2.15 Protection from Natural Hazards

WAC 463-42-265 Proposal - Protection from natural hazards. *The applicant shall describe the means employed for protection of the facility from earthquakes, volcanic eruption, flood, tsunami, storms, avalanche or landslides, and other major natural disruptive occurrences*

Introduction
Natural hazards that reasonably could be expected to occur at the Project site include geologic hazards, such as seismic hazards (earthquakes), volcanic eruptions, and landslides. Floods and tsunami's are not hazards to the site because of the Projects high elevation on ridgelines. The following section describes the types of potential natural hazards that could occur in the area, the probability of the event occurring at the Project site, and the measures used to protect the Project from the hazard. Other natural hazards that could occur in the Project area include wildfires. A discussion of the measures used to protect the Project from wildfires is presented in Section 5.3, 'Public Services and Utilities'. Because Project facilities would be located significantly outside the floodplain of the Yakima River (the closest road or turbine location to the Yakima River is more than 500 feet in elevation above the level of river) and other water bodies, the risk of flood impacts is insignificant and is therefore not discussed here.

2.15.1 Seismic Hazards

The seismic hazards in the region results from three seismic sources: interplate events, intraslab events, and crustal events. Each of these events has different causes, and, therefore, produces earthquakes with different characteristics (peak ground accelerations, response spectra, and duration of strong shaking).

Two of the potential seismic sources are related to the subduction of the Juan De Fuca plate beneath the North American plate. Interplate events occur as a result of movement at the interface of these two tectonic plates. Intraslab events originate in the subducting tectonic plate, away from its edges, when built-up stresses in the subducting plate are released. These source mechanisms are referred to as the Cascadia Subduction Zone (CSZ) source mechanism. The CSZ originates off the coast of Oregon and Washington and subducts beneath both states. The two source mechanisms associated with the CSZ currently are thought to be capable of producing moment magnitudes of approximately 9.0 and 7.5, respectively (Geomatrix, 1995).

Earthquakes caused by movements along crustal faults, generally in the upper 10 to 15 miles, result in the third source mechanism. In Washington, these movements occur on the crust of the North American tectonic plate when built-up stresses near the surface are released. According to the Washington Division of Geology and Earth Resources (WDGER), all earthquakes recorded in eastern Washington have been shallow, with most measured at depths less than 3.7 miles. The largest earthquake in eastern Washington since 1969 was a shallow, magnitude 4.4 event northwest of Othello on December 20, 1973 (WDGER, 2002).

2.15.2 Historical Seismicity and Earthquake Risk and Probability

To provide background on the magnitude and location of earthquakes in the vicinity of the Project site, three earthquake databases managed by the U.S. Geological Survey (USGS) National Earthquake Information Center were searched to identify historical seismic events that have occurred within 60 miles of the Project site (USGS, 2001a). The databases searched were "USGS/NEIC 1973-Present," "Significant U.S. Earthquakes (1568-1989)," and "Eastern, Central, and Mountain States of U.S., 1534-1986." These searches identified 73 seismic events of all magnitudes and intensities that occurred between 1887 and 2000. Table 2.15.2-1 identifies only those seismic events that meet the following criteria:

- Magnitude and/or intensity data are available;
- The magnitude of the event is 3.0 or higher;
- The intensity using the Modified Mercalli (MM) Intensity Scale of the event is III or higher, or the event was actually "felt." For reference, an intensity of MM III is associated with shaking that is "felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake" (USGS, 2002) In comparison a event with an intensity of MM VII would produce the follow effects "Damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars"(USGS, 2002);
- The seismic event was not an aftershock associated with a larger quake at the same location.

Table 2.15.2-1
Historical Seismic Events That Have Occurred Within 60 miles of the Project Site[1]

