

Exhibit H

Geologic and Soil Stability

**Carty Generating Station
October 2026**

Prepared for



Portland General Electric Company

Prepared by



TETRA TECH

This page intentionally left blank

Table of Contents

1.0	Introduction.....	1
2.0	Analysis Area.....	1
3.0	Geologic Report – OAR 345-021-0010(1)(h)(A)	1
3.1	Previous Geotechnical Investigations.....	2
3.1.1	Shannon & Wilson 1975 and 1976	2
3.1.2	Cornforth 2009.....	3
3.1.3	Terracon 2013.....	3
3.1.4	Cornforth 2016.....	3
3.2	Geologic Conditions.....	3
3.2.1	Topographic Setting.....	3
3.2.2	Geologic Setting.....	3
4.0	Evidence of Consultation with DOGAMI – OAR 345-021-0010(1)(h)(B).....	7
5.0	Site-Specific Geotechnical Investigation – OAR 345-021-0010(1)(h)(C).....	7
5.1	Previous Geotechnical Investigations.....	8
5.1.1	Shannon & Wilson 1975 and 1976	8
5.1.2	Cornforth 2009.....	8
5.1.3	Terracon 2013.....	8
5.1.4	Cornforth 2016.....	9
5.2	Future Geotechnical Investigation	9
6.0	Transmission Lines and Pipelines – OAR 345-021-0010(1)(h)(D).....	11
7.0	Seismic Hazard Assessment – OAR 345-021-0010(1)(h)(E)	11
7.1	Methods.....	12
7.2	Maximum Considered Earthquake Ground Motion under IBC 2024.....	12
7.2.1	Earthquake Sources	13
7.2.2	Recorded Earthquakes.....	15
7.2.3	Hazards Resulting from Seismic Events	16
7.2.4	Seismic Shaking or Ground Motion.....	17
7.2.5	Fault Rupture	17
7.2.6	Liquefaction.....	18
7.2.7	Seismically Induced Landslides.....	18
7.2.8	Subsidence	18

7.2.9	Seismic Hazard Mitigation.....	19
8.0	Non-Seismic Geological Hazards – OAR 345-021-0010(1) (h)(F)	19
8.1	Landslides.....	20
8.2	Volcanic Activity	20
8.3	Erosion.....	21
8.4	Flooding.....	21
8.5	Shrinking and Swelling Soils.....	22
8.6	Collapsing Soils.....	22
9.0	Disaster Resilience	23
10.0	Climate Change	24
11.0	Conclusions	24
12.0	References	26

List of Tables

Table H-1.	Stratigraphic Ranges for Subsurface Materials.....	5
Table H-2.	Seismic Design Parameters – Maximum Considered Earthquake	13
Table H-3.	Significant Historical Earthquakes within 50 Miles of the Facility by Magnitude ¹	15

List of Figures

Figure H-1.	Geologic Map
Figure H-2.	Historical Seismicity and Potentially Active Faults
Figure H-3.	Approximate Locations of Previous Geotechnical Investigations
Figure H-4.	Special Flood Hazards and Landslide Hazards

List of Attachments

Attachment H-1.	Record of Correspondence with DOGAMI
Attachment H-2.	Probabilistic Seismic Hazard Deaggregation – 475-Year Return Time
Attachment H-3.	Probabilistic Seismic Hazard Deaggregation – 2,475-Year Return Time
Attachment H-4.	Response Spectrum – Site Class D “Stiff Soil”

Acronyms and Abbreviations

AC	alternating current
ASC	Application for Site Certificate
BESS	battery energy storage system
BCP	Boardman Coal Plant
BMP	best management practice
bgs	below ground surface
Certificate Holder / PGE	Portland General Electric Company
CGS / Facility	Carty Generating Station
Council	Oregon Energy Facility Siting Council
DOGAMI	Department of Geology and Mineral Industries
ESCP	Erosion and Sediment Control Plan
FEMA	Federal Emergency Management Agency
IBC	International Building Code
kV	kilovolt
MW	megawatt
NRCS	Natural Resource Conservation Service
O&M	operations and maintenance
OAR	Oregon Administrative Rules
ODOE	Oregon Department of Energy
OSSC	Oregon Structural Specialty Code
RFA	Request for Amendment
USGS	U.S. Geological Survey

This page intentionally left blank

1.0 Introduction

The Portland General Electric Company (PGE or Certificate Holder) is submitting a Request for Amendment (RFA) 4 to the Site Certificate for the Carty Generating Station (CGS or Facility). The Facility is located approximately 13 miles southwest of Boardman, in Morrow County, Oregon. As currently approved, the Facility is capable of generating up to 450 megawatts (MW) from the natural gas-fueled combined-cycle unit (Unit 1).

In RFA 4, the Certificate Holder is proposing photovoltaic solar energy generation with approximately 200 MW alternating current (AC) of nominal and average generating capacity and BESS with the capability of storing up to 200 MW AC. The overall CGS additions proposed with RFA 4 (including the BESS) are referred to throughout this request as the Carty Solar Farm with proposed RFA 4 changes. The solar generation is proposed in two separate solar areas referred to as the Northern Solar Area, located north of the Carty Reservoir, and the Southern Solar Area, located south of the reservoir [see Figure 2 in RFA 4's Division 27 document (Request for Amendment 4 for the Carty Generating Station)].

Exhibit H provides the information required by Oregon Administrative Rules (OAR) 345-021-0010(1)(h) in support of RFA 4. Analysis in this exhibit incorporates and/or relies on reference information, analysis, and findings found in previous geotechnical investigations performed for the areas within the Amended Site Boundary. The analysis also incorporates and/or relies on information in the Application for Site Certificate (ASC), previous RFAs, and Oregon Department of Energy (ODOE) Final Orders to demonstrate that the Facility, as modified by RFA 4, continues to comply with applicable Site Certificate Conditions and applicable laws, standards, and rules, providing evidence to support findings by the Oregon Energy Facility Siting Council (Council) as required by OAR 345-022-0020.

2.0 Analysis Area

The analysis area for structural standards is the area within the Amended Site Boundary (Figure H-1). The analysis area for historical and potentially active faults and earthquakes includes a 50-mile buffer around the Amended Site Boundary (Figure H-2). The Amended Site Boundary is defined in detail in Section 4.1.1.2 of the RFA 4's Division 27 document (Request for Amendment 4 for the Carty Generating Station).

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

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;

The required geological report is provided through the information in this exhibit, which includes analysis and findings from previous geotechnical investigations performed for areas within the Amended Site Boundary. Current geologic report guidelines were determined based on consultation with the Oregon Department of Geology and Mineral Industries (DOGAMI) as described in Section 4.0 and Attachment H-1. Information previously provided for the Facility in previous geotechnical investigations, the ASC, and prior RFAs has been fully updated in this exhibit to provide current information and in conformance with updated requests from DOGAMI and ODOE. It is noted that in follow-up communication with DOGAMI (Jason McClaughry, DOGAMI, pers. comm., December 19, 2023; Attachment H-1), the request that additional earthquake epicenter information be provided was rescinded.

3.1 Previous Geotechnical Investigations

The following geotechnical investigations have been completed in the vicinity and within the Amended Site Boundary as shown on Figure H-3:

- Geotechnical Investigation Boardman Plant Poverty Ridge Site, Morrow County, Oregon - prepared by Shannon & Wilson, Inc., November 1975 (Shannon & Wilson 1975).
- Supplemental Report - Geotechnical Investigation Boardman Plant Poverty Ridge Site, Morrow County, Oregon - prepared by Shannon & Wilson, Inc., April 1976 (Shannon & Wilson 1976).
- Preliminary Geotechnical Investigation for the Proposed Carty Generating Station, Boardman, Oregon - prepared by Cornforth Consultants, November 11, 2009 (Cornforth 2009).
- Geotechnical Engineering Report, Carty Power Generation Facility, near Boardman, Oregon - prepared by Terracon Consultants, Inc., September 27, 2013 (Terracon 2013).
- Preliminary Geotechnical/Geological Investigations Carty Generating Station - Photovoltaic Solar Facility Project, Boardman, Oregon - prepared by Cornforth Consultants, May 27, 2016 (Cornforth 2016).

3.1.1 Shannon & Wilson 1975 and 1976

The Shannon & Wilson (1975) geotechnical investigation was conducted for the now-retired and demolished Boardman Coal Plant (BCP). The investigation included 34 borings with depths from 14 to 87 feet, laboratory tests, and general geologic research. The Shannon & Wilson (1976) supplemental geotechnical investigation was also conducted for the BCP. The investigation included 15 additional borings and four test pits.

3.1.2 Cornforth 2009

The Cornforth (2009) preliminary geotechnical investigation was conducted for the CGS natural gas-fired power plant to the north of the Carty Reservoir. The scope of work included a site reconnaissance, three borings, laboratory testing, and research relating to geologic/geotechnical issues.

3.1.3 Terracon 2013

The Terracon (2013) geotechnical investigation was for the CGS natural gas-fired power plant to the north of the Carty Reservoir. The study included test borings up to 57 feet in depth, test pit explorations up to 13 feet in depth, infiltration tests to 3 feet, electrical resistivity tests, and seismic shear wave exploration.

3.1.4 Cornforth 2016

The Cornforth (2016) geotechnical investigation was for the Carty Solar Farm installation to the south of the Carty Reservoir and included four borings/piezometer installations, electrical resistivity tests, soils laboratory testing, and general research into seismic and other conditions. Laboratory testing included moisture contents on all soil samples collected; Atterberg limits; grain-size analyses; consolidation tests; collapse potential tests; soil pH tests; sulfate and chloride content tests; and laboratory electrical resistivity tests.

3.2 Geologic Conditions

The topographic and geologic setting within the Amended Site Boundary is described in the following sections.

3.2.1 Topographic Setting

The Amended Site Boundary is in rural Morrow County, approximately 13 miles southwest of Boardman, Oregon, and approximately 9 miles south of the Columbia River. The topography is dominated by Poverty Ridge, Fourmile Canyon, Sixmile Canyon, and two other major drainages located south of the reservoir.

The Amended Site Boundary occupies slopes from 0 to 16.4 percent, with an average of 1.1 percent. Elevations within the Amended Site Boundary range from 588 to 771 feet above mean sea level.

3.2.2 Geologic Setting

The geologic setting of the Amended Site Boundary is located in the Columbia Plateau province (NPS 2026). The topography in the province is dominated by geologically young lava flows that have occurred within the last 17 million years. Over 170,000 cubic kilometers of basaltic lava, known as the Columbia River basalts, cover the western part of the province. In the area of the

Amended Site Boundary, the native terrain is gently sloping downhill to the north toward the Columbia River. This sloping terrain is interrupted occasionally by geologic folds, one of which is Poverty Ridge.

Cataclysmic floods repeatedly swept through this area at the end of the last ice age, or about 13,000 to 15,000 years ago (Cornforth 2016). These floods are named the Missoula floods and were the result of glacial damming of water in western Montana. Figure H-1 (DOGAMI 2026a and USGS 2026a) provides a geologic map for the Amended Site Boundary. Surficial deposits are mapped as Quaternary eolian sand and ash, alluvium, and the Missoula Flood deposits. Most of the Amended Site Boundary is mapped within the Missoula Flood deposits. Areas of eolian sand and ash are mapped in the northwestern and southeastern portions; alluvial deposits are associated with Fourmile and Sixmile canyons. A canyon located in the southwestern portion is mapped as the Saddle Mountains Basalt (part of the Tertiary Columbia River Basalt Group and the Dalles Formation). Underlying materials are indicated to be the Tertiary Saddle Mountains Basalt and the Columbia River Basalt bedrock including the Tertiary Wanapum Basalt.

The geologic descriptions below are summarized from the DOGAMI geologic maps and publications (DOGAMI 2026a), U.S. Geological Survey (USGS) publications (USGS 2026a), as well as previous geotechnical investigations (see Section 5.0) conducted within the Amended Site Boundary.

3.2.2.1 Surficial Geologic Units

The Missoula Flood deposits consist of silts, sands, and fine gravels deposited from repeated catastrophic flood events from outbursts of Glacial Lake Missoula during the end of the last glaciation period. These deposits consist of stripped surface sediments from Eastern Washington and were deposited widespread across the Columbia River basin to elevations as high as over 800 feet in the vicinity of the Amended Site Boundary. Although this deposit is described to have frequent caliche layers (where mean annual precipitation is less than 15 inches per year), geotechnical information did not indicate caliche cementation of this unit (Terracon 2013).

Eolian sand and ash deposits (also referred to as loess in geotechnical reports), are typically comprised of eolian (wind-deposited) silt and fine sand. The unit is described as up to 30 feet in thickness and is material derived from the underlying Missoula Flood deposits being re-worked and deposited once allowed to dry. The Terracon (2013) geotechnical report describes the loess deposits as made up of a semi-stable soil structure commonly referred to as a “honeycomb” structure. This structure makes the soil susceptible to collapse under additional applied load and saturation as further described in Section 8.6. This unit can be broken into two units consisting of “younger loess,” typically 3 to 7 feet in thickness, and “older loess” ranging from 3 to 21 feet in thickness. The “older loess” is also described as semi-consolidated with strong calcium carbonate contents (referred to as caliche cementation in this exhibit).

Alluvial deposits generally consist of sand, gravel, and silts. The Dalles Formation is a sedimentary unit that includes a wide range of sedimentary materials. The Alkali Canyon Formation (of the Dalles Formation) consists of vitric tuff, silty clay, silt, and basalt gravel alluvial fan and braided

stream deposits. Localized areas of the Alkali Canyon Formation include dense sand and gravel alluvial deposits, as well as lean to fat clay deposits.

Geotechnical boring log data from the Terracon (2013) geotechnical investigation is provided in Table H-1. The boring data indicate basalt bedrock was encountered from approximately 29 to 39 feet below ground surface (bgs).

Table H-1. Stratigraphic Ranges for Subsurface Materials

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/Density
Stratum 1 – Loess	5 to 10	Silt, non-plastic to low plasticity, little to no cementation from calcification, damp	Medium stiff to stiff
Stratum 2 – Caliche	14 to 26	Silt, non-plastic to low plasticity, strongly cemented from calcification, damp	Very stiff to very hard
Stratum 3 – Missoula Flood Deposits	22 to 34	Silty sand to sandy silt, non-plastic, little to no cementation from calcification, moist	Dense to very dense
Stratum 3 – The Dalles Formation	29 to 39	Silty sand, sandy silt, and sandy fat clay with variable amounts of gravel, moist	Dense to very dense granular soils and very stiff to very hard fine-grained soils
Stratum 4 – Basalt	Borings terminated within this stratum, depth undetermined	Basalt to vesicular basalt, slightly weathered, mantled with zone of clay matrix and highly jointed basalt	Hard to very hard, very stiff to hard where weathered to soils
Source: Terracon 2013			

Borings performed for the Cornforth (2016) geotechnical investigation confirm the overburden profiles consist of loose to very dense sandy silt and silty sand, displaying varying degrees of caliche cementation. These borings also encountered preserved veins of caliche sedimentation and occasional basaltic rock fragments. Medium hard to hard basalt was encountered from 38 to 43 feet bgs.

Three borings associated with the Cornforth (2009) geotechnical investigation indicated that overburden materials consisted of two sedimentary units: wind-blown silt and fine sand (loess) and the Dalles Formation. The loess generally consisted of fine sandy silt with trace clay that had been cemented to varying degrees. These units ranged in thickness from approximately 9 to 40 feet in the borings. The Dalles Formation consists of slightly clayey, fine sandy silt with occasional gravel-sized basalt fragments encountered near the bottom of the deposit. A weathered rock horizon was

encountered below the loess. The weathered basalt generally consisted of angular gravel-sized rock fragments in a matrix of slightly clayey, sandy silt that ranges in thickness from approximately 7 to 10 feet. The Shannon & Wilson (1975) geotechnical investigation identified basalt bedrock ranges in thickness from 11 to 28 feet and extends from 23 to 72 feet below the existing ground surface.

Groundwater was not observed in the test borings or piezometers to the maximum depth explored of 57 feet bgs (Terracon 2013; Cornforth 2016; Cornforth 2009). In addition, Cornforth (2009) reported that perched groundwater was not indicated during the field investigation.

3.2.2.2 Bedrock Geologic Units

Basalt flows near and within the Amended Site Boundary are mapped as the Wanapum basalt formation of the Tertiary Columbia River Basalt Group (includes the Saddle Mountains Basalt) (DOGAMI 2026a; USGS 2026a). The Wanapum Basalt Formation underlying bedrock is mapped within the majority of the Amended Site Boundary. The Wanapum Basalt formation consists of flows of gray to dark-gray, medium-grained, commonly plagioclase porphyritic basalt, and generally exhibits blocky to platy jointing. Geotechnical reports indicate the underlying bedrock consists of the Columbia River Basalt (Terracon 2013; Cornforth 2016; Cornforth 2009). The basalt generally consists of highly jointed, hard basalt with a matrix of lean to fat clay in the upper transition zone (less than 10 feet) and grades to less jointed rock with depth. Depths to bedrock are described in Section 5.1 based on geotechnical investigations within the Amended Site Boundary.

3.2.2.3 Soils

Soils were evaluated within the Amended Site Boundary excluding the area of the reservoir. Soils overlying the geologic bedrock units have thicknesses greater than 7 feet. The formation settings are predominantly sandy eolian deposits and loess, with lesser amounts of eolian sands over strongly cemented alluvium. Permeability of the soils within the Amended Site Boundary range from moderate to very high. Runoff potential ranges from low to moderately low. The hazard for erosion ranges predominantly (97 percent of the area) from moderate to severe. Wind erosion ratings range from 1 to 3. K factors range from 0.15 to 0.55 (NRCS 2023). K factor indicates the susceptibility of a soil to erosion and is applied in the calculation of sheet and rill erosion vulnerability. The lower the K factor the less susceptible a soil is to detachment, and the more capable a soil is to water permeation.

