Exhibit H
Geological Hazards and Soil Stability

Boardman to Hemingway Transmission Line Project

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Amended Preliminary Application for Site Certificate

June 2017

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LIST OF ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

Amended Project Order	First Amended Project Order, Regarding Statutes, Administrative Rules and Other Requirements Applicable to the Proposed Boardman to Hemingway Transmission Line (December 22, 2014)
ASC	Application for Site Certificate
ASCE	American Society of Civil Engineers
ASTM	ASTM International (formerly known as American Society for Testing and Materials)
BMP	best management practice
CSZ	Cascadia Subduction Zone
DOGAMI	Oregon Department of Geology and Mineral Industries
EFSC or Council	Energy Facility Siting Council
ESCP	Erosion and Sediment Control Plan
FEMA	Federal Emergency Management Agency
IBC	International Building Code
IPC	Idaho Power Company
km	kilometer
kV	kilovolt
LiDAR	light detection and ranging
MCE	maximum credible earthquake
MConE	Maximum Considered Earthquake ground motions
MMI	Modified Mercalli Intensity
MOP	Manual of Practice
MP	milepost
MPE	maximum probable earthquake
NESC	National Electrical Safety Code
NGDC	National Geophysical Data Center
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OAR	Oregon Administrative Rule
ODOE	Oregon Department of Energy
OPS	U.S. Department of Transportation, Office of Pipeline Safety
OSSC	Oregon Structural Specialty Code
PGA	peak ground acceleration
Project	Boardman to Hemingway Transmission Line Project
SLIDO	Statewide Landslide Inventory Database for Oregon
STATSGO	State Soil Geographic Database
U.S.	United States
USACE	U.S. Army Corps of Engineers
USFS	United States Forest Service
USGS	U.S. Geological Survey

Exhibit H
Geological Hazards and Soil Stability

1.0 INTRODUCTION

Exhibit H provides information regarding the geological and soil stability within the Site Boundary for the Boardman to Hemingway Transmission Line Project (Project). The information provided in Exhibit H shows that Idaho Power Company (IPC) has adequately characterized the site and potential geological and soils hazards, and that the Project can be designed, engineered, and constructed to avoid dangers to human safety presented by seismic, geological, and soil hazards.

2.0 APPLICABLE RULES AND AMENDED PROJECT ORDER PROVISIONS

2.1 General Standards for Siting Facilities

The Structural Standard set forth at Oregon Administrative Rule (OAR) 345-022-0020 provides, in relevant part:

> *(1) Except for facilities described in sections (2) and (3), to issue a site certificate, the Council must find that:*
>
> > *(a) The applicant, through appropriate site-specific study, has adequately characterized the site as to the Maximum Considered Earthquake Ground Motion as shown for the site in the 2009 International Building Code and maximum probable ground motion, taking into account ground failure and amplification for the site specific soil profile under the maximum credible and maximum probable seismic events; and*
> >
> > *(b) The applicant can design, engineer, and construct the facility to avoid dangers to human safety presented by seismic hazards affecting the site that are expected to result from maximum probable ground motion events. As used in this rule "seismic hazard" includes ground shaking, ground failure, landslide, liquefaction, lateral spreading, tsunami inundation, fault displacement, and subsidence;*
> >
> > *(c) The applicant, through appropriate site-specific study, has adequately characterized the potential geological and soils hazards of the site and its vicinity that could, in the absence of a seismic event, adversely affect, or be aggravated by, the construction and operation of the proposed facility; and*
> >
> > *(d) The applicant can design, engineer and construct the facility to avoid dangers to human safety presented by the hazards identified in subsection (c).*
>
> *. . . .*[1]

[1] Section (2) and Section (3) of OAR 345-022-0020 apply to energy generation facilities and special criteria facilities, respectively. Here, the Project is neither an energy generation facility nor a special criteria facility. Therefore, Section (2) and Section (3) of OAR 345-022-0020 do not apply to the Project.

2.2 Site Certificate Application Requirements

OAR 345-021-0010(1)(h) provides Exhibit H must include the following Information regarding the geological and soil stability within the Site Boundary:

> *(A) A geologic report meeting the guidance in Oregon Department of Geology and Mineral Industries open file report 00-04 "Guidelines for Engineering Geologic reports and Site-Specific Seismic Hazard Reports."*
>
> *(B) A description and schedule of site-specific geotechnical work that will be performed before construction for inclusion in the site certificate as conditions.*
>
> *(C) Evidence of consultation with the Oregon Department of Geology and Mineral Industries regarding the appropriate site-specific geotechnical work that must be performed before submitting the application for the Department to determine that the application is complete.*
>
> *(D) For all transmission lines, 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, corners, and portions of the proposed route where geologic reconnaissance and other site specific studies provide evidence of existing landslides or marginally stable slopes that could be made unstable by the planned construction.*
>
> *(E) 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 and portions of the proposed alignment where geologic reconnaissance and other site specific studies provide evidence of existing landslides or marginally stable slopes that could be made unstable by the planned construction.*
>
> *(F) An assessment of seismic hazards. For the purposes of this assessment, the maximum probable earthquake (MPE) is the maximum earthquake that could occur under the known tectonic framework with a 10 percent chance of being exceeded in a 50 year period. If seismic sources are not mapped sufficiently to identify the ground motions above, the applicant shall provide a probabilistic seismic hazard analysis to identify the peak ground accelerations expected at the site for a 500 year recurrence interval and a 5000 year recurrence interval. In the assessment, the applicant shall include:*
>
>> *(i) Identification of the Maximum Considered Earthquake Ground Motion as shown for the site under the 2009 International Building Code.*
>>
>> *(ii) Identification and characterization of all earthquake sources capable of generating median peak ground accelerations greater than 0.05g on rock at the site. For each earthquake source, the applicant shall assess the magnitude and minimum epicentral distance of the maximum credible earthquake (MCE).*
>>
>> *(iii) A description of any recorded earthquakes within 50 miles of the site and of recorded earthquakes greater than 50 miles from the site that caused ground shaking at the site more intense than the Modified Mercalli III intensity. The applicant shall include the date of occurrence and a description of the earthquake that includes its magnitude and highest intensity and its epicenter location or region of highest intensity.*

(iv) Assessment of the median ground response spectrum from the MCE and the MPE and identification of the spectral accelerations greater than the design spectrum provided in the 2010 Oregon Structural Specialty Code. The applicant shall include a description of the probable behavior of the subsurface materials and amplification by subsurface materials and any topographic or subsurface conditions that could result in expected ground motions greater than those characteristic of the Maximum Considered Earthquake Ground Motion identified above.