Year	Month	Day	Latitude (° North)	Longitude (° West)	Magnitude[2]	Intensity[3] or felt (F)	Miles from the Project Site
1959	08	06	47.82	120.00	4.4	VIF	54
1966	07	23	47.02	119.50	4.3	V	56
1969	10	09	46.90	121.60	4.4	V	56
1973	12	20	46.94	119.25	4.8	--F	55
1974	4	20	46.76	121.52	4.9	VF	55
1974	7	14	47.6	120.7	3.3	IV	43
1975	4	10	46.93	121.59	3.7	--	55
1975	4	18	46.94	121.64	3.9	IIIF	57
1977	7	13	47.06	120.96	3.6	VF	25
1978	6	27	46.86	120.96	3.7	IIF	27
1979	7	28	46.66	120.66	3.1	IVF	25
1979	12	10	46.7	120.6	3.2	VF	22
1981	2	2	46.28	120.88	4	IVF	53
1981	2	18	47.21	120.9	4.2	VID	27
1981	5	28	46.53	121.42	4.3	--F	57
1981	5	28	46.53	121.42	4.8	IVF	57
1982	1	23	46.55	121.41	3.5	--	56
1983	11	14	46.66	120.57	3.1	VF	24
1983	12	5	46.93	120.7	3.3	IIIF	14
1984	4	11	47.54	120.16	3.6	V	39
1985	1	9	47.06	120.06	3.2	--	17
1985	6	17	47.06	120.05	3.3	--	17
1987	6	11	46.82	120.59	3	--	14
1987	12	2	46.67	120.68	4.1	VF	25
1987	12	2	46.68	120.67	4.3	IVF	25
1988	2	6	47.67	120.02	3	--F	49
1988	5	5	47.65	120.32	3.3	IIIF	45
1988	5	28	46.81	119.43	3.5	--	48
1988	7	9	46.84	119.69	3.7	--	36
1988	7	14	46.89	119.41	3.3	--	48
1990	3	1	47.77	120.96	3.1	--	59
1990	4	22	46.54	119.73	3.3	--	45

Table 2.15.2-1
Historical Seismic Events That Have Occurred Within 60 miles of the Project Site[1]

Year	Month	Day	Latitude (° North)	Longitude (° West)	Magnitude[2]	Intensity[3] or felt (F)	Miles from the Project Site
1990	6	19	46.84	119.32	3.3	--	53
1990	12	15	46.8	119.99	3.1	--	24
1990	12	22	46.8	119.99	3.4	--	24
1991	2	1	46.81	120.56	3.4	--	14
1991	2	22	46.87	120.65	3.2	--	14
1991	2	26	46.72	119.88	3	--	32
1991	3	28	47.68	120.33	3.3	IVF	47
1991	7	6	46.94	120.34	3.4	--	6
1991	7	7	46.93	120.34	3.3	--	6
1991	11	24	47.6	120.24	3.2	--	42
1992	1	24	47.66	120.13	3.4	IIIF	47
1992	10	26	46.86	120.72	3.5	VF	17
1994	4	1	47.66	120.14	3	-F	47
1994	6	18	47.62	121.27	4.3	VF	58
1994	6	25	46.87	119.31	3	--	53
1994	8	7	47.66	120.17	3.1	--	47
1994	11	13	46.59	119.59	3.3	--	48
1995	1	13	46.58	120.71	3.2	--	32
1995	3	9	47.19	120.95	3	--	28
1995	6	30	47.11	120.5	3	--	9
1995	8	29	46.21	119.91	3.1	--	60
1995	12	17	47.6	120.22	3.1	--	42
1996	6	25	47.2	119.51	3	--	45
1997	1	1	46.77	120.46	3.7	--	16
1997	5	27	46.83	119.36	3.3	--	51
1997	7	4	47.72	120.02	3.6	--F	53
1997	9	3	47.69	120.27	3.3	--	48
1997	9	18	47.69	120.02	3.3	--	51
1997	11	6	46.53	119.71	3.3	--	46
1997	11	18	46.14	120.47	3.8	--F	59
1997	11	18	46.14	120.46	3.3	--	59
1998	10	9	46.2	120.71	4	--	57
1998	10	10	46.2	120.7	3.2	--	57
1999	9	19	46.44	119.63	3.1	--	53
1999	9	19	46.39	120.11	3.2	--	44
1999	12	25	47.63	120.2	3	--	45
2000	12	24	47.74	120.28	3.5	IVF	52
2001	2	28	47.75	120.03	3.2	IIIF	55
2001	5	11	47.23	119.35	3.3	--	53
2002	6	6	47.72	120.29	3.4	--F	50

[1]The approximate center of the Project site is located at latitude 147° 08' 52" N, longitude 120° 42' 39" W.
[2] Magnitude values calculated by the U.S. Geological Survey (see http://eqint.cr.usgs/neic/cgi-bin/epic.awk).
[3] Maximum intensity on the Modified Mercalli Intensity Scale of 1931.

According to the Uniform Building Code Seismic Risk Map of the United States, the Project site, along with all of eastern Washington and Eastern Oregon, is located in Seismic Zone 2B. This corresponds to an intensity VII earthquake of the MM Scale, which can produce moderate damage, should one occur. However, in comparison to Alaska and California Seismic Zone 2B is a relatively low hazard zone.