According to the Cornforth (2016) geotechnical investigation, surficial soils in the vicinity of the Amended Site Boundary consist predominantly of up to 28 feet of light brown, cohesionless, wind-blown silt and fine sand (loess). The sand is loose and well drained and is dry at the surface and becomes slightly moist at about 6-inches. Sparsely vegetated and stabilized longitudinal sand dunes aligned parallel to the northeast prevailing wind direction were found to dominate the site topography during a field reconnaissance and stabilizing vegetation consists of desert grasses, sagebrush, and scattered trees. Where vegetation is bare the dune sand is subject to accelerated erosion and wind erosion has created numerous scouring depressions in the silt/sand deposits and minor sediment transport was observed. The dune morphology has a relative relief of 3 to 4 feet in

height and 6 to 8 feet across on the average. Numerous cobble- to boulder-sized lithics (basalt, granite, and schist) were observed scattered across the site, and is a characteristic of the Missoula Floods. The reservoir pool of the Carty Reservoir was observed to be cutting into these deposits, causing erosion and bank instability in some areas.

A more detailed analysis of soils within the Amended Site Boundary can be found in Exhibit I.

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;

A meeting with DOGAMI was held on December 8, 2023, as documented in Attachment H-1. Meeting attendees included the DOGAMI representative, the Certificate Holder and their geotechnical contractor, and the consultant for the Certificate Holder. An ODOE representative was invited to the meeting but was unable to attend. A brief presentation included an overview of the Carty Solar Farm with proposed RFA 4 changes and geologic hazards studies' findings, as well as an overview of the planned pre-construction geotechnical studies. DOGAMI provided feedback regarding the findings and presentation. The DOGAMI representative stated that more updated earthquake information was available for inclusion in the exhibit and agreed to provide a link to the data following the meeting. However, DOGAMI later indicated that this data was not available for download at this time and therefore is not necessary to include in Exhibit H. DOGAMI also stated that the final geotechnical study plan should include specific field boring locations. DOGAMI was otherwise satisfied with the information and general conclusions presented.

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 summary of relevant conclusions and recommendations from the previous geotechnical investigations performed for areas within the Amended Site Boundary is included below, followed by the Certificate Holder's plan for future site-specific geotechnical work to be performed prior to construction.

5.1 Previous Geotechnical Investigations

5.1.1 Shannon & Wilson 1975 and 1976

The Shannon & Wilson (1975) geotechnical investigation and Shannon & Wilson (1976) supplemental geotechnical investigation were conducted for the now-retired and demolished BCP. Most of the structures at the BCP were founded on deep foundations (drilled shafts), which penetrate into cemented soils and basalt bedrock. Surficial soils and unconsolidated deposits were found to have a relatively low moisture content averaging about 6 to 18 percent. Depths to basalt bedrock were found to be 7 to 50 feet below ground surface. The studies concluded that the project was feasible and included engineering recommendations for the design and construction of the BCP based on the geotechnical laboratory tests and boring results.

5.1.2 Cornforth 2009

The Cornforth (2009) preliminary geotechnical investigation was conducted for the CGS natural gas-fired power plant to the north of the Carty Reservoir. The scope of work included a site reconnaissance, three borings, laboratory testing, and research relating to geologic/geotechnical issues. The geotechnical investigation concluded the following:

...siting the Carty Generating Station at the proposed location does not appear to pose significant geotechnical or geological design issues. The predominant foundation conditions include relatively dense cemented silt underlain by weathered rock, which in turn, is underlain by hard basalt. These conditions should provide adequate bearing strata for the project foundations, and the predominantly stiff overburden soils would not be expected to significantly amplify ground shaking from a seismic event. One notable feature occurred in a boring near the gas turbine area where a relatively loose layer of silt (loess) was encountered at the ground surface. Based on this finding, the key geotechnical issue for the Carty project appears to be the potential for collapse of the relatively loose, surficial layer of silt that may occur in localized areas. This problem is simple to address in the design phase, and the approach would include: (i) extending foundations for buildings and appurtenant structures through the looser soil to stronger bearing layers, and/or (ii) excavating and replacing the looser soil with engineered fill that is moisture conditioned, and placed and compacted in lifts.

5.1.3 Terracon 2013

The Terracon (2013) geotechnical investigation was for the CGS natural gas-fired power plant to the north of the Carty Reservoir. Conclusions of the investigation are oriented toward construction of a natural gas-fired power plant and include recommendations for addressing collapsible soils and highly erodible surficial soils, proper excavation, and foundation design.

5.1.4 Cornforth 2016

The Cornforth (2016) investigation was for the Carty Solar Farm installation to the south of the Carty Reservoir. The investigation concluded the following:

...siting the solar facility at the proposed location does not appear to pose significant geotechnical or geological design issues. In general, the subsurface soil conditions across the site are similar with loose to medium dense, silty sand to sandy silt with weak caliche cementation throughout the layer in the upper 18 to 28 feet. All borings encountered slightly looser soils in approximately the upper five feet. These near surface soil units generally increase in relative density with increasing depth, with the soils in Boring B-1 becoming dense from 11 to 28 feet. Underlying these upper soil units are very dense silt and sand, medium stiff to very stiff clayey silt, dense to very dense basalt fragments, and medium hard to hard basalt. These general soil conditions should provide an adequate bearing stratum for the project foundations, and the relatively stiff to dense overburden soils would not be expected to significantly amplify ground shaking from a seismic event. Based on the finding from the preliminary borings and the geologic site reconnaissance, the key geotechnical and geologic issues for the solar facility project appear to be the potential for erosion of the looser surficial soils, and a somewhat low potential for collapse of the relatively loose, surficial wind-blown soils.

In addition, the report stated that “there have been no problems associated with soil collapse, ground surface heave, settlement, landslide movement and no damages from minor seismic events that have occurred during the life span of the existing facility” (Cornforth 2016).

The Cornforth (2016) geotechnical investigation recommended the following:

- Drill additional borings at scattered locations across the site to further characterize the subsurface conditions, as well as collect information for foundation design. For planning purposes, we would anticipate boring depths to again be on the order of 50 feet to achieve 10 to 30 feet penetration into denser overburden soils or to encounter a bedrock contact.
- Complete a laboratory testing program to provide additional data on the soils for design studies. The laboratory data would be used to estimate collapse and settlement potential for any loose, compressible soil layers and to develop foundation soil index and shear strength parameters for design recommendations.
- Conduct geotechnical engineering studies and develop geotechnical recommendations for final design of foundation support systems, site grading, ground surface treatments and access road surfaces.

5.2 Future Geotechnical Investigation

The Certificate Holder will conduct a site-specific geological and geotechnical investigation (tentatively planned for Q1 2024) before beginning construction and will provide draft and final

reports to DOGAMI and ODOE consistent with Site Certificate Condition 5.4(ii) in the Third Amended Site Certificate (Council 2022). The proposed geotechnical scope is tentatively planned to include the following tasks:

1. Review publicly available existing soil and groundwater information in the immediate vicinity of the structures and facilities.
2. Complete a site reconnaissance to evaluate site conditions; assess site access; and stake the proposed exploration locations prior to starting the geotechnical exploration work.
3. Explore subsurface soil and groundwater conditions and soil properties by completing borings, test pits, electrical resistivity, post load test, and double infiltrometer tests at the frequency described below:

Solar Array Areas

- a. Twenty-one (21) borings, depth of 15 feet
- b. Twenty-five (25) test pit excavations, depth of 5 feet (dynamic cone penetrometer test, nuclear soil density testing, temperature test)
- c. Seventeen (17) electrical resistivity tests (maximum “a” spacing 100 feet)
- d. Thirty-six (36) post load tests
- e. Nine (9) double infiltrometer tests.

Proposed Collector Substation Area

- f. Eight (8) borings, depth 50 feet
- g. Two (2) test pit excavations, depth of 5 feet (dynamic cone penetrometer test, nuclear soil density testing, temperature test)
- h. Three (3) electrical resistivity tests (maximum “a” spacing 300 feet)

Draft and final geotechnical engineering reports for the Carty Solar Farm with proposed RFA 4 changes will present the results of the above tasks and include geotechnical recommendations. The geotechnical report will be prepared under the supervision of an Oregon-registered professional engineer. The report will include the following:

- Vicinity and Geology Map;
- Site plan showing the approximate locations of the borings;
- Boring logs and laboratory testing results;
- Geologic characteristics of the site;
- A discussion of the subsurface soil, rock, and groundwater conditions;
- A description of seismic hazards including fault rupture and liquefaction;

- Seismic parameters based on American Society of Civil Engineers' (ASCE) 7-16 code including but not limited to site class for soils or rock and other mapped data;
- Geotechnical design recommendations; and
- Geotechnical construction considerations.

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;

The Carty Solar Farm with proposed RFA 4 changes does not include pipelines carrying hazardous substances as described in OAR 345-021-0010(1)(h)(D).

The Carty Solar Farm with proposed RFA 4 changes will interconnect with the existing transmission system remaining from the BCP via the proposed collector substation. The collector substation will be located in area formerly used for the BCP on the west side of the Northern Solar Area. The collector substation is proposed adjacent to an existing electrical transmission dead-end structure for a 500-kilovolt (kV) transmission line that used to serve the BCP. The existing dead-end structure and associated 500- kV transmission line were retained for reuse from the BCP. The new substation will connect to the existing dead-end structure via an aboveground electrical line extending approximately 300 feet between the proposed substation and existing dead-end structure. Electrical output from the collector substation will be conveyed from the dead-end structure and 500-kV transmission line to the existing Grassland Switchyard. The 300-foot-long connection between the proposed collector substation and existing dead-end structure is a transmission line. The Certificate Holder proposes geotechnical work in this general area as described in Section 5.2 for the proposed collector substation.

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

OAR 345-021-0010(1)(h)(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 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; and

7.1 Methods

Available reference materials were reviewed, and a desktop seismic-hazard assessment was conducted. Topographic and geologic conditions and hazards within the Amended Site Boundary were evaluated using topographic and geologic maps, aerial photographs, existing geologic reports, and data from DOGAMI, the Oregon Water Resources Department, the U.S. Geological Survey (USGS), and the Natural Resource Conservation Service (NRCS).

A desktop seismic-hazard analysis characterized seismicity in the vicinity of the Carty Solar Farm with proposed RFA 4 to evaluate potential seismic impacts. This work was based on the potential regional and local seismic activity described in the existing scientific literature and on subsurface soil and groundwater conditions found in the 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 and characterization of those events in terms of a series of design events.
3. Evaluation of seismic hazards, including potential fault rupture, earthquake-induced landslides, liquefaction and lateral spread, settlement, and subsidence.
4. Review of previous geotechnical investigations conducted in the Amended Site Boundary and immediate vicinity.
5. 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.

As described in Section 5.0 and in accordance with Site Certificate Condition 5.4.ii, a site-specific geotechnical investigation will be conducted by a qualified engineer using current code requirements and state-of-practice methods to inform the final design. It will be reported to DOGAMI and ODOE following the 2014 Oregon State Board of Geologist Examiners' Guideline for Preparing Engineering Geologic Reports.

7.2 Maximum Considered Earthquake Ground Motion under IBC 2024

Overall, the DOGAMI Oregon HazVu: Statewide Geohazards Viewer mapping tool (DOGAMI 2026b) indicates that the Cascadia earthquake hazard is moderate, and the general earthquake hazard in

the Amended Site Boundary is also rated moderate. However, areas mapped as eolian sand and ash deposits and alluvial deposits are rated very strong. The USGS Seismic Hazard Mapping Model (USGS 2026c) developed ground motions using a probabilistic seismic hazard analysis that covered the site of the Carty Solar Farm with proposed RFA 4 changes. Though these motions are not site-specific, they reasonably estimate the ground motions within the Amended 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; ICC 2024) supplemented by the Oregon Structural Specialty Code (OSSC; State of Oregon 2025). The USGS earthquake hazard tool analysis was run for the Amended Site Boundary, and the design event (6.3 magnitude earthquake) 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 0.2128 acceleration from gravity at the bedrock surface for the Amended Site Boundary. The values of PGA on rock are an average representation of the acceleration most likely to occur at the site for all seismic events (crustal, intraplate, or subduction).

Seismic design parameters were developed following IBC 2024. Using current information, the Carty Solar Farm with proposed RFA 4 changes will be designed for Site Class D, according to IBC requirements (Table H-2). Table H-2 shows a range of site classes reflecting the various surficial geology mapped within the Amended Site Boundary. Site Class D represents the loess (eolian sand and ash) deposits that are rated very strong, and Site Class C represents the Missoula Flood deposits that consist of silts, sands, and fine gravels that are predominant. Previous geotechnical studies have used Site Class D for project designs.

Table H-2. Seismic Design Parameters – Maximum Considered Earthquake

Location	Site Class	Earthquake Magnitude	Peak Horizontal Ground Acceleration	Return Period
Amended Site Boundary	D	6.32	0.2128g	2,475 years
Amended Site Boundary	C	6.31	0.1739g	2,475 years
Amended Site Boundary	D	6.39	0.09061g	475 years
Amended Site Boundary	C	6.38	0.06839g	475 years
Source: USGS 2026c.				

7.2.1 Earthquake Sources

In northern Oregon, seismicity is generated when the Juan de Fuca Plate and the North American Plate converge at the Cascadia Subduction Zone. These plates converge at a rate of 1 to 2 inches per year, accumulating large amounts of stress that release 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).

Overall, earthquakes in Oregon are associated with active faults in four regional seismicity zones: the Cascade seismic zone, the Portland Hills zone (the Portland, Oregon, and Vancouver,

Washington, metropolitan area), the south-central zone (Klamath Falls), and northeastern Oregon zone (Niewendorp and Newhouse 2003). 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). Regionally, seismicity has been attributed to crustal deformation from the Cascadia Subduction Zone and volcanism. More than 6,000 earthquakes—most less than magnitude 3—have occurred in Oregon since 1981, with 75 percent of these recorded since March 1993 (Wong and Bott 1995). The 1936 Milton-Freewater earthquake, located approximately 60 miles northeast of the Amended Site Boundary, had a 6.4 magnitude and was felt over an area of approximately 106,000 square miles.

Earthquakes are caused by movements along crustal faults, generally in the upper 10 to 15 miles of the earth's crust. In the vicinity of the Amended Site Boundary, 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 faults mapped within the Amended Site Boundary; however, a fault is mapped on the geologic map east of the boundary (USGS 2026a; Figure H-1). There is no indication that this fault is active within recent/Quaternary time. Several undifferentiated, Quaternary-age, and Class B faults are mapped within 25 miles of the Amended Site Boundary (Figure H-2). These faults are potentially active. The DOGAMI Oregon HazVu: Statewide Geohazards Viewer earthquake hazard layer (DOGAMI 2026b) and the USGS Quaternary Fault and Fold Database (USGS 2026b; Figure H-2) show that the nearest potentially active faults (undifferentiated and mid- to late Quaternary) are about 10 miles north and 15 miles west/southwest of the Amended Site Boundary. Class B potentially active faults are located over 25 miles northeast and southwest of the Amended Site Boundary. Class B faults have geologic evidence that demonstrates the existence of a fault or suggests Quaternary deformation, but either (1) the fault might not extend deeply enough to be a potential source of significant earthquakes, or (2) the currently available geologic evidence is too strong to confidently assign the feature as a Class C (insufficient geologic evidence) but not strong enough to assign it to Class A (active fault) (USGS 2023b). The potentially active faults shown in Figure H-2, within 50 miles of the Amended Site Boundary, present the largest potential for seismic contribution to the Carty Solar Farm with proposed RFA 4 changes.

The site-specific geotechnical investigation will assess the potential for regional faults to affect the Carty Solar Farm with proposed RFA 4 changes, as described in Section 5.0. The investigation will include a description of any potentially active faults, their potential risk to the Carty Solar Farm with proposed RFA 4 changes, and any additional mitigation measures the Certificate Holder will employ to design, construct, and operate the Carty Solar Farm with proposed RFA 4 changes safely.

The 2013 Oregon Resilience Plan by the Oregon Seismic Safety Policy Advisory Commission (OSSPAC 2013) simulated the impact of a magnitude 9.0 Cascadia earthquake scenario. This plan places the Amended Site Boundary into the “very light” shaking category. This means that a magnitude 9.0 Cascadia scenario earthquake would produce a very light shaking event that would be felt outdoors, wake sleepers, disturb or spill liquids, upset small unstable objects, and potentially swing doors or move pictures (OSSPAC 2013).

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

7.2.2 Recorded Earthquakes

Figure H-2 displays the location and approximate magnitude of all recorded earthquakes within approximately 50 miles of the Amended Site Boundary. The seismic events are grouped by magnitude and displayed with differently sized symbols based on the event's strength.

Table H-3 summarizes the earthquakes greater than magnitude 3.0 recorded within 50 miles of the Amended Site Boundary. One earthquake greater than magnitude 4.0 was recorded 35 miles from the Amended Site Boundary. Earthquakes between magnitude 3 and 4 are generally equivalent to a Modified Mercalli Intensity III associated with shaking that is "noticeable indoors but may not be recognized as an earthquake" (USGS 2026d).

