

Appendix C

Additional Information on Geology and Seismicity in the Project Vicinity

Table C-1 Historic Earthquakes in Washington and Oregon

Date	Name/Location	Depth	Magnitude/Maximum Modified Mercalli Intensity ^a
Earthquakes Within 100 Miles of Project Site (Magnitude => 4.0)			
March 6, 1893	Umatilla, Oregon	Shallow	4.7 / VII
November 1, 1918	Corfu, Washington	Shallow	4.4 / V or VI
July 15, 1936	Milton-Freewater	Shallow	6.4 / VII
December 20, 1973	Royal Slope, Washington	Shallow	4.4 ^b / V
Large Earthquakes (Magnitude => 5.0) in Washington and Oregon			
December 14, 1872	North Cascades	Shallow	7.3 / IX
December 12, 1880	Puget Sound	NA	NA / VII
November 29, 1891	Puget Sound	NA	NA / VII
January 3, 1896	Puget Sound	NA	5.7 / VII
March 16, 1904	East Olympic Peninsula	NA	5.3 / VII
January 11, 1909	Puget Sound	Deep	6.0 / VII
August 18, 1915	North Cascades	NA	5.6 / VI
January 23, 1920	Puget Sound	NA	5.5 / VII
July 17, 1932	Central Cascades	Shallow	5.2 / VII
November 12, 1939	Puget Sound	Deep	5.75 ^b / VII
April 29, 1945	Central Cascades	NA	5.5 ^b / VII
February 14, 1946	Puget Sound	Moderate	6.3 ^b / VII
April 21, 1949	Olympia, Washington	Deep	7.1 ^b / VIII
August 5, 1959	East North Cascades	Moderate	5.0 ^b / VI
April 29, 1965	Puget Sound	Deep	6.5 ^b / VIII
February 13, 1981	South Cascades	Shallow	5.5 ^b / VII
March 25, 1993	Scott Mills, Oregon	Shallow	5.6 ^b / VII
May 2, 1996	Duvall, Washington	Shallow	5.3 ^b / NA
February 28, 2001	Nisqually, Washington	Deep	6.8 ^b / NA
^a The Modified Mercalli Intensity is a measure of the intensity of ground shaking at a particular site, and is determined from reports of human reaction to shaking, damage to structures, and other effects (Noson et al. 1988). The range of values is from I (not felt) to XII (damage nearly total).			
^b These magnitudes are measured by instrument. Previous magnitudes are estimated based on felt area. NA = not available			

Table C-2. Soils at the Plant Site and Pipeline Laterals

Map Symbol	Soil Series	Texture	Slope (%)	Drainage	Erosion Hazard	Erosion Factor "K" ^a	Wind Erosion Group ^b	Permeability (inches/hour)	pH	Prime Agricultural Land
Ac	Active Dunes	Sand and fine sand		Excessively drained	High	0.15	1	5–10		No
AfC2	Adkins	Loamy fine sand, eroded	0–15	Well to excessively drained	High	0.37	2	5–10	Moderate to strongly alkaline	No
HoC2	Hezel	Loamy fine sand, eroded	0–15	Somewhat excessively drained	High	0.32	2	2.5–5	Alkaline	No
Hp2	Hezel-Quincy	Fine sand, segregated, eroded	NA	NA	High	0.32	1	2.5–5		No
QcB2	Quincy Complex	Fine sand and loamy fine sand over coarse sand and gravel, eroded	0–8	Somewhat excessively to excessively drained	High	0.32	1-2	5–10		No
Qd	Quincy-Dune-land Complex	Fine sand	NA	Excessively drained	High	0.32	1	5–10		No
QfD2	Quincy	Fine sand, eroded	0–30	Excessively drained	High	0.32	1	5–10	Neutral to mildly alkaline	No
QmB2	Quincy	Loamy fine sand over coarse sand, eroded	0–8	Somewhat excessively drained	High	0.32	2	5–10	Mildly to strongly alkaline	No