(v) An assessment of seismic hazards expected to result from reasonably probable seismic events. As used in this rule "seismic hazard" includes ground shaking, ground failure, landslide, lateral spreading, liquefaction, tsunami inundation, fault displacement and subsidence.

(G) An assessment of soil-related hazards such as landslides, flooding and erosion which could, in the absence of a seismic event, adversely affect or be aggravated by the construction or operation of the facility.

(H) An explanation of how the applicant will design, engineer and construct the facility to avoid dangers to human safety from the seismic hazards identified in paragraph (F). The applicant shall include proposed design and engineering features, applicable construction codes, and any monitoring for seismic hazards.

(I) An explanation of how the applicant will design, engineer and construct the facility to adequately avoid dangers to human safety presented by the hazards identified in paragraph (G).

2.3 Amended Project Order Provisions

The Amended Project Order includes the following discussion regarding Exhibit H:

The Department understands that detailed site-specific geotechnical investigation for the entire site boundary is not practical in advance of completing the final facility design and obtaining full site access. However, OAR 345-021-0010(h) requires evidence of consultation with the Oregon Department of Geology and Mineral Industries (DOGAMI) prior to submitting the application if the applicant proposes to base Exhibit H on limited pre-application geotechnical work. Exhibit H shall include written evidence of consultation with DOGAMI regarding the level of geologic and geotechnical investigation determined to be practical for the application submittal.

Any geotechnical reports included in Exhibit H as supporting evidence that the proposed facility will meet the Council's structural standard should follow the guidelines of DOGAMI's "Open File Report 00-04 "Guidelines for Engineering Geologic Reports and Site Specific Seismic Hazard Reports."

Note that OAR 345-021-0010(1)(h), paragraphs (A), (F)(i), and (F)(iv) contain references to outdated guidelines and codes. Although the Council rules are currently applicable, before the B2H application process is concluded, the department intends to engage in rulemaking and will be seeking EFSC approval of updated rules that reflect currently applicable guidelines and codes. The department anticipates the requirements of OAR 345-021-0010(1)(h) will be modified to require compliance with the rules that became effective July 1, 2014. In anticipation of that rulemaking, the department recommends that the applicant consult directly with DOGAMI regarding the current DOGAMI requirements.

(Amended Project Order, Section III(h))

3.0 ANALYSIS

3.1 Analysis Area

The analysis area for Exhibit H includes all areas within the Site Boundary, which is defined as "the perimeter of the site of a proposed energy facility, its related or supporting facilities, all temporary laydown and staging areas, and all corridors and micrositing corridors proposed by the applicant" (OAR 345-001-0010(55)). The Site Boundary encompasses the following facilities in Oregon:

- The Proposed Route, consisting of 270.8 miles of new 500-kilovolt (kV) electric transmission line, removal of 12 miles of existing 69-kV transmission line, rebuilding of 0.9 mile of a 230-kV transmission line, and rebuilding of 1.1 miles of an existing 138-kV transmission line;
- Four alternatives that each could replace a portion of the Proposed Route, including the West of Bombing Range Road Alternative 1 (3.7 miles), West of Bombing Range Road Alternative 2 (3.7 miles), Morgan Lake Alternative (18.5 miles), and Double Mountain Alternative (7.4 miles);
- One proposed 20-acre station (Longhorn Station);
- Ten communication station sites of less than ¼-acre each and two alternative communication station sites;
- Permanent access roads for the Proposed Route, including 206.3 miles of new roads and 223.2 miles of existing roads requiring substantial modification, and for the Alternative Routes including 30.2 miles of new roads and 22.7 miles of existing roads requiring substantial modification; and
- Thirty-one temporary multi-use areas and 299 pulling and tensioning sites of which four will have light-duty fly yards within the pulling and tensioning sites.

The Project features are fully described in Exhibit B and the Site Boundary for each Project feature is described in Exhibit C, Table C-24. The location of the Project features and the Site Boundary is outlined in Exhibit C.

3.2 Methods

Consistent with direction in the Amended Project Order, IPC will complete the studies necessary to generate the detailed information required by OAR 345-0210-0010(1)(h) in two phases. IPC has already completed Phase 1 of its Exhibit H Geological Hazards and Soil Stability studies. Exhibit H relies on published data, and also field and literature information compiled by IPC's geotechnical consultants. The Engineering and Seismic Hazards Supplement (Attachment H-1) presents the regional geologic and tectonic setting, seismic hazards, and non-seismic geologic hazards that could affect the Project. The Engineering Geology and Seismic Hazards Supplement was based on review of literature and existing mapping, referenced throughout Attachment H-1 and in Attachment H-1, Section 9 – References.

The Engineering and Seismic Hazards Supplement describes a reconnaissance-level survey that examined the proposed transmission line route from its starting point at Longhorn Station, near Boardman, Oregon, to its end point at the Hemingway Substation in Owyhee County, Idaho. IPC recognizes that any desktop analysis or regional study is generally useful for regional applications and should not be used as an alternative to site-specific studies in critical areas.