Table H-3. Significant Historical Earthquakes within 50 Miles of the Facility by Magnitude¹

Year	Month	Day	Latitude	Longitude	Moment Magnitude	Miles from Amended Site Boundary
1993	12	16	45.1958333	-120.0898333	3	34.3
2022	8	13	46.1315	-120.5016667	3.03	44.1
1998	2	3	45.8138333	-120.1921667	3.1	19.2
1997	10	13	46.114	-120.3761667	3.1	38.9
1997	3	23	45.2463333	-120.0493333	3.1	30.4
1997	3	23	45.1951667	-120.0508333	3.1	33.8
1995	11	2	46.15	-119.5643333	3.1	32.8
1995	8	29	46.2081667	-119.9055	3.1	35.0
1989	3	27	45.8158333	-120.2615	3.1	22.3
1987	9	8	45.1911667	-120.072	3.1	34.4
1977	3	11	45.8991667	-119.6656667	3.1	15.0
1975	6	15	46.234	-119.1131667	3.1	49.2
2000	8	17	45.312	-120.0415	3.2	26.0
1997	4	17	45.1885	-120.082	3.2	34.7
1981	6	14	45.9616667	-120.507	3.2	37.4
2004	2	28	46.0363333	-119.0205	3.3	43.8
1997	11	18	46.137	-120.461	3.3	42.9
1975	6	28	46.1053333	-119.7036667	3.3	28.1
2000	1	30	45.1831667	-120.1028333	3.4	35.4
2017	10	12	46.1558333	-120.5401667	3.42	46.6

Year	Month	Day	Latitude	Longitude	Moment Magnitude	Miles from Amended Site Boundary
1999	8	31	45.1863333	-120.0908333	3.5	35.0
1988	9	29	45.8498333	-120.2596667	3.5	23.2
1975	7	1	45.628	-120.002	3.5	7.7
2000	2	1	45.19	-120.1126667	3.6	35.1
1979	2	17	46.1641667	-119.9326667	3.6	32.2
1976	10	10	45.2703333	-120.4995	3.6	41.6
1975	7	1	45.6053333	-120.0161667	3.6	8.9
1964	1	15	45.90	-120.00	3.6	16.0
2008	5	18	46.1676667	-119.5501667	3.7	34.2
1975	6	28	46.099	-119.706	3.8	27.6
1997	11	18	46.1431667	-120.4708333	3.9	43.6
1997	3	22	45.1973333	-120.0671667	3.9	33.9
1992	8	7	45.8603333	-119.5895	3.9	14.7
1985	2	10	45.7045	-119.6345	3.9	7.2
1967	8	5	46.00	-120.00	3.9	22.1
1967	2	13	46.10	-119.75	3.9	27.4
2000	1	30	45.1971667	-120.1248333	4.1	34.9
1893	3	6	46.00	-119.00	4.1	43.4
Source: USGS 2026d.						
1. Magnitude of 3.0 or greater.						

The Ground Response Spectra Assessment (Attachment H-4) assessed the design response spectrum given in the 2024 IBC using the American Society of Civil Engineers' ASCE Hazard Tool (ASCE 2026). Response spectra are provided for the maximum considered earthquake at the Carty Solar Farm with proposed RFA 4 changes location. For the maximum considered earthquake, separate response spectra modified by the amplification factors for Site Class D are provided. Due to the presence of stiff soils at depths between 5 and 26 feet (Terracon 2013) in the Amended Site Boundary, the Carty Solar Farm with proposed RFA 4 changes should be designed for the most conservative Site Class D.

7.2.3 Hazards Resulting from Seismic Events

Potential seismic hazards from a design seismic event for the Carty Solar Farm with proposed RFA 4 changes include seismic shaking or ground motion, fault displacement, instability from landslides or subsurface movement, and adverse effects from groundwater or surface water. These risks are anticipated to be low, as discussed below. Since the Carty Solar Farm with proposed RFA 4 changes

is far from the Oregon coast, and not in a DOGAMI-defined tsunami evacuation zone (DOGAMI 2026c), tsunami inundation is not considered a hazard.

7.2.4 Seismic Shaking or Ground Motion

The Carty Solar Farm with proposed RFA 4 changes will be designed to withstand the maximum risk-based design earthquake ground motions developed for the Facility site. The design seismic event has a 2,475-year recurrence interval. The State of Oregon has adopted the most recent IBC code for structural design. Specifically, this is Chapter 16, Section 1613 (Earthquake Loads) of the SSC Chapter 16, Section 1613 (Earthquake Loads) (State of Oregon 2025). Building codes are frequently updated; the IBC is updated every 3 years. The Certificate Holder will design, engineer, and construct the Carty Solar Farm with proposed RFA 4 changes following the latest IBC, OSSC, and building codes adopted by the State of Oregon at the time of construction.

Based on soil data provided by the NRCS Web Soil Survey (Exhibit I), and geologic and geotechnical information, the surficial materials in the Amended Site Boundary range from Site Class C to Class D. As described above, Site Class D (stiff soil) is the most conservative class appropriate for the Carty Solar Farm with proposed RFA 4 changes (Attachment H-4).

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. The geotechnical studies and analyses provide site-specific parameters, including but not 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 will use these parameters to design a suitable foundation and verify that the foundation/soil interaction meets or exceeds the original equipment manufacturer's site-specific, minimum requirements.

7.2.5 Fault Rupture

Fault displacement is unlikely because there are no active faults within the Amended Site Boundary. However, there is a non-active fault that trends northwest-southeast located east of the Amended Site Boundary. In addition, anticline and syncline areas are mapped within the Amended Site Boundary (DOGAMI 2026a; USGS 2026a). This fault should be reviewed during the site-specific geotechnical analysis. The nearest known active or potentially active faults are approximately 10 miles north and 15 miles west/southwest of the Amended Site Boundary as seen on Figure H-2. There is an unnamed inferred/concealed fault located about 1.5 miles northeast of the Amended Site Boundary (Figure H-1). Observation of the fault area during a field reconnaissance did not reveal any evidence of displacement of surficial deposits (Cornforth 2016).

7.2.6 Liquefaction

Liquefaction is when saturated and cohesionless soils are subjected to dynamic forces like intense or prolonged ground shaking and temporarily lose their strength and liquefy. There is no evidence of historic liquefaction or alluvial fan deposits within the Amended Site Boundary. As shown in Figure H-2, liquefaction susceptibility is rated very low for the Amended Site Boundary (DOGAMI 2026b). The soils in the Amended Site Boundary are generally cohesive and unsaturated.

Groundwater is indicated to be at least 57 feet below ground surface based on previous geotechnical investigations (Terracon 2013), with the exception of soils in the immediate area of the reservoir. Along with the relatively moderate seismic event potential, this indicates that soil liquefaction within the Amended Site Boundary where the Carty Solar Farm with proposed RFA 4 changes will be located is unlikely. However, as discussed above, areas along the reservoir and narrow areas along Sixmile Canyon and Fourmile Canyon within the Amended Site Boundary could have saturated alluvial deposits that would be susceptible to liquefaction. Using Oregon HazVu: Statewide Geohazards Viewer and FEMA floodplains mapping (DOGAMI 2026b; FEMA 2026), 100-year floodplains are mapped in these areas within the Amended Site Boundary or immediate vicinity as shown in Figure H-4. Carty Solar Farm with proposed RFA 4 changes infrastructure will avoid building on natural drainages and canyons. Geotechnical studies (Terracon 2013) concluded that seismic liquefaction risks are very low because the soils are relatively dense and unsaturated.

7.2.7 Seismically Induced Landslides

While regional seismicity could potentially trigger landslides and mass wasting processes in the Amended Site Boundary, the risk is considered moderate for expected shaking in a Cascadia 9.0 magnitude event (DOGAMI 2026b). The landslide database does not show any historic landslides within the Amended Site Boundary or within the immediate vicinity (DOGAMI 2026d). Construction will avoid steep slopes that are most susceptible to landslides. The site-specific geotechnical investigation will review evidence of active faults and landslides, which will inform the final design and layout. 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 gradual downward settling of surface land, often caused by groundwater drawdown, compaction, tectonic movements, mining, or explosive activity.

Geotechnical investigations (Cornfield 2016; Terracon 2013; Cornfield 2009) have shown that the soils that are present on most of the Amended Site Boundary are not saturated and groundwater is indicated to be at least 57 feet below ground surface. However, the Terracon (2013) geotechnical investigation indicates that soils can be saturated in the immediate vicinity of the reservoir. Carty Solar Farm with proposed RFA 4 changes infrastructure will not be located along steep slopes.

Subsidence due to a seismic event is highly unlikely in the Amended Site Boundary as the bedrock is

relatively shallow and the overlying soils are unsaturated where the Carty Solar Farm with proposed RFA 4 changes will be constructed.

Subsidence may also occur due to introduction of moisture into desiccated collapsible soils present in loess. Drainage changes produced by grading and site development can induce moisture changes in the subsurface that can cause collapse of loess that is at a very low natural moisture content. Collapsible soils are discussed in Section 8.6. Design of site drainage will prevent ponding or other concentration of surface water flows, especially near structures; development over existing drainage ways will be avoided, since rerouting of surface water could induce subsidence.

7.2.9 Seismic Hazard Mitigation

The State of Oregon has adopted the IBC 2024 code for structural design. Specifically, this is Chapter 16, Section 1613 (Earthquake Loads) of the 2025 OSSC (State of Oregon 2025). Building codes are frequently updated; the IBC is updated every 3 years. The Certificate Holder will design, engineer, and construct the Carty Solar Farm with proposed RFA 4 changes following the latest IBC, OSSC, and building codes adopted by the State of Oregon at the time of construction. Substation equipment will meet all requirements in the latest version of the Institute of Electrical and Electronics Engineers IEEE 693-2018 standard (which directs the design and qualification of equipment installed in substations and its ability to withstand a seismic event.). Although the region has only a moderate seismicity potential, the solar arrays are designed to resist seismic loads.

As discussed in Section 5.0, site-specific geotechnical exploration will provide data that will guide the Carty Solar Farm with proposed RFA 4 changes infrastructure design to mitigate potential seismic-event hazards. The hazard of a surficial rupture along a fault is low, given the seismic history of the site displayed in geologic mapping. Because the Facility is in a sparsely populated area, there is minimal human safety and environmental risk. Mitigation for potential fault rupture is not needed. No structures will be built on steep slopes prone to instability, thus avoiding potential impacts. Disaster resilience design guidelines 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 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; 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.

Non-seismic geologic hazards in the Columbia Plateau region include landslides, volcanic eruptions, collapsing soils, and erosion. The area within the Amended Site Boundary is primarily relatively flat and includes loess deposits and the existing reservoir, with the exception of several canyon drainages. The Carty Solar Farm with proposed RFA 4 changes will be constructed within a flat-lying portion of the Amended Site Boundary. It will avoid steep slopes and drainages that could experience landslides and soil creep. A discussion of potential non-seismic geologic hazards is presented below.

8.1 Landslides

In 2021, DOGAMI released an update to the Oregon Statewide Landslide Database (SLIDO-4.4; DOGAMI 2026d). SLIDO is a statewide database of known landslides compiled from published maps. The database includes 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-4.4 landslide database was used to overlay landslide areas or landslide-related features on Figure H-4; there are no mapped landslides within the Amended Site Boundary. An area of moderate to high landslide susceptibility is mapped along Fourmile Canyon north of the reservoir; and discontinuous areas of moderate landslide susceptibility are mapped south of the reservoir—primarily along drainages—within the Amended Site Boundary. Most of the Amended Site Boundary is located in low landslide susceptibility areas. Site construction will follow appropriate IBC regulations for construction and avoid steep slopes.

Slopes within the vicinity of the Amended Site Boundary range from approximately zero to 16.4 percent, with an average slope of 1.1 percent. If slope stability issues are identified in the final design geotechnical investigations, the structures will either be relocated during the micro-siting process, or remedial measures will be implemented to improve slope stability.

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. The closest volcano to the Amended Site Boundary is Mount Hood (85 miles west/southwest). Most of the potential volcanic hazard impacts would 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 Carty Solar Farm with proposed RFA 4 changes may occur. Because of the distance to the nearest volcanoes, impacts on the Carty Solar Farm with proposed RFA 4 changes from volcanic activity would be indirect and likely limited to ash fallout. In addition, the Carty Solar Farm with proposed RFA 4 changes is not located near any streams that would be subject to pyroclastic flows from a volcanic eruption from

these close volcanoes. It is unlikely that there would be any adverse effects from volcanic activity on the construction or operation of the Carty Solar Farm with proposed RFA 4 changes.

8.3 Erosion

Erosion can occur when soils are increasingly exposed to wind or water. Wind erosion is influenced by wind intensity, vegetative cover, soil texture, soil moisture, the grain size of the unprotected soil surface, topography, and the frequency of soil disturbance. Wind erosion hazard is generally high to very high. Control measures will be implemented to mitigate wind erosion potential as identified in Exhibit I. Water erosion is primarily a function of 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 site soils is generally moderately low. Slopes in the Amended Site Boundary have an average slope of 1.1 percent; it is noted that slopes greater than 15 percent have a greater erosion risk. The hazard for erosion across the Amended Site Boundary ranges from slight to severe. In Exhibit V, Table V-3 shows the area received a total average annual precipitation of 8.6 inches per year at the Boardman weather station (approximately 10 miles northeast of the Amended Site Boundary) from 1991-2020 (NOAA 2026). The erosion potential and available precipitation make site soils sensitive to water erosion during winter and spring, particularly on steep slopes. A draft Erosion and Sediment Control Plan (ESCP) has been developed to reduce the potential for soil erosion (see Attachment I-1 to Exhibit I). The ESCP includes structural and nonstructural best management practices (BMPs). 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. Nonstructural BMPs include the implementation of materials handling procedures, disposal requirements, and spill prevention methods.

The Certificate Holder will apply for a National Pollutant Discharge Elimination System stormwater construction permit through the Your DEQ Online platform. In addition, Exhibit I contains a comprehensive list of mitigation measures to avoid wind and water erosion and soil impacts.

8.4 Flooding

Federal Emergency Management Agency (FEMA) National Flood Hazard data (FEMA 2026) were compared to the temporary and permanent disturbance areas in the Amended Site Boundary to evaluate flood hazards. Figure H-4 provides a map of FEMA flood plains (FEMA 2026). The reservoir and major canyons/drainages are all mapped within the 100-year floodplain. Additional DOGAMI floodplain mapping was not available (DOGAMI 2026b). All permanent Carty Solar Farm with proposed RFA 4 changes structures will avoid floodplains. However, 1.56 acres of permanent impacts, and 0.21 acres of temporary impacts to floodplains would occur from a solar fenceline along a southeastern drainage of the reservoir.

Seasonal thunderstorms can result in concentrated stormwater runoff and localized flooding. The Carty Solar Farm with proposed RFA 4 changes 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. The engineered access roads and drainages will direct stormwater runoff away from structures and into drainage ditches and culverts as required in the ESCP. Therefore, the risks and potential impacts to the Carty Solar Farm with proposed RFA 4 changes, human safety, and the environment from flood hazards are expected to be low.

8.5 Shrinking and Swelling Soils

Clayey soils are the most susceptible to shrinking and swelling. These soils were not found in the Facility soil data (see Exhibit I). Previous geotechnical reports did not identify shrinking and swelling soils as a concern within the Amended Site Boundary (Terracon 2013; Cornforth 2016). The shrink-swell potential of the soils will be evaluated during the site-specific geotechnical investigations and laboratory testing and analysis during the final design phase for the Carty Solar Farm with proposed RFA 4 changes. If shrinking or swelling soils are present at foundation locations or along road alignments, soil improvement will be necessary. Soil improvement can include reworking and compacting onsite soils, over-excavating soils with shrink-swell potential and replacing with compacted structural fill, constructing impermeable barriers to prevent saturation, or mixing soils to reduce the potential for shrinking and swelling.

8.6 Collapsing Soils

The Terracon (2013) geotechnical investigation found that according to the Collapse Potential classification (ASTM D5333), the near-surface soils in the vicinity of the Amended Site Boundary exhibit moderate risk collapsible soils and the deeper soils exhibit negligible to slight risk collapsible soils. The collapse of the “honeycomb” structure is typically instigated by wetting and loading or overstressing from the loading without wetting. The geotechnical report recommended mitigation of the collapse risk by removing and replacing these less cemented moderate risk soil materials (loess) and keeping the excess bearing pressures low to reduce the risk of overstressing the underlying cemented soils (caliche). The removed loess soils can be re-used as engineered fill (provided they are properly moisture conditioned and compacted as engineered fill). These soils were generally encountered to depths of 5 to 10 feet in the explorations; however, the depths can vary across the site and greater depths greater might be encountered. In these instances, additional removal will be necessary. The deeper caliche appears to consist of a moderately strong to strongly cemented material that likely has been somewhat pre-consolidated in the past (Terracon 2013). Based on the laboratory tests, these materials have on the order of 4 to 8 percent higher densities than the loess soils, indicating probable previous hydro-collapse (consolidation due to previous wetting). Therefore, since this material has considerable shear strength from the cementation and overburden, these soils have negligible to slight risk of collapse settlements.

Terracon (2013) concluded that the problem of potential soil structure collapse was simple to address in the design phase, with considerations given to: (i) extending foundations support for the solar panel support system and other appurtenant structures through the looser soil to stronger

bearing layers at a slightly lower depth, and/or (ii) excavating and replacing the looser soil with engineered fill that is moisture conditioned, and placed and compacted in lifts.

Soil properties will be evaluated by laboratory testing and analysis. Subsurface soil conditions, such as loess or collapsing soils, will be identified during the site-specific geotechnical investigation and will inform the final design of the Carty Solar Farm with proposed RFA 4 changes. If collapsible soils are found, collapse potential will be mitigated by construction techniques (over-excavating and replacing with structural fill, wetting, and compacting) during subgrade preparation.

9.0 Disaster Resilience

Pertinent design codes related to geology, seismicity, and near-surface soils are contained in OSSC Chapter 16, Section 1613 (Earthquake Loads) (State of Oregon 2025). The Carty Solar Farm with proposed RFA 4 changes will be designed to meet or exceed the minimum standards required by these design codes. The Certificate Holder acknowledges that DOGAMI encourages, but does not require, 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 Certificate Holder has extensive experience building energy facilities and designing projects to withstand non-seismic geologic hazards from a structural perspective.

The Carty Solar Farm with proposed RFA 4 changes will be designed, engineered, and constructed to meet all current standards to adequately avoid potential dangers to human safety presented by seismic hazards. A qualified engineer will assess and review the seismic, geologic, and soil hazards associated with infrastructure construction of the Carty Solar Farm with proposed RFA 4 changes. Construction requirements will be modified, as needed, based on the site-specific characterization of seismic, geologic, and soil hazards. Substation structures will be designed under the current version of the OSSC. Substation, transmission line, and collector line equipment will be specified by the latest version of the Institute of Electrical and Electronics Engineers (IEEE) standard (currently IEEE 693-2018). The Carty Solar Farm with proposed RFA 4 changes infrastructure will be in sparsely populated areas; therefore, the risks to human safety and the environment due to seismic hazards will be minimal.