Map Symbol	Soil Series	Texture	Slope (%)	Drainage	Erosion Hazard	Erosion Factor "K" ^a	Wind Erosion Group ^b	Permeability (inches/hour)	pH	Prime Agricultural Land
QnB2	Quincy	Loamy fine sand over gravel, eroded	0-8	Somewhat excessively drained	High	0.32	2	5-10	Mildly to strongly alkaline	No
QuB2	Quincy	Loamy fine sand, eroded	0-8	Somewhat excessively drained	High	0.32	2	5-10	Mildly to moderately alkaline	No
QuC2	Quincy	Loamy fine sand, eroded	8-15	Somewhat excessively drained	High	0.32	2	5-10	Mildly to moderately alkaline	No

Notes:

^a K values range from 0.05 to 0.69. Higher values indicate more erosion susceptibility.

^b See Table C-4 for Wind Erosion Groups. Group 1 is the most susceptible to wind erosion, with higher numbered groups increasingly less susceptible.

NA= Not available

Source: Soil Survey of Walla Walla County, Washington (USDA 1964)

Table C-3. Soils along the Transmission Line Right-of-Way

Map Symbol	Soil Series	Texture	Slope (%)	Drainage	Erosion Hazards		Erosion Factor "K" ^a	Wind Erosion Group ^b	Permeability (inch/hr)	Agricultural Land Use Category
					Wind	Water				
Qd	Quincy-duneland complex	50% fine sand, 30% duneland, 20% minor extent	NA	NA	NA	NA	0.17-0.28	1	6 to 20	NA
Ac	Active duneland	Active duneland	NA	NA	NA	NA	0.17-0.28	1	6 to 20	NA
Hp2	Hezel-Quincy complex	50% Hezel, 40% Quincy, eroded	NA	NA	NA	NA	0.24-0.43	2	Hezel 6 to 20, Quincy 0.08-0.12	NA
QfD2	Quincy series	Fine sand, eroded	0 to 30	Very deep, excessively drained	NA	NA	0.17-0.28	1	6 to 20	NA
HoC2	Hezel series	Loamy fine sand, eroded	0 to 15	Very deep, somewhat excessively drained	NA	NA	0.24-0.43	2	0.2 to 6	NA
SmD2	Sagemoor series	Very fine sandy loam, eroded	8 to 15	Very deep, well drained	NA	NA	0.55	3	0.2 to 2	NA
SmB	Sagemoor series	Very fine sandy loam	3 to 8	Very deep, well drained	NA	NA	0.55-0.64	3	0.2 to 2	NA
SmC	Sagemoor series	Very fine sandy loam	8 to 15	Very deep, well drained	NA	NA	0.55-0.64	3	0.2 to 2	NA

Map Symbol	Soil Series	Texture	Slope (%)	Drainage	Erosion Hazards		Erosion Factor "K" ^a	Wind Erosion Group ^b	Permeability (inch/hr)	Agricultural Land Use Category
					Wind	Water				
BcG	Basalt Rockland	Very steep rockland, 60% rock outcrop, 30% Lickskillet	NA	NA	NA	NA	0.17-0.2	8	Rock 0 to 0.01, Lickskillet 0.06 to 0.14	NA
BdF	Basalt Rockland - Walla Walla complex	50% Rock outcrop, 35% Walla Walla soils	30 to 60	NA	NA	NA	0.2-0.49	5	Rock 0 to 0.01, Walla Walla 0.09 to 0.2	NA
SyD	Starbuck Rocky series	70% Starbuck soils, 20% rock outcrop	0 to 30	NA	NA	NA	0.32-0.55	5	Starbuck 0 to 20, Rock 0 to 0.01	NA
FaC	Farrell series	Very fine sandy loam	3 to 15	Very deep, well drained	NA	NA	0.49-0.55	3	0.6 to 2.0	NA
BcD	Basalt Rockland	Undulating to hilly	NA	NA	NA	NA	0.2-0.28	7	Rock 0 to 0.01, Lickskillet 0.06 to 0.14	NA
RtB	Ritzville series	Very fine sandy loam	0 to 8	Very deep, well drained	NA	NA	0.49-0.55	3	0.6 to 2	NA
RiD2	Ritzville series	Silt loam, eroded	8 to 30	Very deep, well drained	NA	NA	0.55	4L	0.6 to 2	NA
RiD	Ritzville series	Silt loam	8 to 30	Very deep, well drained	NA	NA	0.49-0.55	5	0.6 to 2	NA
RiB	Ritzville series	Silt loam	0 to 8	Very deep, well drained	NA	NA	0.49-0.55	5	0.6 to 2	NA