As described further in Section 3 of Attachment H-1, IPC proposes to conduct a Phase 2 site-specific geotechnical investigation, which will be conducted prior to final design and construction. Phase 2 will support final design, engineering, and construction specifications and will be used to avoid or mitigate site-specific geologic hazards. Following completion of Phase 2, IPC will develop a Phase 2 Site-Specific Geotechnical Report following the 2014 Guidelines for Preparing Engineering Geological Reports (OSBGE 2014). IPC will submit the Phase 2 Site-Specific Geotechnical Report to the DOGAMI and the Oregon Department of Energy (ODOE) prior to construction.

Also, since the issuance of the Project Order, the Energy Facility Siting Council (EFSC or Council) has revised the references to the guidelines and codes in OAR 345-021-0010(1)(h). Consistent with these revisions and consistent with the direction provided by DOGAMI, the most up-to-date building and structural codes that apply to transmission line projects will be used during the final design and construction of the Project. Current codes will be used to meet reliability standards and other external regulations. It is specifically assumed that current requirements embedded in structural, electrical building, and other codes meet or exceed the requirements of prior codes.

3.3 Geologic Report

> 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: (A) A geologic report meeting the guidance in Oregon Department of Geology and Mineral Industries open file report 00-04 “Guidelines for Engineering Geologic reports and Site-Specific Seismic Hazard Reports.”

OAR 345-021-0010(1)(h)(A) requires submission of a geological report meeting the standards of DOGAMI’s *Guidelines for Engineering Geologic Reports* (DOGAMI Guidelines). The DOGAMI Guidelines provide general guidance for completing engineering geology reports in Oregon. Adopted by the Oregon State Board of Geologist Examiners in 2004, it contains a suggested guide for the preparation of engineering geologic reports in Oregon. The DOGAMI Guidelines state that “the engineering geologic report should include sufficient facts and interpretation of the suitability of the site for the proposed use. Because of the wide variation in size and complexity of projects and scope of work, the guidelines are intended to be flexible and should be tailored to the specific project.” As such, the guidelines do not provide rigid requirements for every engineering geologic report.

The DOGAMI Guidelines include general types of information that may be considered in an engineering geology report. All of these may or may not be included, depending on the Project, or additional information may be necessary not mentioned in the DOGAMI Guidelines. General project information may include client, supervising geologist, project location and setting, purpose of report, topography, earth materials present, reference sources, geologic hazards, locations of test holes and excavations, field and laboratory test methods, statement of geologist’s financial information if applicable, and signature and seal of certified engineering geologist. Geologic maps and cross-sections may be necessary to define the geologic conditions present. Geologic descriptions are typically found in an engineering report including bedrock rock types, relative age or formation names, distribution and thickness, and physical characteristics, structural features, surficial deposits, surface and subsurface hydrologic conditions, and seismic considerations. The geologic factors observed are typically discussed in the context of suitability for proposed land use to identify geologic conditions that may result in risk to land use, recommendations for site grading, drainage considerations, and limitations of study. Recommendations for additional investigations or hazard mitigations are also a part of typical engineering geology and seismic hazard reports.

Attachment H-1 includes an introduction, summary of topographical and geological features, general description of the scope of the proposed site-specific investigation, and summaries and mitigation strategies for seismic and non-seismic hazards. In turn, Exhibit H supplements the data contained in Attachment H-1 in a format that closely matches the requirements of OAR 345-021-0010(1)(h)(A).

To support the detailed design, IPC will carry out the Phase 2 program of site-specific geological and geotechnical work to investigate subsurface soil and geologic conditions following site certificate approval and apply site-specific geotechnical design recommendations. The geotechnical investigation will emphasize areas that require engineering design and areas identified as potential geologic hazards in the Engineering Geology and Seismic Hazards Supplement, including seismicity, slope failure, liquefaction, and subsidence. The site-specific geotechnical investigation will be performed prior to final design and construction.

Using the results of the geotechnical investigation, IPC will prepare a final engineering geologic report, the Phase 2 Site-Specific Geotechnical Report, prior to final design and construction to assess site-specific hazards in conformance with the DOGAMI Guidelines. As described in the DOGAMI Guidelines, the Phase 2 Site-Specific Geotechnical Report will include additional facts and site-specific interpretation regarding geologic materials, processes, and history to allow evaluation of the suitability of specific affected sites for the proposed Project uses.

IPC has responded to many portions of the DOGAMI Guidelines in Exhibit H and Exhibit I, and will respond to the remaining applicable guidelines in the Phase 2 Site-Specific Geotechnical Report and related studies.

3.4 Site-specific Geotechnical Work

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

OAR 345-021-0010(1)(h)(B) requires a description and schedule of pre-construction geotechnical work. Here, site-specific geologic and geotechnical investigations will include more detailed geologic field reconnaissance to identify faults and landslides and geologic data acquisition for soil, seismic, slope stability, and flood analyses.

Based on the geologic reconnaissance performed to date, IPC's geotechnical engineers have identified approximately 469 initial geotechnical boring locations for the Proposed Route (see Attachment H-1, Section 3.0 and Appendix C of Attachment H-1). Appendix A of Attachment H-1 includes maps of these proposed borehole locations. Section 3 of the Attachment H-1 provides an overview of the proposed site-specific geotechnical work, including right-of-way considerations, access and disturbance, and exploration methods.

Boring locations will occur at a maximum spacing of approximately 1 mile along the alignments, including at:

- dead-end structures;
- any corners or changes in alignment heading (angles);
- crossings of highways, major roads, rivers, railroads, and utilities such as power transmission lines, natural gas pipelines, and canals; and

- locations necessary to verify lithologic changes and/or geologic hazards such as landslides, steep slopes, or soft soil areas.