The Carty Solar Farm with proposed RFA 4 changes infrastructure will be designed, engineered, and constructed to meet or exceed all current standards. The Certificate Holder proposes to design, engineer, and construct the Carty Solar Farm with proposed RFA 4 changes to avoid dangers to human safety-related and non-seismic hazards in many ways, including conducting site-specific geotechnical evaluations (see Section 5.0). Typical mitigation measures for non-seismic 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 Carty Solar Farm with proposed RFA 4 changes in the event of hazards. Should Facility elements like access roads be damaged, they will be assessed and repairs made quickly to ensure recovery of operations after a major storm event.

10.0 Climate Change

The University of Washington conducted a study to assess climate vulnerability and adaptation in the Columbia River Plateau, where the Carty Solar Farm with proposed RFA 4 changes 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 on power lines in the region.

Reinforcing the local electric grid with solar power and battery energy storage increases energy grid resilience 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 the delivery of power generated through various sources, minimizing the potential reduction in hydropower's role under future conditions. All aspects of this Facility support resiliency in the face of future climate change. The Carty Solar Farm with proposed RFA 4 changes will be designed to withstand extreme events as explained above in Section 9.0.

11.0 Conclusions

The risk of seismic hazards to human safety at the Facility is low. The Certificate Holder reviewed regional geologic information and performed a site-specific desktop analysis of potential seismic, geologic, and soils hazards. In addition, several previous geotechnical investigations have been conducted within areas of the Amended Site Boundary that confirm low seismic risk. A site-specific geotechnical investigation will be conducted, allowing the Certificate Holder to design, engineer, and construct the Carty Solar Farm with proposed RFA 4 changes to the most current standards at the time of construction (Condition 6.6, Council 2022). The site-specific geotechnical investigation and Carty Solar Farm with proposed RFA 4 changes design will comply with the following conditions from the Third Amended Site Certificate: Conditions 5.4, 6.7, 6.8, 6.10, 6.11 (Council 2022). This exhibit reflects input from DOGAMI and demonstrates that the Certificate Holder can design, engineer, and construct the Carty Solar Farm with proposed RFA 4 changes to avoid dangers to human safety. The following supporting evidence is provided, with the remaining evidence to be provided before construction:

- The risk of seismic hazards to human safety at the Facility is considered low. The Certificate Holder has adequately characterized the seismic hazard risk of the site under OAR 345-022-0020(1)(a) and considered seismic events and amplification for the Facility's site-specific

subsurface profile. Carty Solar Farm with proposed RFA 4 changes components include solar modules, transformers, generators, site access roads, a battery energy storage system, and one onsite substation with equipment. The proposed O&M building will be staffed; however, the probability of a large seismic event occurring while the O&M building is occupied is much lower than for a typical building or facility. This very low probability results in minimal risk to human safety. During preconstruction geotechnical investigations, any potentially active faults in the vicinity will be surveyed.

- The Certificate Holder has demonstrated that the Carty Solar Farm with proposed RFA 4 changes 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 the most recently updated IBC requirements, following OAR 345-022-0020(1)(b). These standards require that for the design seismic event, the factors of safety used in the Carty Solar Farm with proposed RFA 4 changes design exceed specific values. For example, in the case of slope design, a factor of safety of at least 1.1 is usually required during seismic stability evaluation. This safety factor is introduced to account for uncertainties in the design process and ensure that performance is acceptable. If slope stability safety factors are not met, the Carty Solar Farm with proposed RFA 4 changes components will either be relocated during the micrositeing process or remedial measures to improve slope stability will be implemented. For slope stability, the remedial measures could include the 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 Carty Solar Farm with proposed RFA 4 changes, adherence to the IBC requirements will ensure that appropriate protection measures for human safety are taken.
- The Certificate Holder has provided appropriate site-specific information and demonstrated (per OAR 345-022-0020(1)(c)) that the construction and operation of the Carty Solar Farm with proposed RFA 4 changes, in the absence of a seismic event, will not adversely affect or aggravate the geological or soil conditions of the Facility site or vicinity. The risks posed by non-seismic geologic hazards are generally considered low because the Carty Solar Farm with proposed RFA 4 changes can be designed to minimize or avoid the hazards of landslides and soil erosion. Landslide and slope stability issues will be identified during the final design and mitigated. Erosion hazard resulting from soil and wind action will be minimized by implementing an erosion control plan. The Certificate Holder will notify ODOE in the event that site investigations or trenching reveal conditions in the foundation rock different from what was evaluated, or if shear zones, artesian aquifers, deformations, or clastic dikes are found in the vicinity of the site.
- The Certificate Holder has demonstrated that the Carty Solar Farm with proposed RFA 4 changes can be designed, engineered, and constructed to avoid human safety and environment impacts from geological and soil hazards, per OAR 345-022-0020(1)(d). 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 Carty Solar Farm with proposed RFA 4 changes. 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.

- Finally, the Certificate Holder has assessed future climate conditions for the expected life span of the Carty Solar Farm with proposed RFA 4 changes, and the potential impacts of those conditions on the Carty Solar Farm with proposed RFA 4 changes.

Therefore, for the reasons outlined in this exhibit, the construction and operation of the proposed Carty Solar Farm with proposed RFA 4 changes will comply with the structural standards as outlined in OAR 345-022-0020, as well as the standard in OAR 345-021-0010(1)(h).

12.0 References

- ASCE (American Society of Civil Engineers). 2026. ASCE Hazard Tool. <https://asce7hazardtool.online/> Accessed October 2026.
- Cornforth (Cornforth Consultants). 2009. Preliminary Geotechnical Investigation for the Proposed Carty Generating Station, Boardman, Oregon. Prepared by Cornforth Consultants, November 11, 2009.
- Cornforth. 2016. Preliminary Geotechnical/Geological Investigations, Carty Generating Station - Photovoltaic Solar Facility Project, Boardman, Oregon. Prepared by Cornforth Consultants, May 27, 2016.
- Council (Energy Facility Siting Council). 2022. Third Amended Site Certificate for the Carty Generating Station. Energy Facility Siting Council, Salem, Oregon. July 2022.
- DOGAMI (Oregon Department of Geology and Mineral Industries). 2010. Creating a culture of preparedness—Oregon’s earthquake risk and resiliency. *Cascadia*, Winter 2010. DOGAMI, Oregon. <https://www.oregongeology.org/pubs//cascadia/CascadiaWinter2010.pdf>
- DOGAMI 2026a. Geologic Map of Oregon. <https://gis.dogami.oregon.gov/maps/geologicmap/> and [DOGAMI - Digital Data Publication Preview - OGDC-6. Oregon Geologic Data Compilation. release 6.](https://www.oregongeology.org/pubs//tim/p-TIM-overview.htm) Accessed October 2026.
- DOGAMI. 2026b. Oregon HazVu: Statewide Geohazards Viewer. <https://gis.dogami.oregon.gov/maps/hazvu/>. Accessed October 2026.
- DOGAMI. 2026c. Tsunami Inundation Map (TIM) Series. <https://www.oregongeology.org/pubs//tim/p-TIM-overview.htm>. Accessed October 2026.
- DOGAMI. 2026d. Statewide Landslide Information Database for Oregon (SLIDO-4.4). <https://www.oregongeology.org/slido/data.htm>. Accessed October 2026.

- FEMA (Federal Emergency Management Agency). 2026. FEMA National Flood Hazard Layer. <https://www.fema.gov/national-flood-hazard-layer-nfhl>. Accessed October 2026.
- ICC (International Code Council). 2024. 2024 International Building Code (IBC). International Code Council, Washington D.C. <https://www.oregongeology.org/pubs/tim/p-TIM-overview.htm>.
- Michalak, J., J. Withley, J. Lawler, and T. Nogeire. 2014. Climate Vulnerability and Adaptation in the Columbia Plateau, Wa. Prepared for the Great Northern Landscape Conservation Cooperative, University of Washington, Seattle, Washington. https://www.researchgate.net/publication/267750432_Climate_Vulnerability_and_Adaptation_in_the_Columbia_Plateau_Washingtonw.
- Niewendorp, C.A., and M.E. Newhouse. 2003. Map of selected earthquakes for Oregon 1841-2002. Open-File Report O-03-02. DOGAMI, Oregon.
- NOAA (National Oceanic and Atmospheric Administration). 2026. U.S. Climate Normals Quick Access. Station: Boardman Station USC00350858. [NOAA NCEI U.S. Climate Normals Quick Access](#).
- NPS (National Park Service). 2026. Physiographic Provinces Map. <https://www.nps.gov/subjects/geology/physiographic-provinces.htm>. Accessed October 2026.
- NRCS (Natural Resource Conservation Service). 2023. Web Soil Survey. <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>. Accessed September 2023.
- Shannon & Wilson. 1975. Geotechnical Investigation Boardman Plant Poverty Ridge Site, Morrow County, Oregon. Prepared by Shannon & Wilson, Inc., November 1975.
- Shannon & Wilson. 1976. Supplemental Report - Geotechnical Investigation Boardman Plant Poverty Ridge Site, Morrow County, Oregon. Prepared by Shannon & Wilson, Inc., April 1976.
- OSSPAC (Oregon Seismic Safety Policy Advisory Commission). 2013. The Oregon Resilience Plan. Salem, Oregon. February 2013. https://www.oregon.gov/oem/documents/oregon_resilience_plan_final.pdf
- State of Oregon. 2025. 2025 Oregon Structural Specialty Code (OSSC). Building Codes Division, State of Oregon. Salem, Oregon. <https://www.oregon.gov/bcd/codes-stand/Documents/25ossch01.pdf>
- Terracon (Terracon Consultants, Inc.). 2013. Geotechnical Engineering Report, Carty Power Generation Facility, near Boardman, Oregon. Prepared by Terracon Consultants, Inc., September 27, 2013.
- USGS (U.S. Geological Survey). 2026a. Geologic Map Viewer. https://ngmdb.usgs.gov/Prodesc/proddesc_82680.htm. Accessed October 2026.
- USGS. 2026b. Quaternary Fault and Fold Database. <https://www.usgs.gov/programs/earthquake-hazards/faults>. Accessed October 2026.

USGS. 2026c. Earthquake Hazard Toolbox. <https://earthquake.usgs.gov/nshmp/hazard/disagg/>. Accessed October 2026.

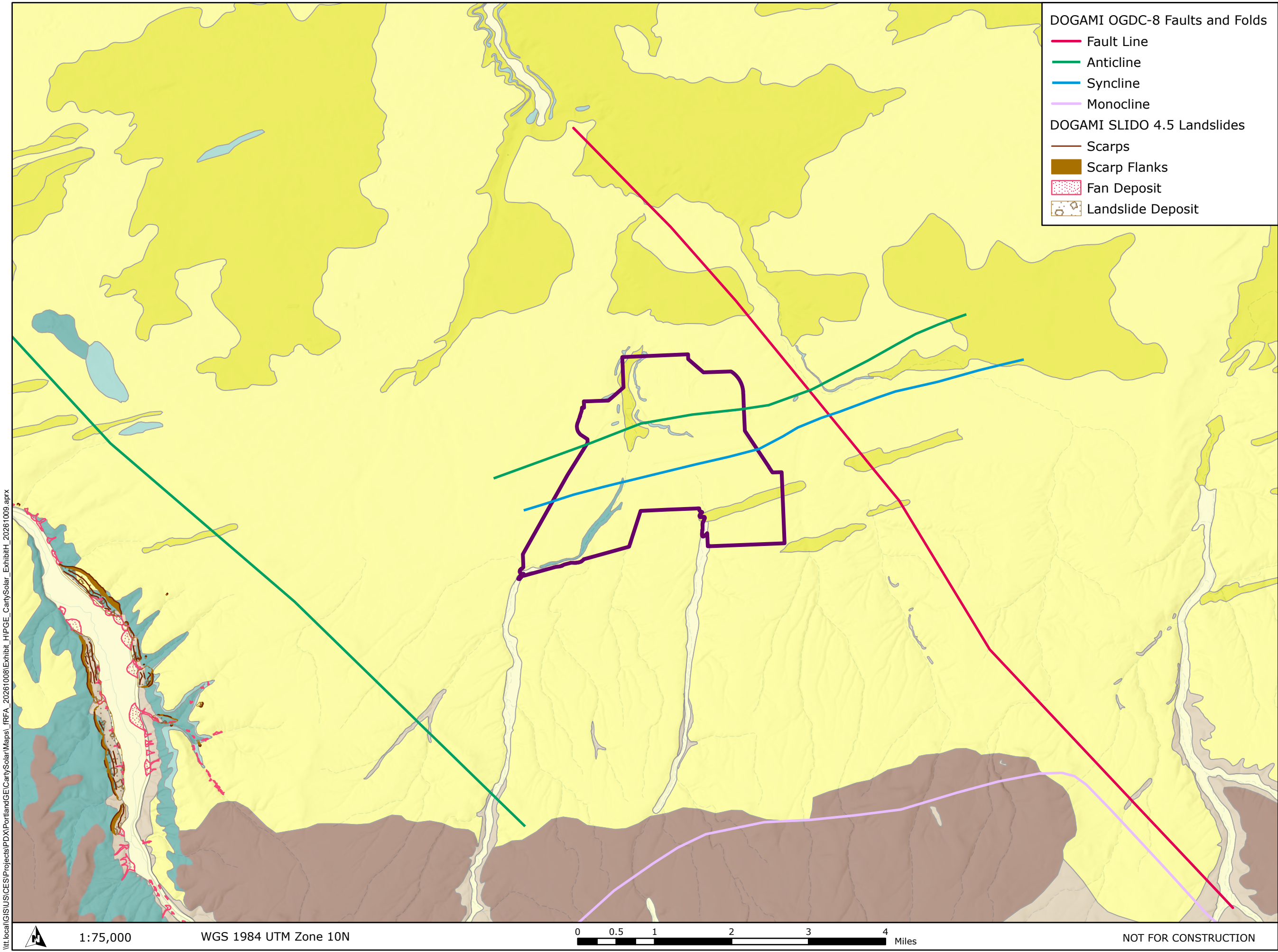
USGS. 2026d. Latest Earthquakes Interactive Map and Catalog. Version 1.3.1. U.S. Geological Survey. <https://earthquake.usgs.gov/earthquakes/map>. Accessed October 2026.

Wong, I.G., and J.D.J. Bott, 1995, A look back at Oregon's earthquake history, 1841-1994: Oregon Department of Geology and Mineral Industries, Oregon Geology, Vol. 57, no. 6, p. 125-139. Available online: <https://pubs.oregon.gov/dogami/og/OGv57n06.pdf>. Accessed December 2023.

Figures

This page intentionally left blank

\\tt.local\GIS\US\CES\Projects\PD\X\Portland\GE\CartySolar\Maps_IRFA_2026\1008\Exhibit_HIPGE_CartySolar_2026\1009.aprx



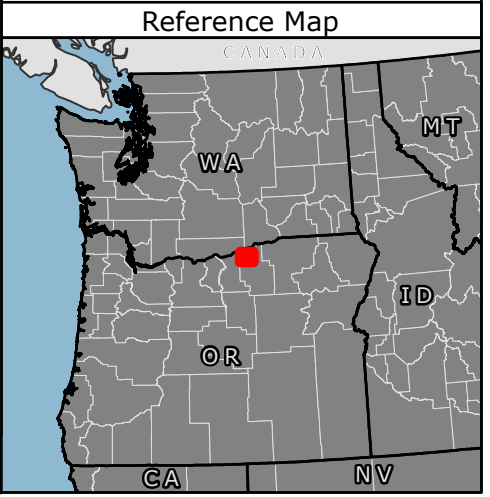
- DOGAMI OGDC-8 Faults and Folds**
- Fault Line
 - Anticline
 - Syncline
 - Monocline
- DOGAMI SLIDO 4.5 Landslides**
- Scarps
 - Scarp Flanks
 - Fan Deposit
 - Landslide Deposit

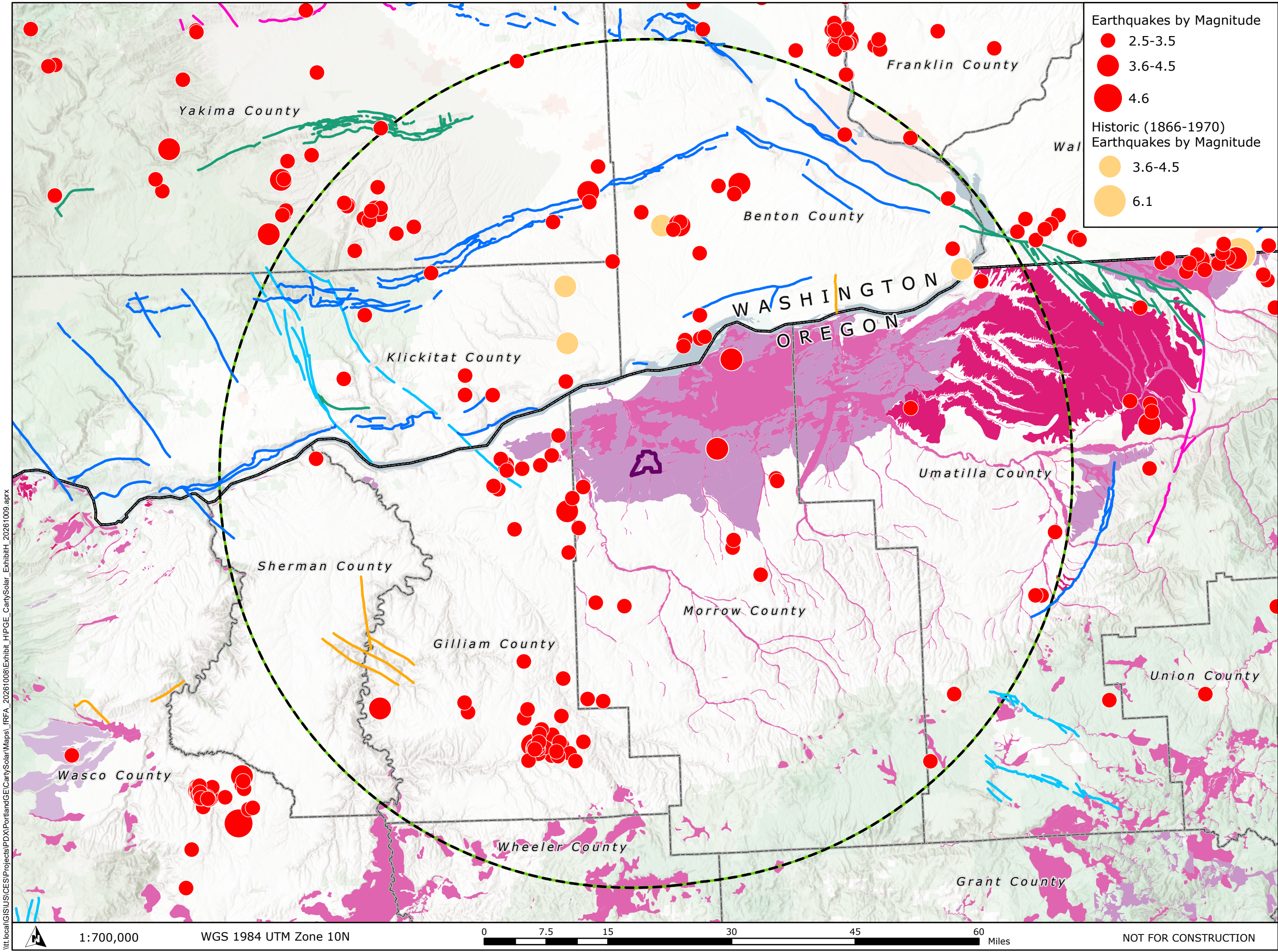
Carty Generating Station Request for Amendment 4