An earthquake magnitude of 5.5 to 6.0 was selected as being the dominating event at the Project site. The earthquake magnitude selected for the Project site was based on USGS deaggregation seismic hazard mapping for the Umatilla, Oregon, and Walla Walla, Washington, areas. These locations were selected as the closest locations with available data that are representative of the Ellensburg, Washington area's seismology. The USGS seismic hazard maps present the average magnitude of all potential sources at a given location, and provide the percent contribution at discrete locations of the overall seismic hazard. However, as shown in Table 2.15.2-1, seismograph records since 1959 indicate the Project area itself has been essentially a-seismic in historical time. The closest recorded seismic event with a magnitude of 3.0, or MM intensity of III or greater, had an epicenter about 5.6 miles from the Project site. The largest recorded seismic event occurred 56.5 miles from the Project site and had a magnitude of 4.9.

Seismic ground acceleration for the Project site was determined according to the National Earthquake Hazards Reduction Program (NEHRP) maps for probabilistic ground motion (FEMA, 1997), and the USGS National Seismic Hazard Mapping Project database. One of the values generally used to determine an earthquake's relation to building damage is peak ground acceleration (PGA). According to USGS, a PGA of 0.10 g (g equals the acceleration as a result of gravity) may be the approximate threshold of damage to older (pre-1965) dwellings or dwellings not made to resist earthquakes. In comparison, some post-1985 dwellings, built to California earthquake standards, have experienced severe shaking (0.60 g) with only chimney damage and damage to dwelling contents.

The PGA at the site corresponding to a 10 percent probability of exceedance in 50 years (approximately 500-year return period) is between 0.119 g and 0.121 g at the bedrock surface. This value of PGA on rock is an average representation of the acceleration most likely to occur at the site for all seismic events (crustal, intraplate, or subduction) for the 500-year return period.

2.15.3 Earthquake Hazard Protection Measures

The State of Washington's current regulations for design use the 1997 Uniform Building Code (UBC). Pertinent design codes as they relate to geology, seismicity, and near surface soils are in Chapter 16, Divisions IV and V, Earthquake Design and Soil Profile Types, respectively (UBC, 1997). All facilities for the Project must be designed to at least these minimum standards.

Current engineering standards (that is, UBC) will be used in the design of the Project facilities. These standards require that under the design earthquake, the factors of safety or resistance factors used in design exceed certain values. This factor of safety is introduced to account for uncertainties in the design process and to ensure that performance is acceptable. Application of the UBC in Project design will provide adequate protection for the Project facilities and ensure protection measures for human safety, given the relatively low level of risk for the site.

As noted in Section 3.1.2, 'Geology', the only fault that crosses the Project site, crosses under the H, I, and J turbine strings (Exhibit 6). Given the lack of evidence of late Quaternary surface displacement along the fault, and geologic evidence that Holocene displacement has not occurred, this fault is not considered to pose a significant hazard to the proposed Project and further investigation or other mitigation measures are not warranted.

The Project area is not generally susceptible to liquefaction or lateral spreading. This is because liquefaction and lateral spreading require saturated soils. The Project would be located in the unsaturated uplands, above the water table, with rainfall. In addition, the probability of a significant earthquake event occurring during the construction activities is extremely remote. Seismic impacts hazard during construction is negligible. The probability that the crustal faults in the Project area are active is relatively low, and, therefore, the potential for fault offsets during a large earthquake also appears to be low.

2.15.4 Volcanic Hazards

Within the State of Washington, the USGS recognizes five volcanoes as either active or potentially active: Mount Baker, Glacier Peak, Mount Rainier, Mount Adams, and Mount St. Helens. In the last 200 years, only Mount St. Helens has erupted more than once (USGS, 2000a). Impacts to the Project from volcanic activity can be either direct or indirect.

Direct impacts include the effects of lava flows, blast, ash fall, and avalanches of volcanic products (Waldron, 1989). Indirect effects include mudflows, flooding, and sedimentation (Waldron, 1989). Data accumulated as a result of the 1980 Mount St. Helens eruption indicates that there could be ash fallout in the geographic region surrounding the Project site if one of the five regional volcanoes were to erupt.

In the event that a volcanic eruption would damage or impact Project facilities, the Project facilities would be shut down until safe operating conditions return. If an eruption occurred during construction, a temporary shutdown would most likely be required to protect equipment and human health.