Reconnaissance and test borings, trenching techniques, and collection of rock and soil samples will be employed to help assess subsurface conditions. Collected rock and soil samples will be field classified and tested to determine geotechnical behaviors. Upon completion of soil and rock sampling, further laboratory tests will be conducted to measure physical and engineering properties of the soil and rock. Laboratory tests may include natural water content, particle size analysis, liquid and plastic limits, and moisture-density relationship. All testing will be performed in accordance with ASTM International (ASTM) or U.S. Army Corps of Engineers (USACE) testing requirements for consistency. Depending upon the materials encountered, additional testing in general accordance with ASTM or USACE testing procedures may be required to evaluate swell or settlement potential, direct shear, unconfined compressive strength, specific gravity and corrosion.

The results of the initial geotechnical investigation may identify data gaps that could result in additional investigation until sufficient information is received to ensure that the Project can be designed, engineered, and constructed. As detailed in Attachment H-1, it is anticipated that boring depths will generally be no more than 50 feet below the designed finish grade of the transmission center line. Subsurface investigation will be accomplished by hollow-stem auger in unconsolidated areas above the groundwater level and by mud rotary methods below groundwater level. In areas where rock is encountered, the rock will be cored using HQ triple-tube rock-coring techniques. Soil and bedrock samples will be collected for analysis of geotechnical properties. Rock-coring methods will be used in an attempt to obtain continuous samples of rock, where encountered during drilling. Other standard sample collection methods are described in Attachment H-1.

Depth to groundwater will also be measured in the borings. If seasonal high groundwater is anticipated to interact with foundations, piezometers may be installed to assess groundwater fluctuations.

For proposed structures (such as stations or communication stations) near identified faults or within historical and pre-historic landslide areas, additional geotechnical investigation will be conducted to acquire necessary data for seismic and slope stability analysis. The degree of analysis will be contingent on hazard present, facility to be constructed, and potential danger to human safety and infrastructure.

IPC will obtain the necessary detailed information through invasive field and laboratory studies essential for the design, engineering, and constructing of the proposed facilities. When appropriate, IPC may use geophysical methods to investigate the underlying soils and rock. Typical indirect methods would include, but not be limited to, seismic refraction and resistivity methods.

Based on the results of the geotechnical field work, other studies employing alternative investigation methods may be required to expand design knowledge necessary to assess seismic hazards and failure-prone slopes. For example, preliminary seismic sources and maximum probable ground shaking were analyzed and are presented in Attachment H-1. However, during the field investigation, faults that cross the Project will be evaluated to confirm location and assess activity. Additional investigative methods may include field geomorphic and geologic investigation, followed by trenching where towers would need to be relocated to avoid active faults.

In known landslide-prone areas, steep slopes will also be evaluated to examine the potential for slope failure. Subsurface investigations will examine soil/rock properties, depth to slide planes, groundwater depths, groundwater fluctuations, or depth to bedrock or specific soil horizons. Investigation methods may include borings, trenches, geophysical surveys, inclinometer installation and monitoring, and laboratory testing of soil/rock. Site modifications and mitigation strategies will be developed and implemented for each unstable area as required. IPC's preferred mitigation strategy will be to construct towers in stable locations and avoid unstable areas.

Geotechnical field investigations will commence when IPC obtains access and permission to proposed field investigation sites. The results will inform the final design and siting of the transmission line and related and supporting facilities: station, fly yards, stream crossings, roadway intersections, laydown yards, and multi-use yards. Table H-1 describes the general timeframe for detailed geotechnical work by facility and location. IPC will submit the results of the site-specific geotechnical investigation in the Phase 2 Site-Specific Geotechnical Report, which will be provided to DOGAMI and ODOE prior to construction.

Table H-1. Schedule of Site-Specific Geotechnical Work

Facility	Location	General Timeframe
Station	Morrow County	Summer and Fall 2020[1]
Transmission Line Spread 1	Morrow, Umatilla, and Union counties	Summer and Fall 2020[1]
Transmission Line Spread 2	Baker and Malheur counties	Summer and Fall 2020[1]

[1] Actual schedule will depend upon federal access approvals to conduct geotechnical investigations.

3.5 Consultation with DOGAMI

> OAR 345-021-0010(1)(h)(C): Evidence of consultation with the Oregon Department of Geology and Mineral Industries regarding the appropriate site-specific geotechnical work that must be performed before submitting the application for the Department to determine that the application is complete.

OAR 345-021-0010(1)(h)(C) requires consultation with DOGAMI on the geotechnical work. Regarding the Project, DOGAMI and the ODOE were consulted at an in-person meeting on April 4, 2011, in Portland, Oregon. Based upon comments made during this meeting by Mr. Bill Burns, Engineering Geologist for DOGAMI, IPC responded with a letter to DOGAMI (Attachment H-2). Excerpts from the letter are as follows:

1) *The SLIDO (Statewide Landslide Inventory Database for Oregon) was being updated based on new LIDAR data, and you requested that the updated SLIDO 2 data should be incorporated into the geotechnical hazard assessment and engineering design prior to construction.*

2) *Geological and soil hazard analysis is not required at each tower location. The degree of investigation should be contingent on the type of hazards present, facility to be constructed, and potential danger to human safety. The degree of analysis will vary across the Project corridor.*

3) *The most recent IBC and Oregon Structural Specialty Code (OSSC) requirements should be used although current Oregon Administrative Rules reference historical IBC requirements.*

4) *You were aware that in transmission line construction, design for wind and ice forces is more than sufficient to account for typical seismic forces.*

5) *A detailed geotechnical plan may be submitted concurrently with the Application for Site Certification (ASC) and the Engineering Geologic Report for the Project may be submitted after filing the ASC.*

6) *Exhibit H should contain as much detail as possible. DOGAMI will only review Exhibit H and its Attachment so reference should not be made to other documents.*

7) *You indicated that the April 2011 meeting would satisfy the requirements of DOGAMI consultation.*

Attachment H-2 contains a letter to DOGAMI, confirming DOGAMI's acknowledgement of the bulleted items listed above. The Engineering Geology and Seismic Hazards Supplement was attached to the letter to DOGAMI for the agency's review and evaluation.