Map Symbol	Soil Series	Texture	Slope (%)	Drainage	Erosion Hazards		Erosion Factor "K" ^a	Wind Erosion Group ^b	Permeability (inch/hr)	Agricultural Land Use Category
					Wind	Water				
RiF	Ritzville series	Silt loam	45 to 60	Very deep, well drained	NA	NA	0.49-0.55	5	0.6 to 2	NA
RtD	Ritzville series	Very fine sandy loam	8 to 30	Very deep, well drained	NA	NA	0.49-0.55	5	0.6 to 2	NA
RiE	Ritzville series	Silt loam	30 to 45	Very deep, well drained	NA	NA	0.49-0.55	5	0.6 to 2	NA
RtF2	Ritzville series	Very fine sandy loam, eroded	30 to 60	Very deep, well drained	NA	NA	0.49-0.55	5	0.6 to 2	NA
79C	Ritzville series	Very fine sandy loam	7 to 12	Deep, well drained	Moderate	Moderate	0.43-0.49	3	Moderate, 10 to 13	Small grain-fallow
79B	Ritzville series	Very fine sandy loam	2 to 7	Deep, well drained	Moderate	Moderate	0.43-0.49	3	Moderate, 10 to 13	Small grain-fallow
79D	Ritzville series	Very fine sandy loam	12 to 25	Deep, well drained	Moderate	High	0.43-0.49	3	Moderate, 10 to 13	Small grain-fallow
79E	Ritzville series	Very fine sandy loam	25 to 50	Deep, well drained	Moderate	High	0.43-0.49	3	Moderate, 10 to 13	Small grain-fallow
50F	Licksillet series	Rock outcrop complex	40 to 70	Shallow, well drained	High	Slight	0.15-0.17	NA	Moderate, 1 to 3	Rangeland and wildlife habitat
85F	Xeric Torriorthents series	Rock outcrop – Xeric Torriorthents complex	10 to 20	Moderately deep to deep, somewhat excessively drained to well drained	High	High	NA	NA	Variable	Rangeland and wildlife habitat

Map Symbol	Soil Series	Texture	Slope (%)	Drainage	Erosion Hazards		Erosion Factor "K" ^a	Wind Erosion Group ^b	Permeability (inch/hr)	Agricultural Land Use Category
					Wind	Water				
75E	Quincy series	Loamy fine sand	5 to 25	Deep, excessively drained	High	Slight	0.17	2	Rapid, 3 to 6	Irrigated cropland rangeland and wildlife habitat
23	Dune land	Eolian sand	0 to 3	Deep, excessively drained	High	Slight	NA	NA	Rapid to very rapid	Wildlife habitat and limited livestock grazing
15B	Burke series	Silt loam	1 to 7	Moderately deep, well drained	Moderate	Moderate	0.43-0.49	4L	Moderate to 26 inches, then very slow to 4 to 8	Small grained-fallow, few areas used for irrigated crops and rangeland
74B	Quincy series	Fine sand	0 to 5	Deep, excessively drained	High	Slight	0.17	1	Rapid, 2.5 to 5	Irrigated cropland pasture and rangeland
123B	Winchester Quincy series complex	Loamy fine sand	0 to 5	Deep, excessively drained	High	Slight	0.1-0.15	1	Rapid, 2.5-3.5 1.5-3	Irrigated cropland pasture and rangeland, and wildlife habitat
93B	Starbuck series	Very fine sandy loam	2 to 20	Shallow, well drained	Moderate	Moderate	0.28-0.43	3	Moderate, 1.5-3.5	Rangeland and wildlife habitat
78B	Quincy series	Rock outcrop	1 to 20	Deep, excessively drained	Moderate	Moderate	0.17	1	Rapid, 3-6	Non-irrigated crops, irrigated crops, rangeland
122B	Winchester series	Sand	0 to 5	Deep, excessively drained	Very high	Slight	0.1-0.15	1	Rapid, 2.5-3.5	Irrigated crops, pasture and rangeland, and wildlife habitat

