333	29.18
M 3.2	Oregon	07/07/75	7.70 km (4.78 mi)	45.951	45.951	42.45
M 3.5	Oregon	07/01/75	5.00 km (3.11 mi)	45.628	45.628	31.46
M 3.6	Oregon	07/01/75	14.85 km (9.23 mi)	45.6053333	45.6053333	32.45
M 2.7	Washington	06/28/75	8.86 km (5.51 mi)	46.0921667	46.0921667	25.90
M 3.8	Washington	06/28/75	10.47 km (6.51 mi)	46.099	46.099	25.78
M 3.3	Washington	06/28/75	8.84 km (5.49 mi)	46.1053333	46.1053333	26.05
M 3.1	Washington	06/15/75	1.34 km (0.83 mi)	46.234	46.234	29.67
M 2.8	Oregon	05/22/75	24.85 km (15.44 mi)	45.3785	45.3785	38.31
M 2.8	Washington	05/22/75	1.61 km (1.00 mi)	46.3918333	46.3918333	40.22
M 2.7	Oregon	05/09/75	-0.38 km (-0.23 mi)	45.633	45.633	21.35
M 2.8	Washington	05/09/75	0.85 km (0.53 mi)	46.431	46.431	42.90

Magnitude	Location	Date	Depth	Latitude	Longitude	Proximity from Project Site Boundary (miles)
M 2.8	Washington	12/29/73	10.56 km (6.56 mi)	46.0488333	46.0488333	21.63
M 2.5	Washington	12/09/72	1.81 km (1.13 mi)	46.4188333	46.4188333	42.93
M 2.6	Washington	12/09/72	2.01 km (1.25 mi)	46.4188333	46.4188333	42.94
M 2.5	Oregon	08/27/72	-0.46 km (-0.29 mi)	45.5328333	45.5328333	33.95
M 2.6	Oregon	08/21/72	6.79 km (4.22 mi)	45.5751667	45.5751667	31.73
M 2.9	Washington	11/14/70	1.17 km (0.73 mi)	46.4298333	46.4298333	42.79
M 2.9	Washington	11/07/70	0.17 km (0.11 mi)	46.442	46.442	43.64
M 2.5	Oregon	09/29/70	19.38 km (12.04 mi)	45.7605	45.7605	1.48
M 2.5	Washington	08/31/69	2.41 km (1.50 mi)	46.4291667	46.4291667	42.75
M 2.6	Washington	07/31/69	5.42 km (3.37 mi)	46.4185	46.4185	42.02
M 2.8	Washington	04/19/69	-0.32 km (-0.20 mi)	45.8975	45.8975	17.01
Source: USGS Geological Hazards Science Center, U.S. Quaternary Faults and Folds Database						

Attachment H-5. Ground Response Spectra Assessment – Site Class D

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Design Maps Summary Report

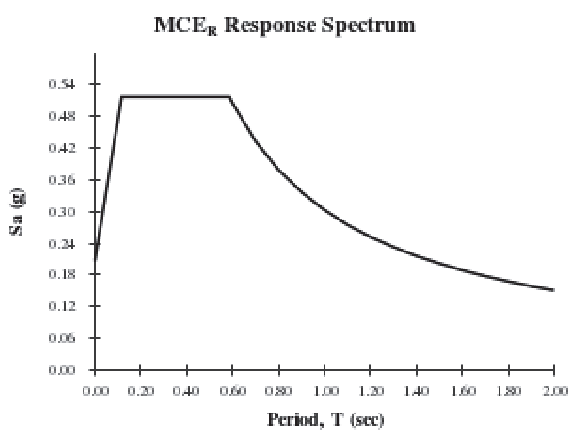
User–Specified Input

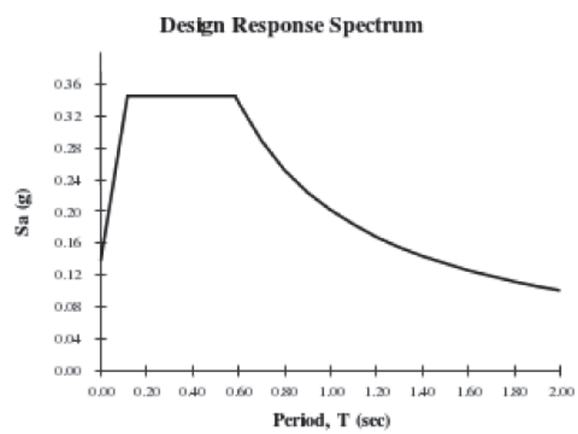
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	45.59136°N, 118.99729°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

$S_S =$	0.338 g	$S_{MS} =$	0.517 g	$S_{DS} =$	0.345 g
$S_1 =$	0.134 g	$S_{M1} =$	0.303 g	$S_{D1} =$	0.202 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





Attachment H-6. Ground Response Spectra Assessment – Site Class C

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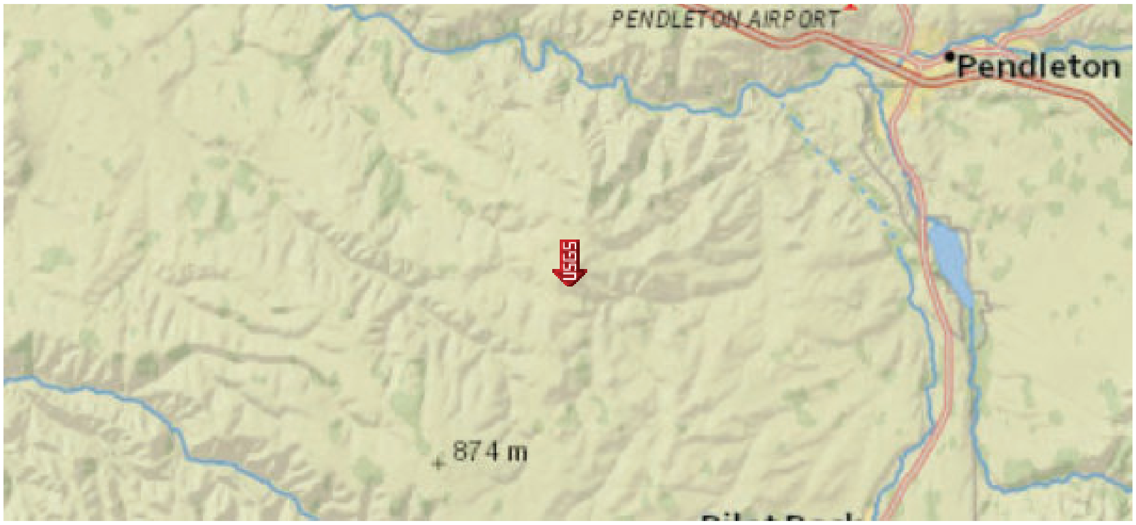
Design Maps Summary Report

User–Specified Input

Report Title	Nolin Hills Thu July 26, 2018 21:41:47 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	45.59136°N, 118.99729°W
Site Soil Classification	Site Class C – "Very Dense Soil and Soft Rock"
Risk Category	I/II/III



USGS–Provided Output

$S_S =$ 0.338 g	$S_{MS} =$ 0.405 g	$S_{DS} =$ 0.270 g
$S_1 =$ 0.134 g	$S_{M1} =$ 0.223 g	$S_{D1} =$ 0.149 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.