3.6 Locations of Geotechnical Work

> OAR 345-021-0010(1)(h)(D): For all transmission lines, 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, corners, and portions of the proposed route where geologic reconnaissance and other site specific studies provide evidence of existing landslides or marginally stable slopes that could be made unstable by the planned construction.

OAR 345-021-0010(1)(h)(D) requires identification of geotechnical investigation sites. Here, sites for geotechnical investigation shall include indicative tower or substation locations and the following:

- dead-end structures;
- any corners or changes in alignment heading (angles);
- crossings of highways, major roads, rivers, railroads, and utilities such as power transmission lines, natural gas pipelines, and canals; and
- locations necessary to verify lithologic changes and/or geologic hazards such as landslides, steep slopes, or soft soil areas.

Attachment H-1, Appendix C presents a summary table with the approximate locations and rationale for the proposed boring locations. Additional borings may be necessary to fill data gaps from the initial drilling program. Appendix A of Attachment H-1 presents a series of geologic maps, showing the transmission line indicative alignment, and geologic features.

3.7 Pipelines

> OAR 345-021-0010(1)(h)(E): 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 and portions of the proposed alignment where geologic reconnaissance and other site specific studies provide evidence of existing landslides or marginally stable slopes that could be made unstable by the planned construction.

OAR 345-021-0010(1)(h)(E) applies to pipelines. This subpart of the regulations does not apply to the Project, because the Project includes no pipelines.

3.8 Earthquakes and Seismic Hazards

> OAR 345-021-0010(1)(h)(F): An assessment of seismic hazards. For the purposes of this assessment, the maximum probable earthquake (MPE) is the maximum earthquake that could occur under the known tectonic framework with a 10 percent chance of being exceeded in a 50 year period. If seismic sources are not mapped sufficiently to identify the ground motions above, the applicant shall provide a probabilistic seismic hazard analysis to identify the peak ground accelerations expected at the site for a 500 year recurrence interval and a 5000 year recurrence interval. . . .

OAR 345-021-0010(1)(h)(F) requires an assessment of seismic hazards. The detailed seismic evaluation is presented in Attachment H-1. IPC is governed by the National Electric Safety Code (NESC) and is required to apply various weather-related structural loading cases while designing transmission lines. IPC will apply all NESC-required, weather-related loading cases as well as additional cases identified to be important to the integrity of the lines.

Notably, NESC Section 250.A.4 indicates that by designing for the required line and tower loading cases, nothing further is required to resist earthquake loads. It states, "The structural capacity provided by meeting the loading and strength requirements of Sections 25 (Loadings for Grades B and C) and 26 (Strength Requirements) provides sufficient capability to resist earthquake ground motions."

Additionally, the American Society of Civil Engineers (ASCE) *Guidelines for Electrical Transmission Line Structural Loading* (Wong and Miller 2010) states the following:

> *Transmission structures need not be designed for ground-induced vibrations caused by earthquake motion because, historically, transmission structures have performed well under earthquake events, and transmission structure loadings caused by wind/ice combinations and broken wire forces exceed earthquake loads. This may not be the case if the transmission structure is partially erected or if the foundations fail due to earth fracture or liquefaction.*

> *Transmission structures are designed to resist large, horizontal loads of wind blowing on the wires and structures. These loads and the resulting strengths provide ample resistance to the largely transverse motions of the majority of earthquakes. Decades of experience with lines of all sizes has shown that very infrequent line damages have resulted from soil liquefaction or when earth failures affect the structural capacity of the foundation.*

Generally, NESC-mandated combined ice and loading cases have been determined by the industry to be sufficient to address seismic hazards from earthquakes.

Although seismic design criteria do not apply to transmission structures, seismic hazards must be evaluated in accordance with the OAR. The detailed seismic hazards evaluation is presented in Attachment H-1. For the purposes of this preliminary evaluation, the seismic sources are not mapped sufficiently to perform a deterministic evaluation of ground motions along a several-hundred-mile-long powerline alignment. Therefore, probabilistic peak ground acceleration (PGA) estimates for a 500- and 5,000-year return period have been included in this evaluation and are shown in Attachment H-1.

3.8.1 Maximum Considered Earthquake Ground Motion

OAR 345-021-0010(1)(h)(F): . . . In the assessment, the applicant shall include: (i) Identification of the Maximum Considered Earthquake Ground Motion under the 2009 International Building Code.

Seismic hazards will be evaluated according to the International Building Code (IBC). This evaluation provides PGA, short- and long-period (0.2 and 1.0 second) spectral accelerations. The OAR specifies use of IBC 2009 for design, however we assume the most recent version of IBC will be used during final design. As requested by ODOE and DOGAMI, both OAR-referenced building codes in addition to the current building codes were considered as discussed in Attachment H-1. The 2012 IBC provides Maximum Considered Earthquake ground motions (MConE) that correspond to a 2 percent probability of exceedance in 50 years, or a 2,500-year return period. The PGA, short- and long-period (0.2 and 1.0 second) spectral accelerations are shown in Attachment H-1.

3.8.2 Earthquake Sources

OAR 345-021-0010(1)(h)(F)(ii): Identification and characterization of all earthquake sources capable of generating median peak ground accelerations greater than 0.05g on rock at the site. For each earthquake source, the applicant shall assess the magnitude and minimum epicentral distance of the maximum credible earthquake (MCE).

Evaluation of source specific probabilistic ground motions along the 272.8-mile alignment has been provided using U.S. Geological Survey (USGS) 2002 and 2014 PGA and spectral accelerations on rock. Site class determinations and site specific hazard evaluations for structure locations will be determined during geotechnical design studies.

The four sources of earthquakes and seismic activity in Oregon are crustal, interplate, intraplate, and volcanic (DOGAMI 2010). The Project is not located on a plate boundary and the nearest is over 80 miles from the Project. However the Project may experience ground shaking from any of the earthquake types. The most significant earthquake sources near the Project are intraplate or crustal earthquakes; however, intraplate earthquakes may rarely occur and are located hundreds of miles from the Project.