Figure H-1 Geologic Map

MORROW COUNTY, OR

- Amended Site Boundary
- DOGAMI Surface Geology**
- Qal - Alluvium (Quaternary)
 - Qe - Eolian sand and ash (Quaternary)
 - Qmf - Missoula Flood deposits (Quaternary)
 - Tem - Saddle Mountains Basalt, Elephant Mountain member (Miocene)
 - Tp - Saddle Mountains Basalt, Pomona basalt (Miocene)
 - Tf - Wanapum Basalt, Undifferentiated Frenchman Springs flows (Miocene)
 - Tac - Alkali Canyon Formation (Miocene/Pliocene)
- TETRA TECH PGE





Earthquakes by Magnitude

- 2.5-3.5
- 3.6-4.5
- 4.6

Historic (1866-1970) Earthquakes by Magnitude

- 3.6-4.5
- 6.1

Carty Generating Station Request for Amendment 4

Figure H-2 Historical Seismicity and Potentially Active Faults

MORROW COUNTY, OR

Amended Site Boundary

Analysis Area (50-mile Buffer)

County Boundary

State Boundary

Fault Age

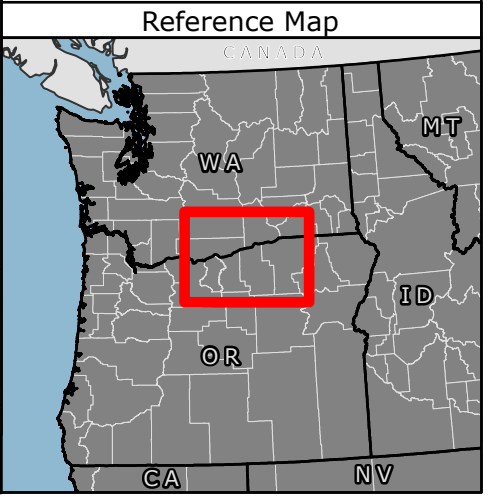
- Class B
- Late Quaternary
- Latest Quaternary
- Middle and Late Quaternary
- Undifferentiated Quaternary

Liquefaction Susceptibility

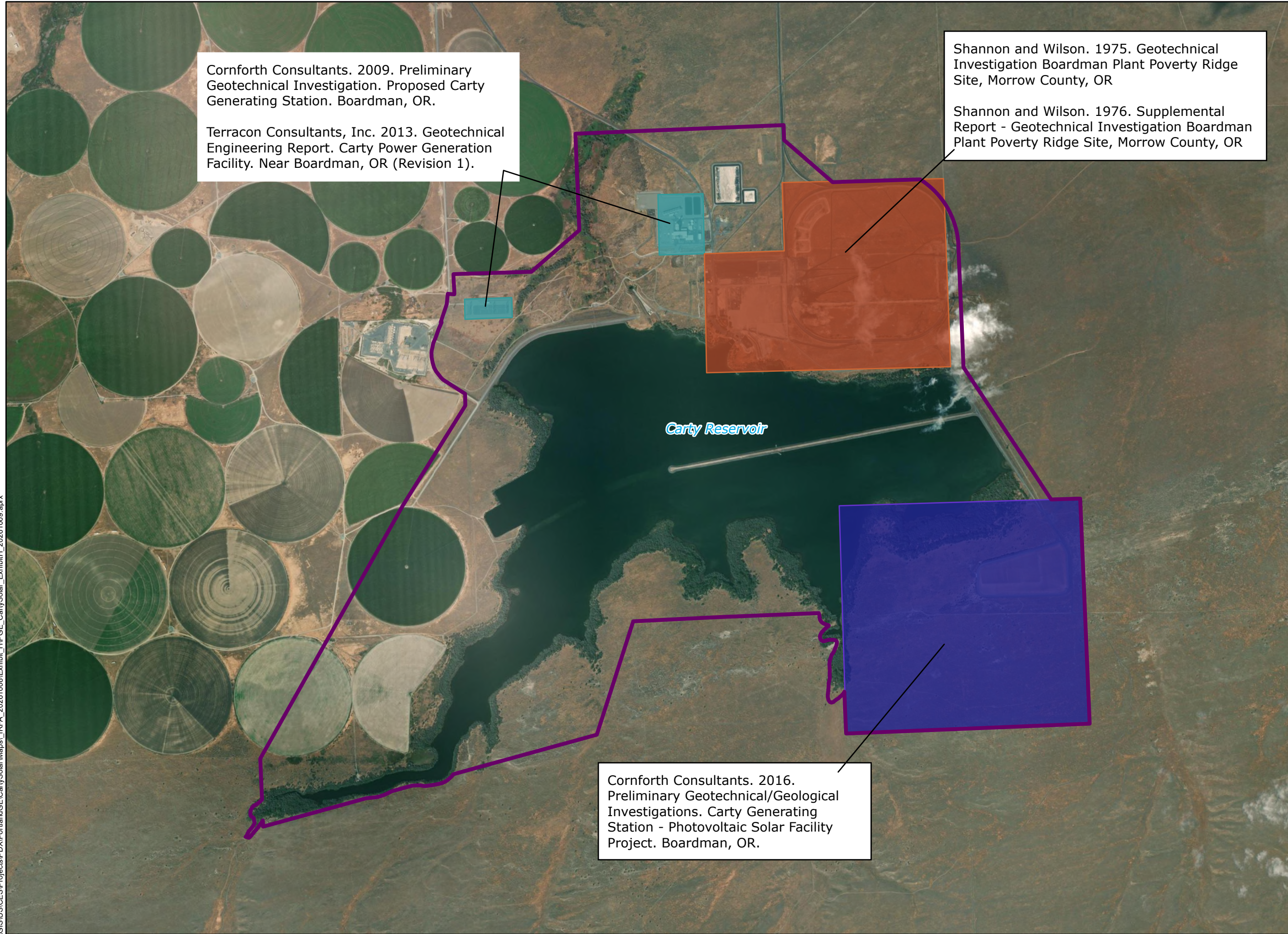
- 0 - None
- 1 - Very Low
- 2 - Low
- 3 - Moderate
- 4 - High
- 5 - Very High

TETRA TECH

PGE



\\t.local\GIS\USCES\Projects\PDX\Portland\GECartySolar\Maps\FRA_20261008\Exhibit_HIPGE_CartySolar_20261009.aprx



Cornforth Consultants. 2009. Preliminary Geotechnical Investigation. Proposed Carty Generating Station. Boardman, OR.

Terracon Consultants, Inc. 2013. Geotechnical Engineering Report. Carty Power Generation Facility. Near Boardman, OR (Revision 1).

Shannon and Wilson. 1975. Geotechnical Investigation Boardman Plant Poverty Ridge Site, Morrow County, OR

Shannon and Wilson. 1976. Supplemental Report - Geotechnical Investigation Boardman Plant Poverty Ridge Site, Morrow County, OR

Carty Reservoir

Cornforth Consultants. 2016. Preliminary Geotechnical/Geological Investigations. Carty Generating Station - Photovoltaic Solar Facility Project. Boardman, OR.

**Carty
Generating Station
Request for
Amendment 4**

**Figure H-3
Approximate Locations
of Previous Geotechnical
Investigations**

MORROW COUNTY, OR

Amended Site Boundary



Reference Map



Carty Generating Station Request for Amendment 4

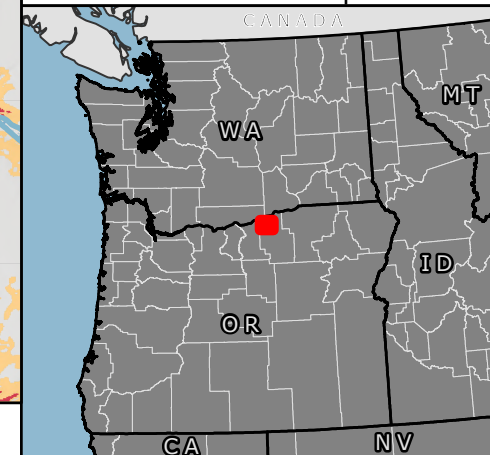
Figure H-4 Special Flood Hazards and Landslide Hazards

MORROW COUNTY, OR

- Amended Site Boundary
- County Boundary
- River/Stream
- Historic Landslides
- SLIDO Landslide Susceptibility
 - Low
 - Moderate
 - High
- FEMA Special Flood Hazard Areas
 - Zone A, 1% Annual Chance Flood Hazard
 - Zone X, 0.2% Annual Chance Flood Hazard
 - Zone X, Area of Minimal Flood Hazard



Reference Map



\\tt.local\GIS\US\CES\Projects\PD\X\Portland\GECartySolar\Maps_IRFA_20261008\Exhibit_HIPGE_CartySolar\Exhibit_20261009.aprx



1:75,000

WGS 1984 UTM Zone 10N

0 0.5 1 2 3 4 Miles

NOT FOR CONSTRUCTION

Attachment H-1. Record of Correspondence with DOGAMI

This page intentionally left blank



Memorandum

Date: December 13, 2023
Project: Request for Amendment 4 to the Site Certificate for the Carty Generating Station
Subject: DOGAMI Consultation for Request for Amendment 4 to the Site Certificate within the Oregon Energy Facility Siting Council Process (Exhibit H)

Conference Call Meeting with Oregon Department of Geology and Mineral Industries (DOGAMI), December 8, 2023, at 12 pm PST

A virtual meeting was held to discuss seismicity, geology, and soils for the forthcoming Request for Amendment 4 (RFA 4) to the Site Certificate for the Carty Generating Station (CGS). The Certificate Holder is the Portland General Electric Company (PGE). RFA 4 involves increasing the output from photovoltaic solar energy generation and the addition of a battery energy storage system (Project) to the approved CGS. The main purpose for the meeting was to consult with DOGAMI and get that agency's input for inclusion in Exhibit H for RFA 4. Attendees included the following: Jason McClaughry (DOGAMI), Lenna Cope (PGE), Mike Abel (PGE), Brian Boehm (Black & Veatch), Brian Christensen (Black & Veatch), Paul Seilo (Tetra Tech), and Rachel Miller (Tetra Tech).

The following Project information was presented (via a PowerPoint presentation) from the draft Exhibit H for RFA 4:

- Lenna (PGE) and Paul (Tetra Tech) provided a Project overview including a map of the overall Project features and vicinity.
- Rachel (Tetra Tech) discussed the resources and methods used for the geology and geologic hazards analyses to be included in RFA 4.
- Rachel also discussed the geologic hazards studies and results to be included in RFA 4, including maps of the geology of the area, a map of seismic information including earthquakes and faults, and a map of landslide and floodplains hazards.
- Lenna and attendees from Black & Veatch provided an overview of the planned geotechnical work that would be performed during the pre-construction phase of the improvements proposed with RFA 4. The geotechnical work would focus on seismic, geologic, and soils hazards identified during the research conducted for Exhibit H as well as additional geotechnical desktop research.

The following feedback was received from DOGAMI:

- Jason (DOGAMI) indicated that earthquake data that might be more up to date than what is available from the USGS should be reviewed and included on the earthquake map. This would be DOGAMI data. He indicated that he would provide a link to the data (**Action Item**).
- Jason stated that the information, in general, looked good for what is required for Exhibit H. He made some recommendations on how to more easily distinguish between geologic features shown on one of the maps (i.e., use colors that are less similar).
- Jason asked how much of the planned geotechnical work that would be performed during the pre-construction phase would be desktop versus field work. Black & Veatch explained that it will be a mix of both and gave Jason examples of each.
- Jason also requested that the planned field locations for borings should be specific and connected to specific coordinates on the ground. Black & Veatch indicated the boring locations would be specified prior to the field work and each would be tied to specific recommended coordinates.

From: [MCCLAUGHRY Jason * DGMI](#)
To: [Miller, Rachel](#)
Cc: [Seilo, Paul](#); [Short, Kristy](#)
Subject: RE: DOGAMI earthquake epicenter data
Date: Tuesday, December 19, 2023 3:14:11 PM

CAUTION: This email originated from an external sender. Verify the source before opening links or attachments.

Hi Rachel:

Thanks for the email. We have been discussing this internally and trying to come to a best decision as our earthquake epicenters are not directly available as GIS files through HazVu. Our data is composited from a number of available sources (both recording stations, published literature, and gray literature) and also may not be necessarily completely up to date as of 2023. It also is not easily shareable. So, I think we have concluded that using the USGS referenced epicenters you showed is acceptable for your purpose. They generally characterize the hazard and are an accessible published resource. Ideally one might compile all available data from the regional recording stations but this could be a large task outside the scope of what you are doing. I hope this helps and please let us know if we can be of further assistance.

A majority of DOGAMI's historic earthquake data come from this paper. Wong, I.G., and Bott, J.D.J, 1995, A look back at Oregon's earthquake history, 1841-1994: Oregon Department of Geology and Mineral Industries, Oregon Geology, Vol. 57, no. 6, p. 125-139.

Best Regards,
Jason

Jason D. McClaughry, R.G.
Geological Survey and Services Program Manager
Oregon Department of Geology and Mineral Industries
Baker City| 1995 3rd Street, Suite 130| Baker City, Oregon 97814
Portland| 800 NE Oregon Street, Suite 965| Portland, Oregon 97232
Cell: (541) 519-3419
jason.mcclaughry@dogami.oregon.gov | www.oregon.gov/dogami

Unless otherwise indicated, all information in this correspondence is classified as Level 1, "Published" according to State of Oregon statute and administrative policy.

From: Miller, Rachel <rachel.miller@tetrattech.com>
Sent: Tuesday, December 19, 2023 1:05 PM
To: MCCLAUGHRY Jason * DGMI <Jason.MCCLAUGHRY@dogami.oregon.gov>
Cc: Seilo, Paul <PAUL.SEILO@tetrattech.com>; Short, Kristy <KRISTY.SHORT@tetrattech.com>
Subject: DOGAMI earthquake epicenter data
Importance: High

Hi Jason,

I know you must be busy. We need to wrap up an application to submit to ODOE ASAP. Can you

provide the link to download the specialized DOGAMI earthquake epicenter information ASAP?

FYI – we can view the information on HazVu, but all the links to download the data send our GIS staff back to the NEIC site for the USGS which is the source of the earthquake data we already have.

I will try to call later today.

Thanks,

Rachel Miller | Senior Geologist/Hydrogeologist P.G.

Mobile: 720-771-3452

rachel.miller@tetrattech.com

Tetra Tech, Inc. | Sciences

390 Union Boulevard, Suite 400 | Lakewood, CO 80228 | www.tetrattech.com

PLEASE NOTE: This message, including any attachments, may include confidential and/or inside information. Any distribution or use of this communication by anyone other than the intended recipient is strictly prohibited and may be unlawful. If you are not the intended recipient, please notify the sender by replying to this message and then delete it from your system.



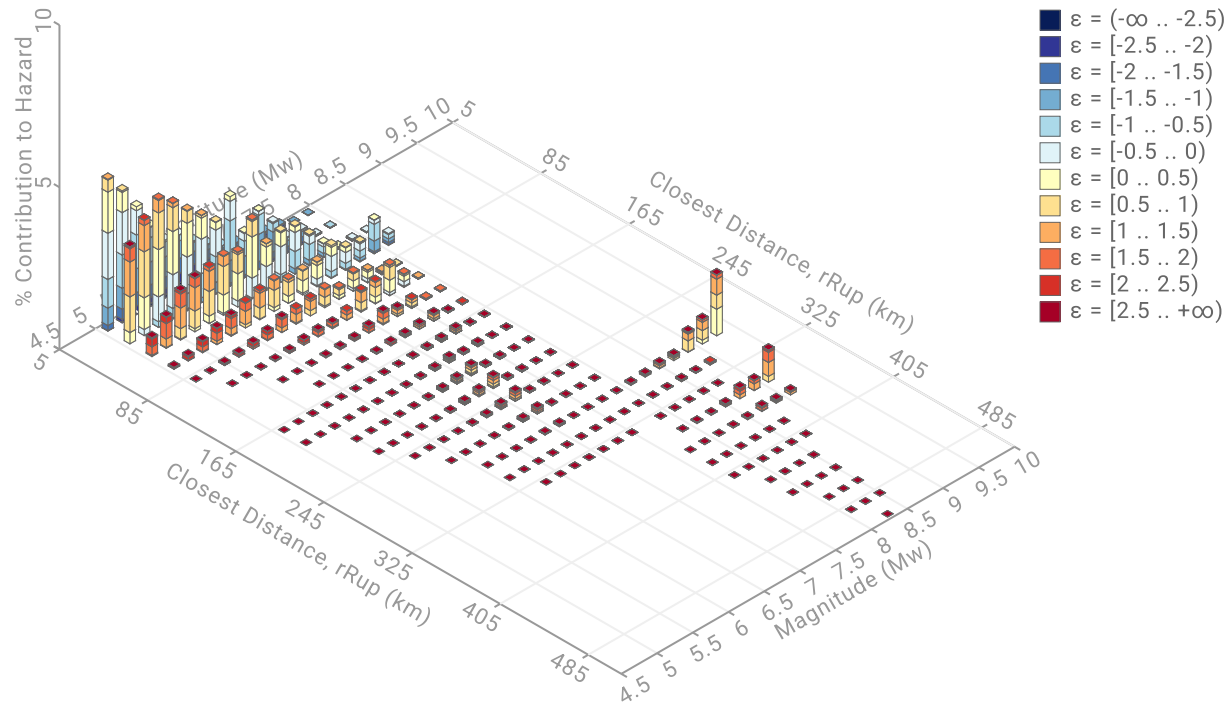
Think Green - Not every email needs to be printed.