Map Symbol	Soil Series	Texture	Slope (%)	Drainage	Erosion Hazards		Erosion Factor "K" ^a	Wind Erosion Group ^b	Permeability (inch/hr)	Agricultural Land Use Category
					Wind	Water				
119A	Wanser series	Loamy fine sand	0 to 3	Deep, poorly drained	High	Slight	0.24-0.32	2	Rapid, 3-6	Irrigated crops, pasture and rangeland
3A	Adkins series	Fine sandy loam, wet	0 to 3	Deep well drained soil wet - canal seepage	Moderate	Slight	0.32-0.37	3	Moderately rapid, 8-10	Irrigated crops, pasture, wildlife habitat
94A	Starbuck series	Rock outcrop complex	0 to 5	Shallow, well drained	Moderate	Moderate	0.28-0.43	3	Moderate, 1.5-3.5	Pasture, rangeland and wildlife habitat
1B	Adkins series	Fine sandy loam	0 to 5	Deep, well drained	Moderate	Slight	0.32-0.37	3	Moderate, 8-11	Irrigated crops, nonirrigated crops, pasture, rangeland and wildlife habitat
70	Pits, Gravels	Excavated, waterworn gravel, commonly mixed with sand	NA	Commonly occurs with other units such as the Quincy and Adkins soils	NA	NA	NA	NA	NA	NA – little support offered for vegetation
14B	Burbank series	Loamy fine sand	0 to 5	Deep, excessively drained	High	Slight	0.1-0.24	2	Rapid to 30, and very rapid below 1.5-3.5	Irrigated crops, rangeland, pasture and wildlife habitat
2C	Adkins series	Fine sandy loam, gravelly substratum	0 to 5	Deep, well drained	Moderate	Moderate	0.15-0.32	3	Moderately rapid, 6-9	Irrigated crops, pasture, rangeland and wildlife habitat
Sources: Soil Survey of Umatilla County Area, Oregon (USDA 1984), Soil Survey of Walla Walla County, Washington (USDA 1964)										
^a K values range from 0.05 to 0.69. Higher values indicate more erosion susceptibility.										
^b See Table C-4 for Wind Erosion Groups. Group 1 is the most susceptible to wind erosion with higher numbered groups increasingly less susceptible. NA = Not Available										

Table C-4 Wind Erosion Groups

Group	Soil Description
1	Sand, fine sand, and very fine sand. These soils are extremely erodible and it is difficult to establish vegetation on them.
2	Loamy sand, loamy fine sand, and loamy very fine sand. These soils are very highly erodible.
3	Sandy loam, coarse sandy loam, fine sandy loam, and very fine sandy loam. These soils are highly erodible.
4L	Calcareous loamy soils that are less than 35% clay and more than 5% finely divided calcium carbonates. These soils are erodible.
4	Clay, silty clay, clay loam, and silty clay loam that are more than 35% clay. These soils are moderately erodible.
5	Loamy soils that are less than 20% clay and less than 5% finely divided calcium carbonate and sandy loam and sandy clay that are less than 5 % finely divided calcium carbonate. These soils are slightly erodible.
6	Loamy soils that are 20 to 35% clay and less than 5% finely divided calcium carbonate, except silty clay loam. These soils are very slightly erodible.
7	Silty clay loam that is less than 35% clay and less than 5 % finely divided calcium carbonate. These soils are very slightly erodible.
8	Stony or gravelly soils and other soils not subject to wind erosion.
Source: USDA (1964, 1984)	