- **Crustal earthquakes** are generally shallow (<30 kilometers [km] depth), resulting from active faulting in the upper North American Plate. Crustal earthquakes typically have a maximum magnitude near 7.0, and recurrence intervals are dependent on stress accumulation and release but can range from tens to hundreds of years.
- **Interplate earthquakes** are those that occur between two plate boundaries. Interplate seismicity in Oregon is generated from the convergence of the Juan de Fuca Plate and the North American Plate at the Cascadia Subduction Zone (CSZ) just off the coast of Washington and Oregon (USGS 2009a). These plates converge at a rate of 1 to 2 inches per year and accumulate large amounts of stress that are released abruptly in earthquake events. The CSZ and similar plate boundaries are capable of producing large, 9.0 magnitude subduction zone earthquakes. Recurrence intervals are typically on the order of 300 to 500 years.
- **Deep Intraplate earthquakes** occur deep (50-70 km depth) in the CSZ and have a maximum magnitude potential near 7.0. Recurrence intervals for deep intraplate earthquakes are generally between 500 to 600 years.

Because of their proximity, crustal faults represent the most significant seismic hazard to the proposed transmission alignment. A map of Quaternary faults is presented in Attachment H-1, Appendix D, Figure D9. The map presents the locations of known and inferred faults.

Table H-2 is a summary table of significant faults considered capable of generating a large earthquake within 5 miles of the Proposed Route and Alternative Route by county. These faults are potentially capable of producing a PGA greater than 0.05 g along the Proposed Route and Alternative Route. Of the youthful Quaternary faults identified by USGS (Table H-2), faults less than 15,000 years old are recent by geologic standards and likely pose the greatest potential for future earthquakes. These faults are assumed to be active.

Table H-2. USGS Quaternary Faults within 5 Miles of Project by County

County	Fault Name	Approximate Milepost	Age (years)	Active?
Morrow	None	N/A	N/A	N/A
Umatilla	Hite Fault System, Thorne Hollow Section[1]	80[1]	<130,000	No
	Hite Fault System, Agency Section	63.5	<1,600,000	No
Union	West Grande Ronde Valley Fault Zone (includes Mount Emily, La Grande, and Craig Mountain Sections)[2]	89–119.5[2]	<15,000	Yes
	South Grande Ronde Valley Fault Zone[1]	115-126[1]	<750,000	No
Baker	Unnamed East Baker Valley Faults[2]	140–148[2]	<750,000	No
	West Baker Valley Faults[2]	149.5-152.5[2]	<130,000	No
Malheur	Cottonwood Mountain Fault	224.5	<15,000	Yes
	Faults Near Owyhee Dam[1]	246–258.5[1]	<1,600,000 Class B[3]	No

[1] Faults do not intersect the Project centerline; milepost (MP) reflects its closest location to the Project centerline.

[2] The West Grande Ronde Valley Fault Zone intersects the Project centerline near approximately MP 109. The Unnamed East Baker Valley Faults intersect the Project centerline at multiple locations near approximately MPs 141, 143, and 148. The West Baker Valley Fault intersects the Project centerline at multiple locations near approximately MPs 150, 151, and 152.

[3] Class B Faults are faults of uncertain origin that may be older than Quaternary.

3.8.3 Recorded Earthquakes

> OAR 345-021-0010(1)(h)(F)(iii): A description of any recorded earthquakes within 50 miles of the site and of recorded earthquakes greater than 50 miles from the site that caused ground shaking at the site more intense than the Modified Mercalli III intensity. The applicant shall include the date of occurrence and a description of the earthquake that includes its magnitude and highest intensity and its epicenter location or region of highest intensity.

Due to the large areas of impact from earthquakes, the analysis area for recorded earthquakes was larger than the Site Boundary, and chosen by a variable buffer distance around epicenters, or groups of epicenters, of historical earthquakes. The seismology department at University of Nevada at Reno states that earthquakes of Richter magnitude 6.1 to 6.9 may affect areas up to 100 km from the epicenter (UNR 1996). Given that estimate, an analysis area radius of 25 miles was selected for earthquakes less than magnitude 6. A radius of 50 miles was assumed for earthquakes of magnitude 6 to less than 7, and the analysis area was extended out to 100 miles for earthquakes of magnitude 7 or greater. The distance of 100 miles was chosen because, above that distance, the effect on the proposed transmission line from even the strongest recorded past earthquakes would be minimal. The locations of historical earthquake epicenters were also reviewed relative to the Proposed Route and Alternative Routes. Earthquake data for Idaho and Oregon were obtained from the applicable state geologic survey departments. None of the recorded earthquakes within the Site Boundary exceeded Richter magnitude 6.0. The recommended design earthquake magnitudes of 6.0 to 6.2 appear realistic, given the maximum magnitude of historic earthquakes.

Historical earthquakes recorded by the USGS Earthquake Search Database (USGS 2016), the National Geophysical Data Center (NGDC 1985), and the Pacific Northwest Seismic Network (2008) are presented in Appendix D of Attachment H-1. A map of recorded earthquakes with magnitudes of 2 or greater within 50 miles of the Project is shown as Attachment H-1, Appendix D, Figure D10.

The NGDC reports 40 records of earthquakes measured at Modified Mercalli Intensity (MMI) III or greater within 50 miles of the Project. MMI values within the 50-mile route ranged from IV to VII. Attachment H-1, Appendix D, Table D2 lists these earthquakes, the date of occurrence, the earthquake magnitude, the MMI, and the city where it was felt. For earthquakes that were reported in terms of magnitude only, a MMI was estimated. The USGS (2009) provides the following descriptions of MMI values (abbreviated from the 12 levels of MMI):

> *III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.*
>
> *IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.*
>
> *V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.*
>
> *VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.*
>
> *VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.*

Based on the number of historical earthquakes that have occurred within 50 miles of the Project, it is assumed that earthquakes will occur during the life of the Project. However, the Project will be designed to withstand weather-related forces; according to the NESC, the structural capacity provided by meeting the loading and strength requirements for weather-related stresses provide sufficient capability to resist earthquake ground motions.