2.15.5 Landslide Potential and Avoidance

Project facilities would not be located on unstable slopes or landslide-prone terrain. The turbine structures would be located on relatively flat ground and, therefore, sliding of the soil and alluvial materials is not expected to be a design consideration for these structures, as the geometry of slope movement is not expected to be greater than the setback distance. Unstable areas prone to landslides as a result of seismic events would require steep slopes exceeding 10 feet in height, comprised of thick soils.

In addition, the Project is located in areas with a relatively thin veneer of soil covering consolidated alluvium and basaltic rock. Areas of steep slopes exceeding 10 feet in height and comprised of thick soils generally are not present at the Project site. Therefore, risk of a seismically induced landslide in the soils and rock is minimal. Furthermore, observations of near surface (less than 10 feet in depth) site stratigraphy conducted during a geotechnical investigation, and visual observations of the landscape and surface geology in the immediate Project area, indicate that potential landslide-prone terrain is not visually apparent on the Project site.

In the event that facilities such as roads are constructed below slopes steeper than 21 to 30 degrees, soil movement and rock fall from alluvium overburden exposed along road cut banks could impact these roads if the cut bank slope were to fail (i.e., during an earthquake.) However, the proposed site layout does not include any roads below such steep slopes. Furthermore, because Project access roads are used infrequently, the risk associated with rock fall and/or slope movement to a vehicle and driver is low.

2.15.6 Erosion Potential and Storm Design

Impacts to the geologic formations during construction would be moderate to low. The Project would alter the landscape with minor cuts-and-fills for roadways and leveling for turbine foundations. These alterations would result in minimal impact to existing topography and surface drainage and not cause any significant change.

Because the construction of roads, turbine foundations and other Project facilities would be engineered, these facilities would be subject to the requirements of a National Pollutant Discharge Elimination System (NPDES) storm water construction permit and other pertinent construction and project operation permits and pollution control regulations. These regulations would require the development of an erosion control plan and implementation of erosion control best management practices (BMPs) during Project construction and operation. As a result, it is likely that Project facilities would be constructed with more protections against erosion than existing farm roads in the Project area. (A more detailed discussion of Surface Water Runoff and Stormwater Management is found in Section 2.10, 'Surface Water Runoff'.)

A detailed construction Storm Water Pollution Prevention Plan (SWPPP) will be developed for the Project to help minimize the potential for discharge of pollutants from the site during construction activities. The SWPPP will be designed to meet the requirements of the Washington State Department of Ecology General Permit to Discharge Storm water through its storm water pollution control program (Chapter 173-220 WAC) associated with construction activities.

The SWPPP will include both structural and non-structural best management practices (BMPs). Examples of structural BMPs could include the installation of silt curtains and/or other physical controls to divert flows from exposed soils, or otherwise limit runoff and pollutants from exposed areas of the site. Examples of non-structural BMPs include management practices such as implementation of materials handling, disposal requirements and spill prevention methods.

The SWPPP will be prepared along with a detailed Project grading plan design by the Engineering, Procurement and Construction (EPC) Contractor when design level topographic surveying and mapping is prepared for the Project site. Implementation of the construction BMPs is carried out by the EPC Contractor, with enforcement supervised by the Project's resident Site Environmental Protection Manager (SEPMA) who will be responsible for implementing the SWPPP.

Site-specific BMPs will be identified on the construction plans for the site slopes, construction activities, weather conditions, and vegetative buffers. The sequence and methods of construction activities will be controlled to limit erosion. Clearing, excavation, and grading will be limited to the minimum areas necessary for construction of the Project. Surface protection measures, such as erosion control blankets or straw matting, also may be required prior to final disturbance and restoration if potential for erosion is high.

All construction practices will emphasize erosion control over sediment control through such non-quantitative activities as:

- Straw mulching and vegetating disturbed surfaces;
- Retaining original vegetation wherever possible;
- Directing surface runoff away from denuded areas;
- Keeping runoff velocities low through minimization of slope steepness and length; and
- Providing and maintaining stabilized construction entrances.

A more detailed description of the materials, methods and approaches used as part of the BMP for effective storm water pollution prevention and erosion control is provided in Section 2.10, 'Surface Water Runoff'.

2.15.7 Rain Level Monitoring

The SEPMA shall be responsible for checking and recording precipitation levels at the Project site using a rain gauge. This benchmark will be used to determine the performance of the SWPPP measures that have been implemented during construction. After construction, the O&M group will also continue to monitor rainfall amounts and monitor the in-place erosion control systems while re-seeded areas become more established. Modifications and additional landscaping will be performed where needed by the O&M group after Project turnover.