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

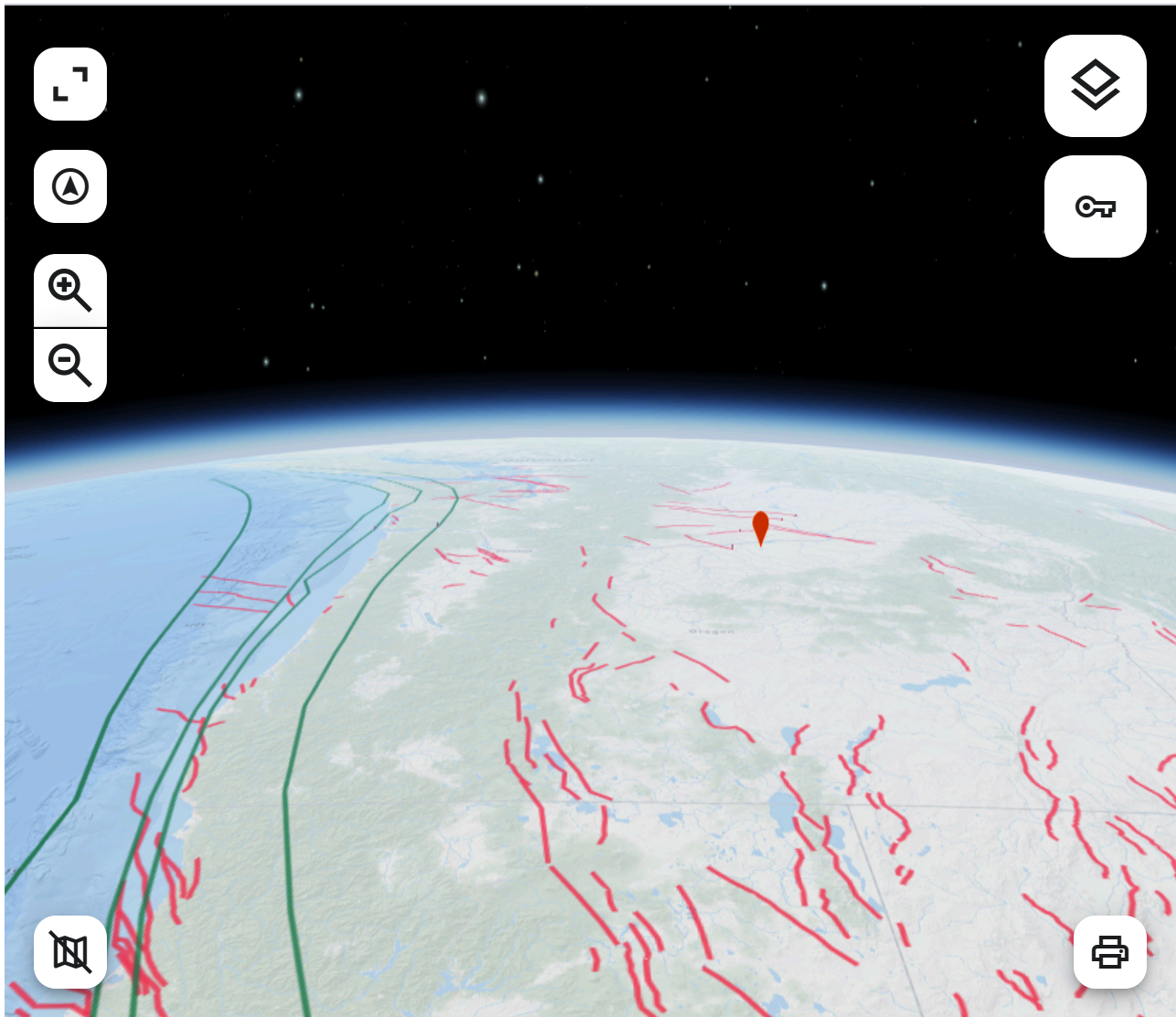
This page intentionally left blank

Disaggregation Report

Disaggregation



Geographical Disaggregation



Oregon State Parks | WA State Parks GIS | CHS | Esri | GEBCO | TomTom | Garmin | Natu... Powered by [Esri](#)

Parameter Summary

Model: Conterminous U.S. 2023.R2
Latitude: 45.694677 °
Longitude: -119.817594 °
Site Class: C (Vs30 530)

Intensity Measure Type: PGA
Return Period: 475 (10% in 50)
Component: Total



Disaggregation Summary: Total

Disaggregation targets

Return period : 475 yrs

Exceedance rate : $2.105\text{e-}3 \text{ yr}^{-1}$

PGA ground motion : $6.839\text{e-}2 \text{ g}$

Recovered targets

Return period : 472.3178 yrs

Exceedance rate : $2.117\text{e-}3 \text{ yr}^{-1}$

Totals

Binned : 100 %

Residual : 0 %

Trace : 1.41 %

Mean (over all sources)

m : 6.38

r : 64.45 km

ϵ_0 : 0.09σ

Mode (largest m-r bin)

m : 5.1

r : 12.51 km

ϵ_0 : -0.29σ

Contribution : 4.67 %

Mode (largest m-r- ϵ_0 bin)

m : 5.5

r : 27.08 km

ϵ_0 : 0.26σ

Contribution : 1.46 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ϵ : min = -3.0, max = 3.0, Δ = 0.5σ

Epsilon keys

$\epsilon 0$: $[-\infty \dots -2.5)$

$\epsilon 1$: $[-2.5 \dots -2.0)$

$\epsilon 2$: $[-2.0 \dots -1.5)$

$\epsilon 3$: $[-1.5 \dots -1.0)$

$\epsilon 4$: $[-1.0 \dots -0.5)$

$\epsilon 5$: $[-0.5 \dots 0.0)$

$\epsilon 6$: $[0.0 \dots 0.5)$

$\epsilon 7$: $[0.5 \dots 1.0)$

$\epsilon 8$: $[1.0 \dots 1.5)$

$\epsilon 9$: $[1.5 \dots 2.0)$

$\epsilon 10$: $[2.0 \dots 2.5)$

$\epsilon 11$: $[2.5 \dots +\infty]$

Disaggregation Contributions: Total

Source Set	Source	Type	r	m	ϵ_0	lon	lat	az	%
WUS Branch Average (opt)		Grid							76.14
WUS Branch Average		FaultSystem							14.87
	Arlington - Shutler Butte (0)		24.85	6.76	-1.14	120.131°W	45.652°N	259.06	2.84
	Uhtanum Ridge - Gable Mountain (5)		62.60	7.78	-0.84	119.386°W	46.522°N	19.73	1.87
	Horse Heaven Hills (4)		45.93	6.99	-0.46	119.957°W	46.144°N	347.88	1.4
	Saddle Mountains (7)		106.16	7.45	0.46	119.167°W	46.701°N	23.86	1.11
Cascadia (full, bottom)		Interface							3.03
	Cascadia (full, bottom)		288.66	9.15	0.83	123.413°W	46.300°N	284.91	3.03
WA Intralab		Slab							2.25
Cascadia (full, middle)		Interface							1.51
	Cascadia (full, middle)		341.80	8.97	1.44	124.137°W	46.300°N	282.95	1.51

Switch Applications



Open an application in a new tab with the current control panel values

 Dynamic Hazard Curves

 Risk-Targeted Ground Motion

 Model Maps

 NCM Geophysical Profiles

 Magnitude Frequency Distribution

 Earthquake Rates and Probabilities



Application Metadata

Application: Disaggregation

Version: 22.5.0

URL: <https://earthquake.usgs.gov/nshmp/hazard/disagg>

Repository : nshmp-apps

Version: 22.5.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-apps>

Repository : nshmp-lib-ng

Version: 22.9.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-lib-ng>

Repository : nshmp-template

Version: 22.8.9

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-template>

Repository : nshmp-haz

Version: 2.11.4

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-haz>

Repository : nshmp-lib

Version: 1.7.22

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-lib>

Repository : nshm-conus

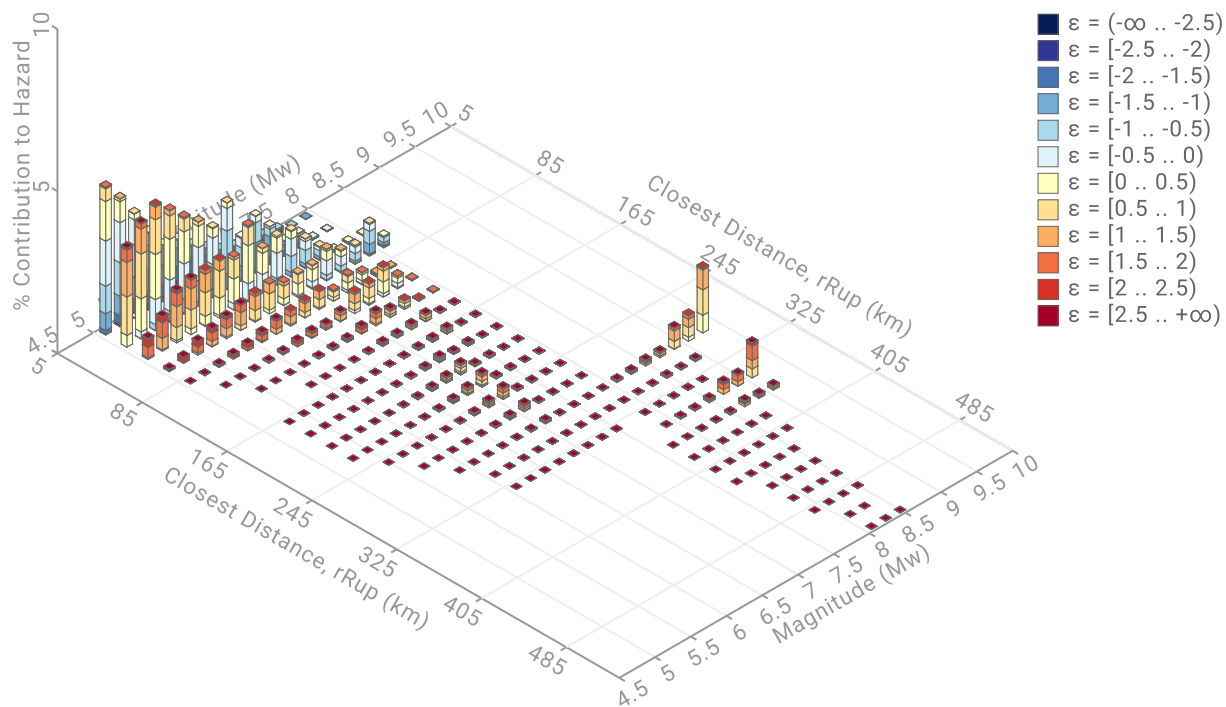
Version: 6.2.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git>

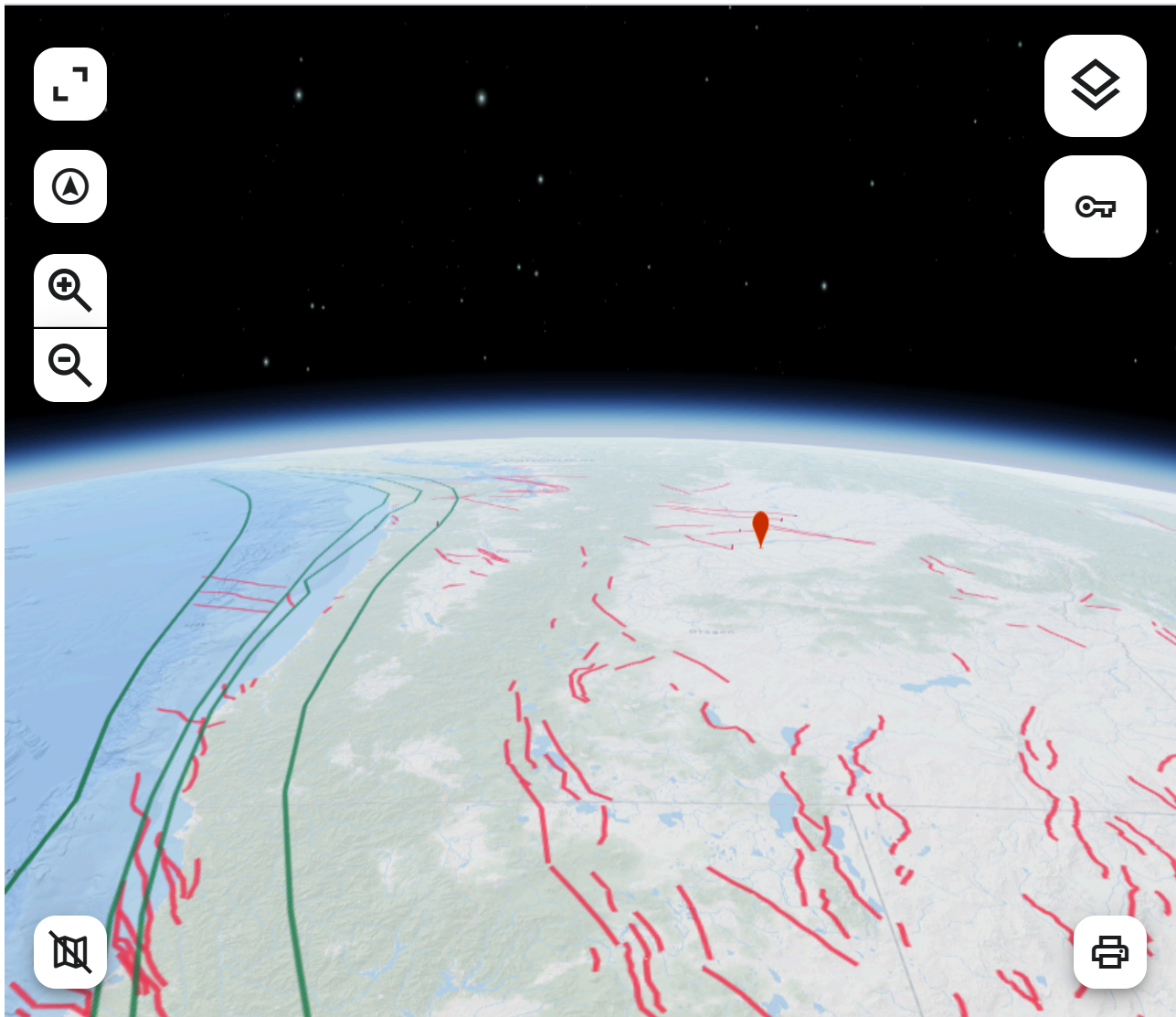
October 15, 2026, 12:08 PM

Disaggregation Report

Disaggregation



Geographical Disaggregation



Oregon State Parks | WA State Parks GIS | CHS | Esri | GEBCO | TomTom | Garmin | Natu... Powered by [Esri](#)

Parameter Summary

Model: Conterminous U.S. 2023.R2

Intensity Measure Type: PGA

Latitude: 45.694677 °

Return Period: 475 (10% in 50)

Longitude: -119.817594 °

Component: Total

Site Class: D (Vs30 260)



Disaggregation Summary: Total

Disaggregation targets

Return period : 475 yrs

Exceedance rate : $2.105\text{e-}3 \text{ yr}^{-1}$

PGA ground motion : $9.061\text{e-}2 \text{ g}$

Recovered targets

Return period : 474.52497 yrs

Exceedance rate : $2.107\text{e-}3 \text{ yr}^{-1}$

Totals

Binned : 100 %

Residual : 0 %

Trace : 1.58 %

Mean (over all sources)

m : 6.39

r : 67.48 km

ϵ_0 : 0.16σ

Mode (largest m-r bin)

m : 5.1

r : 12.51 km

ϵ_0 : -0.27σ

Contribution : 4.55 %

Mode (largest m-r- ϵ_0 bin)

m : 5.1

r : 12.72 km

ϵ_0 : -0.23σ

Contribution : 1.39 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ϵ : min = -3.0, max = 3.0, Δ = 0.5σ

Epsilon keys

ϵ_0 : $[-\infty \dots -2.5)$

ϵ_1 : $[-2.5 \dots -2.0)$

ϵ_2 : $[-2.0 \dots -1.5)$

ϵ_3 : $[-1.5 \dots -1.0)$

ϵ_4 : $[-1.0 \dots -0.5)$

ϵ_5 : $[-0.5 \dots 0.0)$

ϵ_6 : $[0.0 \dots 0.5)$

ϵ_7 : $[0.5 \dots 1.0)$

ϵ_8 : $[1.0 \dots 1.5)$

ϵ_9 : $[1.5 \dots 2.0)$

ϵ_{10} : $[2.0 \dots 2.5)$

ϵ_{11} : $[2.5 \dots +\infty]$

Disaggregation Contributions: Total

Source Set	↪	Source	Type	r	m	ϵ_0	lon	lat	az	%
WUS Branch Average (opt)			Grid							75.52
WUS Branch Average			FaultSystem							14.48
		Arlington - Shutler Butte (0)		24.85	6.76	-1.05	120.131°W	45.652°N	259.06	2.77
		Uhtanum Ridge - Gable Mountain (5)		62.60	7.78	-0.78	119.386°W	46.522°N	19.73	1.81
		Horse Heaven Hills (4)		45.93	6.99	-0.40	119.957°W	46.144°N	347.88	1.35
		Saddle Mountains (7)		106.16	7.45	0.46	119.167°W	46.701°N	23.86	1.08
Cascadia (full, bottom)			Interface							3.23
		Cascadia (full, bottom)		288.66	9.15	0.88	123.413°W	46.300°N	284.91	3.23
WA Intralab			Slab							2.57
Cascadia (full, middle)			Interface							1.66
		Cascadia (full, middle)		341.80	8.97	1.45	124.137°W	46.300°N	282.95	1.66