3.8.4 Median Ground Response, MCE and MPE

> OAR 345-021-0010(1)(h)(F)(iv): Assessment of the median ground response spectrum from the MCE and the MPE and identification of the spectral accelerations greater than the design spectrum provided in the Oregon Structural Specialty Code (2010 edition). The applicant shall include a description of the probable behavior of the subsurface materials and amplification by the subsurface materials and any topographic or subsurface conditions that

> could result in expected ground motions greater than those characteristic of the Maximum Considered Earthquake Ground Motion identified above.

The MPE is the largest earthquake that a fault is predicted capable of generating under the known tectonic framework within a 500-year return period while the MCE is the largest earthquake that an active or potentially active fault is capable of generating. For this preliminary evaluation, the seismic sources are not mapped sufficiently to perform deterministic evaluations of ground motions along a several hundred-mile-long power line alignment. The location, length, and age of offset for credible fault ruptures are not sufficiently documented to determine magnitude and minimum epicentral distance. Therefore, as discussed in Attachment H-1, Section 4.1, probabilistic PGAs for a 500- and 5,000-year return period have been evaluated.

The ground motions provided in Attachment H-1 correspond to a Site Class B/C (soft rock) soil profile. The OAR requires "assessment of the median ground response spectrum" and "a description of the probable behavior of the subsurface materials and amplification by subsurface materials and any topographic of subsurface conditions that could result in expected ground motions greater than those characteristic of the MConE." To develop ground motions that correspond to other Site Class types, Site Coefficients that consider site soil type and level of ground shaking are required. The Site Class definitions and Site Coefficients can be obtained from ASCE 7-10. Subsurface explorations along the alignment have not been performed. Therefore, site-specific design criteria for structures will be prepared upon completion of the geotechnical investigations program.

3.8.5 Seismic Hazards Resulting from Seismic Events

> OAR 345-021-0010(1)(h)(F)(v): An assessment of the seismic hazards expected to result from reasonably probable seismic events. As used in this rule "seismic hazard" includes ground shaking, ground failure, landslide, lateral spreading, liquefaction, tsunami inundation, fault displacement and subsidence.

The Project may be subject to ground shaking, ground failure, landslides, liquefaction, fault displacement, and subsidence from reasonably probable seismic events. The Project is well above sea level and far from the Pacific Coast; therefore, tsunami inundation was not considered.

Interplate events occur between two tectonic plates, such as the CSZ where the Juan de Fuca Plate subducts beneath the North American Plate. Interplate events include subduction earthquakes that have the potential to be the largest earthquakes that may occur in the Pacific Northwest. Intraplate events are seismic events that occur within a tectonic plate. The Nisqually earthquake of 2001 was identified as an intraplate seismic event. Crustal earthquakes typically occur within 10 miles of the surface along shallow faults and are considered the most likely source to impact the Project. IPC identified known significant faults near the facility (see Attachment H-1, Section 4.2).

Ground Motion or Seismic Shaking

Ground shaking will be evaluated after subsurface explorations are performed and soil site classes can be determined. IPC's engineers have relied on the seismic results from Attachment H-1 to perform initial designs, and as additional information is collected during the site-specific geotechnical investigation, designs will be modified if necessary to construct facilities to avoid dangers to human safety presented by seismic hazards.

Ground Failure

Ground failure and fault displacement can occur from fault rupture in an active fault zone. Known Quaternary faults located within 5 miles of the Proposed Route that could be considered active include the Cottonwood Mountain fault and segments of the West Grande Ronde Valley fault zone (see Table H-2). Of these active faults, the Hite Fault System, Agency Section, West Grande Ronde Valley Fault Zone, Unnamed East Baker Valley Faults, West Baker Valley Fault, and the Cottonwood Mountain fault crosses the Proposed Route and should be considered during final design. Ground failure including landslide, lateral spreading, liquefaction, and surface rupture or settlement will be evaluated once ground accelerations and subsurface conditions are known.

A preliminary seismic risk assessment was conducted from a review of earthquake hazard zones included in Federal Emergency Management Agency (FEMA) data, prepared for the U.S. Department of Transportation, Office of Pipeline Safety (OPS, 1996). The OPS data provide earthquake hazard rankings for the United States, including those portions of Idaho and Oregon near the proposed transmission lines. The OPS report utilized information from the USGS National Earthquake Hazards Reduction Program. The USGS compiled a large database of past earthquake magnitudes and locations. Based on those data, earthquake hazards were assigned to all parts of the country. Based on historical earthquake magnitudes and locations, geographic areas were assigned an earthquake hazard ranking, ranging from zero (no earthquake hazard) to 100 (highest earthquake hazard). For this earthquake hazard assessment, a high earthquake hazard was assigned for areas with earthquake hazard rankings of 85 to 100. Locations with earthquake hazard rankings between 70 and 84 were considered as medium risk, and rankings less than 70 were considered low risk. To identify existing earthquake conditions the mileage crossed for each earthquake hazard risk (low, medium, or high) was mapped and expressed as a percent for each county. To disclose overall hazard risk, the mileage crossed by the Proposed Route and alternative route in each county was identified.

Table H-3 presents the percent of low, medium, and high earthquake risk (in miles) along the Proposed Route and alternative routes by county. The OPS data indicate that earthquake risk is greatest in the northern portion of the Proposed Route, with all 82 percent of Morrow County in medium earthquake risk. The OPS data indicate the remainder of the Proposed Route contains low risk of earthquakes. The West of Bombing Range Road Alternatives 1 and 2 contains medium risk. The Morgan Lake and Double Mountain Alternatives contain a low risk of earthquakes.