Switch Applications



Open an application in a new tab with the current control panel values

 Dynamic Hazard Curves

 Risk-Targeted Ground Motion

 Model Maps

 NCM Geophysical Profiles

 Magnitude Frequency Distribution

 Earthquake Rates and Probabilities



Application Metadata

Application: Disaggregation

Version: 22.5.0

URL: <https://earthquake.usgs.gov/nshmp/hazard/disagg>

Repository : nshmp-apps

Version: 22.5.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-apps>

Repository : nshmp-lib-ng

Version: 22.9.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-lib-ng>

Repository : nshmp-template

Version: 22.8.9

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-template>

Repository : nshmp-haz

Version: 2.11.4

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-haz>

Repository : nshmp-lib

Version: 1.7.22

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-lib>

Repository : nshm-conus

Version: 6.2.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git>

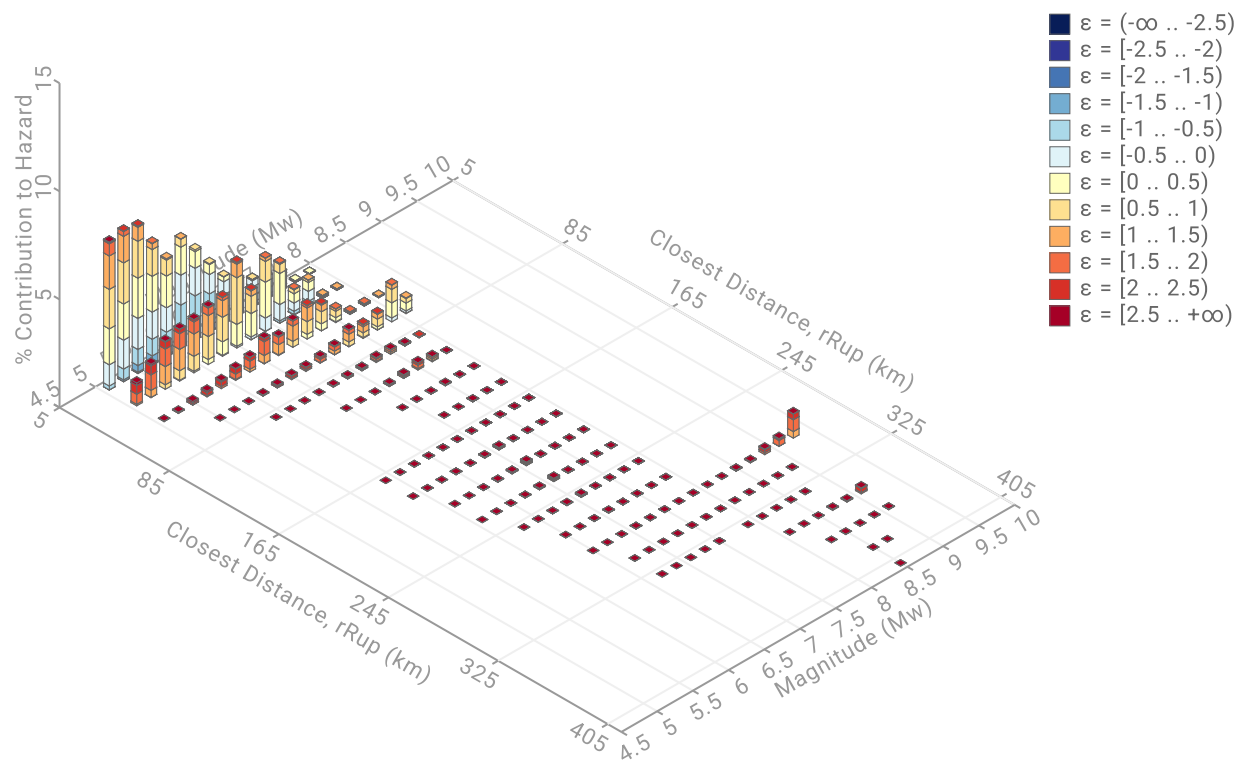
October 15, 2026, 12:08 PM

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

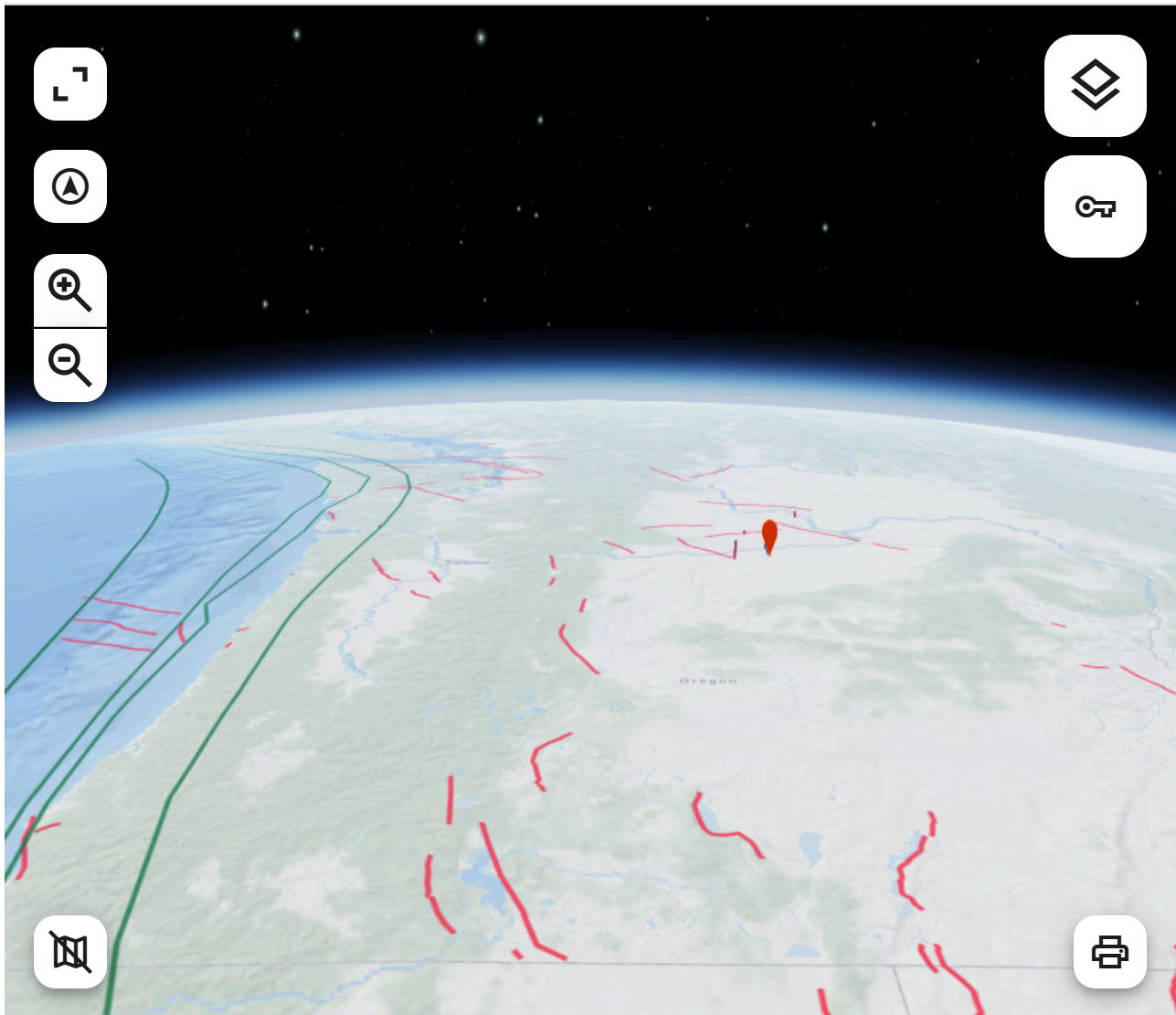
This page intentionally left blank

Disaggregation Report

Disaggregation



Geographical Disaggregation



Oregon State Parks | WA State Parks GIS | CHS | Esri | GEBCO | TomTom | Garmin | Natu... Powered by [Esri](#)

Parameter Summary

Model: Conterminous U.S. 2023.R2

Intensity Measure Type: PGA

Latitude: 45.694677 °

Return Period: 2475 (2% in 50)

Longitude: -119.817594 °

Component: Total

Site Class: C (Vs30 530)



Disaggregation Summary: Total

Disaggregation targets

Return period : 2475 yrs

Exceedance rate : 4.040e-4 yr⁻¹

PGA ground motion : 1.739e-1 g

Recovered targets

Return period : 2447.6389 yrs

Exceedance rate : 4.086e-4 yr⁻¹

Totals

Binned : 100 %

Residual : 0 %

Trace : 0.91 %

Mean (over all sources)

m : 6.31

r : 32.85 km

ε₀ : 0.48 σ

Mode (largest m-r bin)

m : 5.3

r : 11.22 km

ε₀ : 0.43 σ

Contribution : 6.95 %

Mode (largest m-r-ε₀ bin)

m : 6.5

r : 26.37 km

ε₀ : 0.71 σ

Contribution : 2.16 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]



Disaggregation Contributions: Total

Source Set	Source	Type	r	m	ϵ_0	lon	lat	az	%
WUS Branch Average (opt)		Grid							81.73
	PointSourceFinite: -119.818, 45.789		10.54	5.75	-0.03	119.818°W	45.789°N	0.00	1.57
	PointSourceFinite: -119.818, 45.816		12.86	5.84	0.17	119.818°W	45.816°N	0.00	1.57
	PointSourceFinite: -119.818, 45.798		11.31	5.78	0.04	119.818°W	45.798°N	0.00	1.57
	PointSourceFinite: -119.818, 45.771		9.04	5.70	-0.23	119.818°W	45.771°N	0.00	1.5
	PointSourceFinite: -119.818, 45.753		7.61	5.65	-0.41	119.818°W	45.753°N	0.00	1.48
	PointSourceFinite: -119.818, 45.780		9.79	5.72	-0.15	119.818°W	45.780°N	0.00	1.47
	PointSourceFinite: -119.818, 45.762		8.31	5.67	-0.32	119.818°W	45.762°N	0.00	1.46
	PointSourceFinite: -119.818, 45.789		11.57	5.77	0.03	119.818°W	45.789°N	0.00	1.46
	PointSourceFinite: -119.818, 45.798		12.35	5.80	0.10	119.818°W	45.798°N	0.00	1.45
	PointSourceFinite: -119.818, 45.816		13.91	5.85	0.23	119.818°W	45.816°N	0.00	1.45
	PointSourceFinite: -119.818, 45.807		12.08	5.81	0.11	119.818°W	45.807°N	0.00	1.44
	PointSourceFinite: -119.818, 45.825		13.64	5.87	0.23	119.818°W	45.825°N	0.00	1.43
	PointSourceFinite: -119.818, 45.771		10.06	5.71	-0.17	119.818°W	45.771°N	0.00	1.4
	PointSourceFinite: -119.818, 45.753		8.60	5.67	-0.34	119.818°W	45.753°N	0.00	1.38
	PointSourceFinite: -119.818, 45.780		10.81	5.74	-0.09	119.818°W	45.780°N	0.00	1.36
	PointSourceFinite: -119.818, 45.762		9.32	5.69	-0.25	119.818°W	45.762°N	0.00	1.36
	PointSourceFinite: -119.818, 45.834		14.42	5.90	0.29	119.818°W	45.834°N	0.00	1.34
	PointSourceFinite: -119.818, 45.807		13.13	5.83	0.16	119.818°W	45.807°N	0.00	1.33
	PointSourceFinite: -119.818, 45.825		14.70	5.88	0.28	119.818°W	45.825°N	0.00	1.32
	PointSourceFinite: -119.818, 45.852		15.99	5.96	0.39	119.818°W	45.852°N	0.00	1.26
	PointSourceFinite: -119.818, 45.735		6.32	5.61	-0.59	119.818°W	45.735°N	0.00	1.25
	PointSourceFinite: -119.818, 45.834		15.48	5.91	0.34	119.818°W	45.834°N	0.00	1.24
	PointSourceFinite: -119.818, 45.843		15.21	5.93	0.34	119.818°W	45.843°N	0.00	1.22
	PointSourceFinite: -119.818, 45.861		16.80	5.98	0.45	119.818°W	45.861°N	0.00	1.19
	PointSourceFinite: -119.818, 45.735		7.23	5.63	-0.52	119.818°W	45.735°N	0.00	1.18
	PointSourceFinite: -119.818, 45.852		17.05	5.97	0.44	119.818°W	45.852°N	0.00	1.16
	PointSourceFinite: -119.818, 45.744		6.94	5.63	-0.50	119.818°W	45.744°N	0.00	1.14
	PointSourceFinite: -119.818, 45.843		16.27	5.94	0.39	119.818°W	45.843°N	0.00	1.13
	PointSourceFinite: -119.818, 45.861		17.85	6.00	0.49	119.818°W	45.861°N	0.00	1.1
	PointSourceFinite: -119.818, 45.744		7.90	5.65	-0.43	119.818°W	45.744°N	0.00	1.07
	PointSourceFinite: -119.818, 45.879		18.39	6.03	0.54	119.818°W	45.879°N	0.00	1.06
	PointSourceFinite: -119.818, 45.870		17.60	6.01	0.50	119.818°W	45.870°N	0.00	1.03
	PointSourceFinite: -119.818, 45.888		19.17	6.06	0.58	119.818°W	45.888°N	0.00	1
WUS Branch Average		FaultSystem							15.03
	Arlington - Shutler Butte (0)		24.85	6.80	0.34	120.131°W	45.652°N	259.06	5.65
	Uhtanum Ridge - Gable Mountain (5)		62.60	7.84	0.55	119.386°W	46.522°N	19.73	2.92
	Horse Heaven Hills (4)		45.93	7.05	0.95	119.957°W	46.144°N	347.88	1.49
Cascadia (full, bottom)		Interface							1.62
	Cascadia (full, bottom)		288.66	9.18	1.76	123.413°W	46.300°N	284.91	1.62

Switch Applications



Open an application in a new tab with the current control panel values

 Dynamic Hazard Curves

 Risk-Targeted Ground Motion

 Model Maps

 NCM Geophysical Profiles

 Magnitude Frequency Distribution

 Earthquake Rates and Probabilities



Application Metadata

Application: Disaggregation

Version: 22.5.0

URL: <https://earthquake.usgs.gov/nshmp/hazard/disagg>

Repository : nshmp-apps

Version: 22.5.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-apps>

Repository : nshmp-lib-ng

Version: 22.9.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-lib-ng>

Repository : nshmp-template

Version: 22.8.9

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-template>

Repository : nshmp-haz

Version: 2.11.4

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-haz>

Repository : nshmp-lib

Version: 1.7.22

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-lib>

Repository : nshm-conus

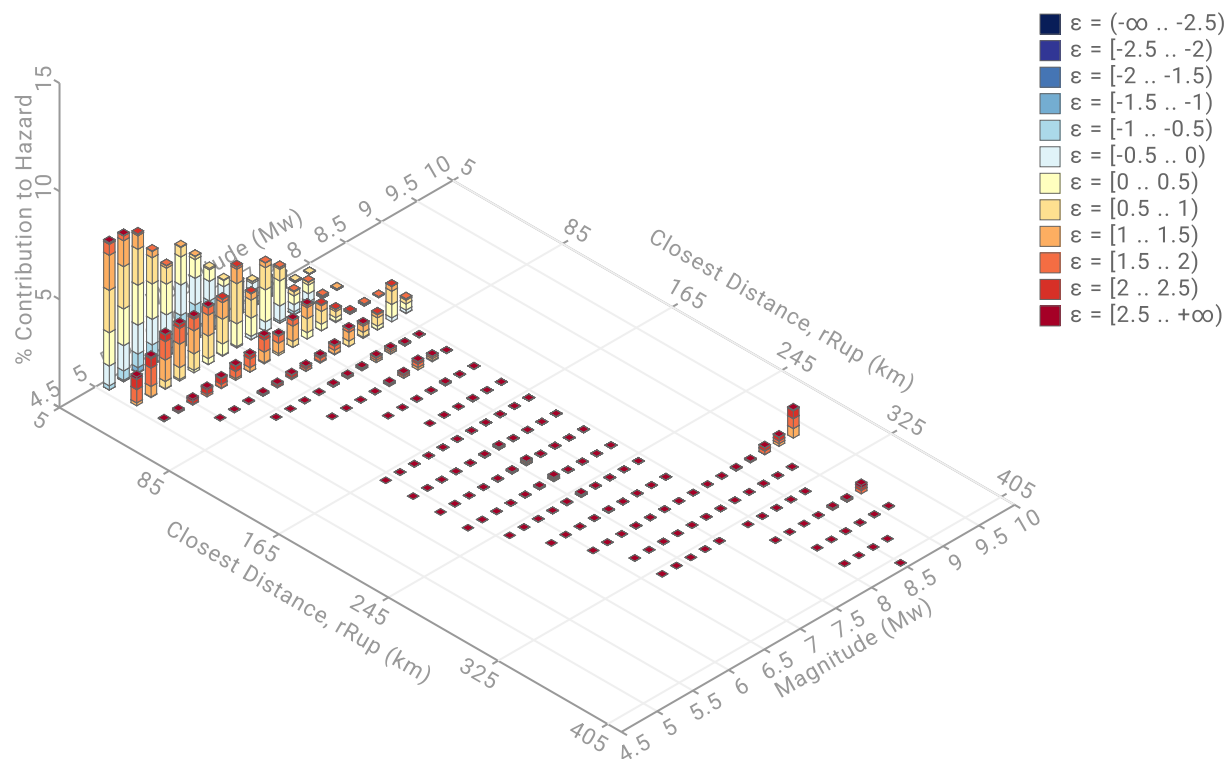
Version: 6.2.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git>

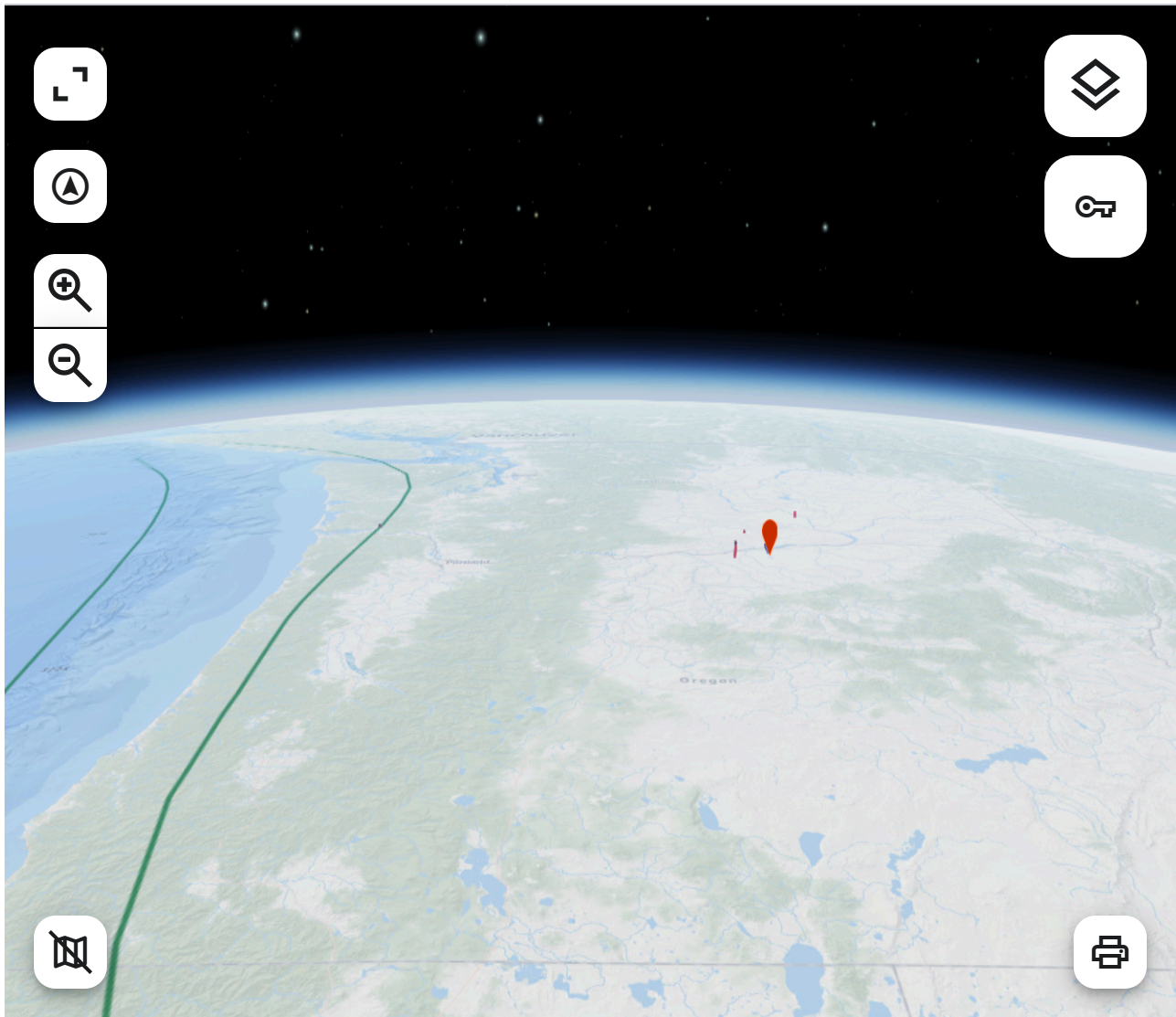
October 15, 2026, 12:08 PM

Disaggregation Report

Disaggregation



Geographical Disaggregation



Oregon State Parks | WA State Parks GIS | CHS | Esri | GEBCO | TomTom | Garmin | Natu... Powered by [Esri](#)

Parameter Summary

Model: Conterminous U.S. 2023.R2
Latitude: 45.694677 °
Longitude: -119.817594 °
Site Class: D (Vs30 260)

Intensity Measure Type: PGA
Return Period: 2475 (2% in 50)
Component: Total



Disaggregation Summary: Total

Disaggregation targets

Return period : 2475 yrs

Exceedance rate : 4.040e-4 yr⁻¹

PGA ground motion : 2.128e-1 g

Recovered targets

Return period : 2455.0626 yrs

Exceedance rate : 4.073e-4 yr⁻¹

Totals

Binned : 100 %

Residual : 0 %

Trace : 0.88 %

Mean (over all sources)

m : 6.32

r : 36.26 km

ε₀ : 0.58 σ

Mode (largest m-r bin)

m : 5.1

r : 10.93 km

ε₀ : 0.67 σ

Contribution : 6.8 %

Mode (largest m-r-ε₀ bin)

m : 5.1

r : 10.94 km

ε₀ : 0.76 σ

Contribution : 1.96 %

Discretization

r : min = 0.0, max = 1000.0, Δ = 20.0 km

m : min = 4.4, max = 9.4, Δ = 0.2

ε : min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0 : [-∞ .. -2.5)

ε1 : [-2.5 .. -2.0)

ε2 : [-2.0 .. -1.5)

ε3 : [-1.5 .. -1.0)

ε4 : [-1.0 .. -0.5)

ε5 : [-0.5 .. 0.0)

ε6 : [0.0 .. 0.5)

ε7 : [0.5 .. 1.0)

ε8 : [1.0 .. 1.5)

ε9 : [1.5 .. 2.0)

ε10 : [2.0 .. 2.5)

ε11 : [2.5 .. +∞]



Disaggregation Contributions: Total

Source Set	Source	Type	r	m	ϵ_0	lon	lat	az	%
WUS Branch Average (opt)		Grid							81.06
	PointSourceFinite: -119.818, 45.816		12.90	5.82	0.25	119.818°W	45.816°N	0.00	1.51
	PointSourceFinite: -119.818, 45.798		11.32	5.77	0.12	119.818°W	45.798°N	0.00	1.49
	PointSourceFinite: -119.818, 45.789		10.55	5.75	0.05	119.818°W	45.789°N	0.00	1.49
	PointSourceFinite: -119.818, 45.771		9.04	5.70	-0.15	119.818°W	45.771°N	0.00	1.41
	PointSourceFinite: -119.818, 45.816		13.93	5.83	0.29	119.818°W	45.816°N	0.00	1.39
	PointSourceFinite: -119.818, 45.780		9.79	5.72	-0.08	119.818°W	45.780°N	0.00	1.39
	PointSourceFinite: -119.818, 45.798		12.35	5.78	0.17	119.818°W	45.798°N	0.00	1.39
	PointSourceFinite: -119.818, 45.753		7.60	5.65	-0.31	119.818°W	45.753°N	0.00	1.38
	PointSourceFinite: -119.818, 45.789		11.57	5.76	0.10	119.818°W	45.789°N	0.00	1.38
	PointSourceFinite: -119.818, 45.825		13.69	5.85	0.31	119.818°W	45.825°N	0.00	1.38
	PointSourceFinite: -119.818, 45.807		12.11	5.80	0.18	119.818°W	45.807°N	0.00	1.38
	PointSourceFinite: -119.818, 45.762		8.30	5.67	-0.23	119.818°W	45.762°N	0.00	1.37
	PointSourceFinite: -119.818, 45.771		10.05	5.71	-0.09	119.818°W	45.771°N	0.00	1.32
	PointSourceFinite: -119.818, 45.753		8.59	5.66	-0.25	119.818°W	45.753°N	0.00	1.3
	PointSourceFinite: -119.818, 45.780		10.81	5.73	-0.02	119.818°W	45.780°N	0.00	1.29
	PointSourceFinite: -119.818, 45.834		14.49	5.88	0.36	119.818°W	45.834°N	0.00	1.29
	PointSourceFinite: -119.818, 45.762		9.31	5.68	-0.17	119.818°W	45.762°N	0.00	1.28
	PointSourceFinite: -119.818, 45.825		14.73	5.86	0.35	119.818°W	45.825°N	0.00	1.28
	PointSourceFinite: -119.818, 45.807		13.14	5.81	0.23	119.818°W	45.807°N	0.00	1.28
	PointSourceFinite: -119.818, 45.852		16.10	5.93	0.46	119.818°W	45.852°N	0.00	1.23
	PointSourceFinite: -119.818, 45.834		15.53	5.89	0.40	119.818°W	45.834°N	0.00	1.2
	PointSourceFinite: -119.818, 45.843		15.30	5.90	0.41	119.818°W	45.843°N	0.00	1.19
	PointSourceFinite: -119.818, 45.735		6.31	5.62	-0.48	119.818°W	45.735°N	0.00	1.17
	PointSourceFinite: -119.818, 45.861		16.93	5.95	0.52	119.818°W	45.861°N	0.00	1.16
	PointSourceFinite: -119.818, 45.852		17.13	5.94	0.50	119.818°W	45.852°N	0.00	1.14
	PointSourceFinite: -119.818, 45.735		7.23	5.63	-0.42	119.818°W	45.735°N	0.00	1.11
	PointSourceFinite: -119.818, 45.843		16.33	5.91	0.45	119.818°W	45.843°N	0.00	1.1
	PointSourceFinite: -119.818, 45.861		17.95	5.96	0.55	119.818°W	45.861°N	0.00	1.08
	PointSourceFinite: -119.818, 45.744		6.93	5.64	-0.40	119.818°W	45.744°N	0.00	1.07
	PointSourceFinite: -119.818, 45.879		18.57	5.99	0.61	119.818°W	45.879°N	0.00	1.05
	PointSourceFinite: -119.818, 45.870		17.75	5.97	0.56	119.818°W	45.870°N	0.00	1.01
	PointSourceFinite: -119.818, 45.744		7.90	5.65	-0.34	119.818°W	45.744°N	0.00	1.01
WUS Branch Average		FaultSystem							14.81
	Arlington - Shutler Butte (0)		24.85	6.80	0.39	120.131°W	45.652°N	259.06	5.26
	Uhtanum Ridge - Gable Mountain (5)		62.60	7.83	0.55	119.386°W	46.522°N	19.73	2.83
	Horse Heaven Hills (4)		45.93	7.05	0.93	119.957°W	46.144°N	347.88	1.49
Cascadia (full, bottom)		Interface							1.93
	Cascadia (full, bottom)		288.66	9.17	1.78	123.413°W	46.300°N	284.91	1.93

Switch Applications



Open an application in a new tab with the current control panel values

 Dynamic Hazard Curves

 Risk-Targeted Ground Motion

 Model Maps

 NCM Geophysical Profiles

 Magnitude Frequency Distribution

 Earthquake Rates and Probabilities



Application Metadata

Application: Disaggregation

Version: 22.5.0

URL: <https://earthquake.usgs.gov/nshmp/hazard/disagg>

Repository : nshmp-apps

Version: 22.5.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-apps>

Repository : nshmp-lib-ng

Version: 22.9.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-lib-ng>

Repository : nshmp-template

Version: 22.8.9

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-template>

Repository : nshmp-haz

Version: 2.11.4

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-haz>

Repository : nshmp-lib

Version: 1.7.22

URL: <https://code.usgs.gov/ghsc/nshmp/nshmp-lib>

Repository : nshm-conus

Version: 6.2.0

URL: <https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus.git>

October 15, 2026, 12:08 PM

**Attachment H-4.
Response Spectrum – Site Class D “Stiff
Soil”**

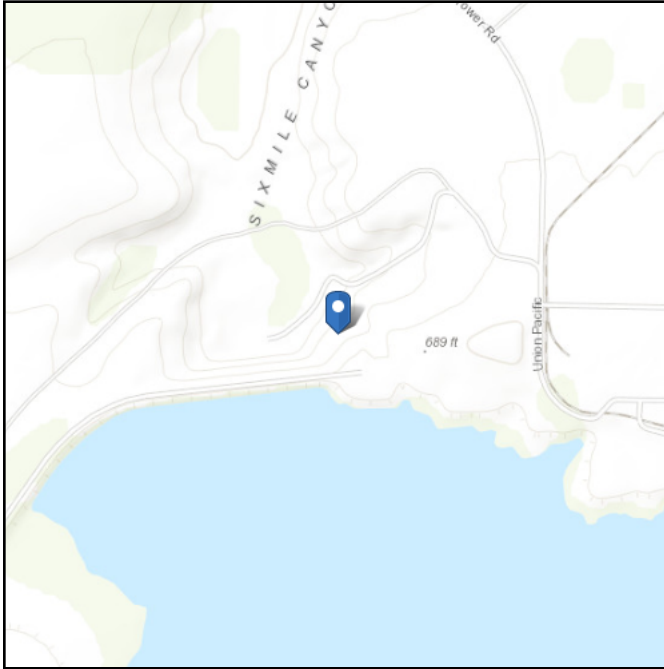
This page intentionally left blank

ASCE Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 41-23
Risk Category: NaN
Soil Class: D - Stiff Soil

Latitude: 45.694677
Longitude: -119.817594
Elevation: 658.7424701808083 ft
(NAVD 88)



Site Soil Class: D - Stiff Soil

Hazard Level BSE-2N:

S_{XS} : 0.6 S_{X1} : 0.34

Hazard Level BSE-1N:

S_{XS} : 0.4 S_{X1} : 0.23

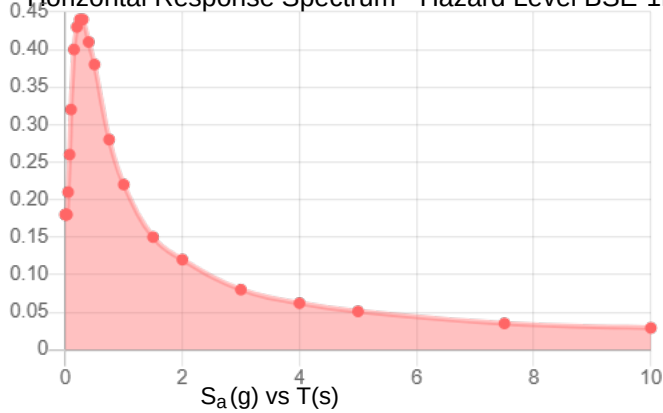
Hazard Level BSE-2E:

S_{XS} : 0.43 S_{X1} : 0.24

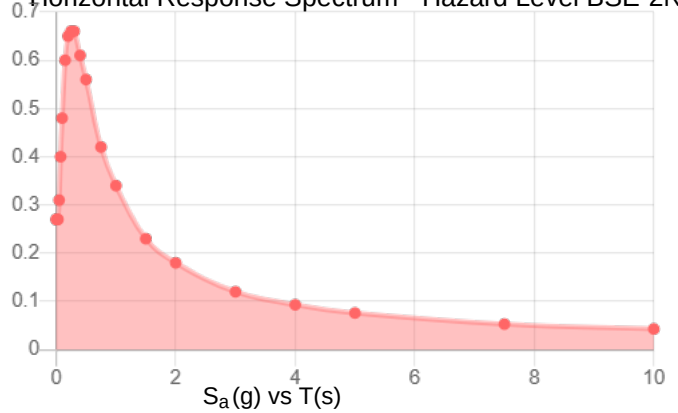
Hazard Level BSE-1E:

S_{XS} : 0.18 S_{X1} : 0.11

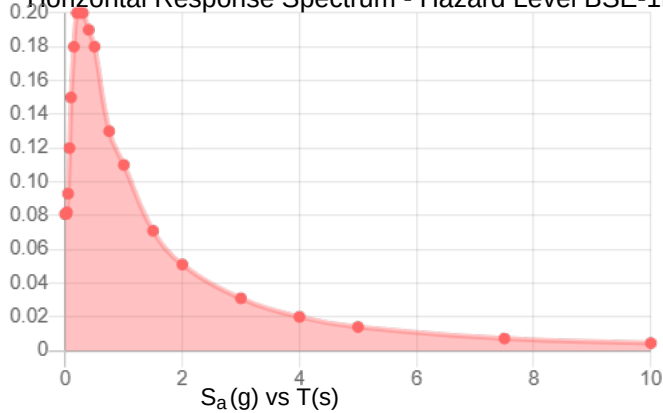
Horizontal Response Spectrum - Hazard Level BSE-1N



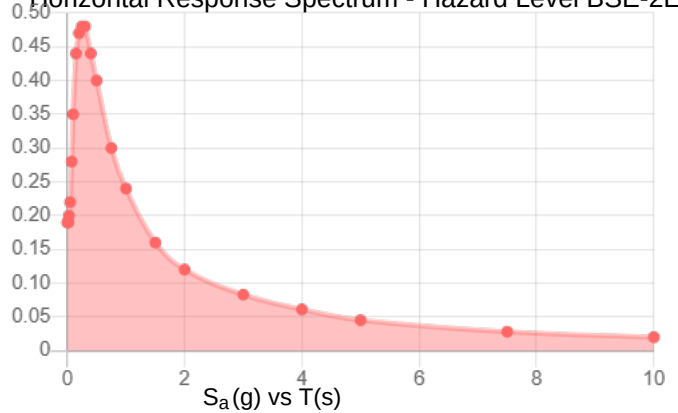
Horizontal Response Spectrum - Hazard Level BSE-2N



Horizontal Response Spectrum - Hazard Level BSE-1E



Horizontal Response Spectrum - Hazard Level BSE-2E



Data Accessed: Thu Oct 15 2026

The ASCE Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

ASCE does not intend, nor should anyone interpret, the results provided by this Tool to replace the sound judgment of a competent professional, having knowledge and experience in the appropriate field(s) of practice, nor to substitute for the standard of care required of such professionals in interpreting and applying the contents of this Tool or the ASCE standard.

In using this Tool, you expressly assume all risks associated with your use. Under no circumstances shall ASCE or its officers, directors, employees, members, affiliates, or agents be liable to you or any other person for any direct, indirect, special, incidental, or consequential damages arising from or related to your use of, or reliance on, the Tool or any information obtained therein. To the fullest extent permitted by law, you agree to release and hold harmless ASCE from any and all liability of any nature arising out of or resulting from any use of data provided by the ASCE Hazard Tool.