Table H-3. OPS Earthquake Hazard Risk – Proposed Route and Alternative Route

Facility	County	Miles Crossed[1]	Earthquake Hazard Risk by Centerline Miles Crossed/Percent of Miles Crossed – Proposed Route and Alternative Route		
			Low < 70	Medium 70 to 85	High 85 to 100
Proposed Route	Morrow	47.5	8.5/18	39.0/82	0
	Umatilla	40.9	40.9/100	0	0
	Union	39.9	39.9/100	0	0
	Baker	69.2	69.2/100	0	0
	Malheur	75.2	75.2/100	0	0
Total Proposed Route		***272.8***	***257.5/87***	***39.0/13***	0
Alternative Routes					

Facility	County	Miles Crossed[1]	Earthquake Hazard Risk by Centerline Miles Crossed/Percent of Miles Crossed – Proposed Route and Alternative Route		
			Low < 70	Medium 70 to 85	High 85 to 100
West of Bombing Range Road Alt. 1	Morrow	3.7	0	3.7/100	0
West of Bombing Range Road Alt. 2	Morrow	3.7	0	3.7/100	0
Morgan Lake	Union	18.5	18.5/100	0	0
Double Mountain	Malheur	7.4	7.4/100	0	0

[1] Column may not sum exactly due to rounding.

Landslides

Appendix E of Attachment H-1 contains a summary of each landslide that was identified along the Proposed Route and alternative routes that could potentially affect the stability of proposed tower foundations or associated work areas. The review includes site photographs and preliminary maps of unstable or landslide surfaces. Appendix E of Attachment H-1 was compiled through review of the DOGAMI 2014 SLIDO, version 3.2 database, published geologic maps, aerial imagery, Digital Terrain Model data, DOGAMI light detection and ranging (LiDAR) data, and limited site reconnaissance. The data were used to map landslides within 1 mile of the Proposed Route. IPC's engineers will collect Project-specific LiDAR data prior to final design and will use it to identify historic and prehistoric landslides, as possible. IPC's engineers will include the areas of soil instabilities in the site-specific geotechnical analysis.

Liquefaction

Liquefaction is a phenomenon in which saturated, primarily cohesionless soils temporarily lose their strength when subjected to dynamic forces such as intense and prolonged ground shaking and seismic activity. All portions of the Site Boundary have the potential for ground shaking from earthquakes. Areas that are most susceptible to liquefaction have a combination of thick unconsolidated sediments, and a shallow water table (within 50 feet of the surface). Because the majority of the transmission line crosses relatively stable terrain with shallow bedrock and deep groundwater, the majority of the Site Boundary has a low susceptibility to liquefaction.

Prior to the development of final engineering design, liquefaction studies will be conducted for susceptible areas, including areas that cross or approach rivers and areas where thick unconsolidated sediments are encountered in the field. Additional evaluation of liquefaction also may be needed as the final alignment and tower locations are chosen. The geotechnical engineer will recommend additional exploration and/or analysis as applicable to assess liquefaction hazards in the geotechnical design report for the transmission line.

Subsidence

Subsidence is the sinking or the gradual downward settlement of the land surface, and is often related to groundwater drawdown, compaction, tectonic movements, mining, or explosive activity. Seismic activity in the area could lead to the settling of sediment and could also exacerbate potential subsidence associated with groundwater withdrawal in more populous regions. No historical cases of subsidence in the Site Boundary have been identified, and the majority of the site has a low susceptibility to subsidence. At this time, there are no specific locations where subsidence studies will be performed. However, if subsidence-prone areas are identified during the Phase 2 geotechnical investigation, the transmission line will be designed and located to avoid subsidence hazards.

Lateral Spreading

Lateral spreading is the permanent horizontal movement of a liquefiable soil deposit due to the presence of initial shear stresses on horizontal planes within the soil during a seismic event. It occurs predominantly within gradual slopes or on flat sites situated near riverbanks, shorelines, bulkheads, or wharves. For locations where liquefaction poses a risk, an assessment will be made to determine if lateral spreading would be an additional hazard.

3.9 Soil-Related and Geologic Hazards

> OAR 345-021-0010(1)(h)(G): An assessment of soil-related hazards such as landslides, flooding, and erosion which could, in the absence of a seismic event, adversely affect or be aggravated by the construction or operation of the facility.

3.9.1 Mass Wasting and Landslides

Mass wasting is a generic term for landslides, rockslides, rockfall, debris flows, soil creep, and other processes that include the downslope movement of masses of soil and rock. Mass wasting can be initiated by precipitation events, sometimes in conjunction with land use. Slope stability is a function of moisture content, slope gradient, rock and soil type, slope aspect, vegetation, seismic conditions and ground-disturbing activities. Appendix E Attachment H-1 contains a detailed reconnaissance of the Site Boundary showing the locations of known landslides and soil instabilities. Additional information will be collected on unstable areas during the site-specific, Phase 2 geotechnical investigation. Those data will assist in design of a transmission line that either avoids unstable areas or is built to withstand the effects of land movements to avoid dangers to human safety.

3.9.2 Flooding

Floodplain maps published by FEMA were reviewed to evaluate flooding potential within the Site Boundary. Because FEMA floodplain maps typically provide coverage for use by insurers in populated areas, and FEMA data are scarce away from populated areas, more comprehensive data also were evaluated. To evaluate flood hazards, DOGAMI Statewide Flood Hazard Database for Oregon – FEMA Flood Insurance Study inundation zones (2015) were compared to the temporary and permanent disturbance areas associated with the preliminary design (Table H-4). Project work areas, which include multi-use areas, pulling and tensioning sites, and structure work areas, would be temporary features and have temporary impacts in flood zones. Temporary flood zone impacts would occur in Morrow County (4.8 acres), in Baker County (30.3 acres), and in Malheur County (10 acres). Work areas for alternative routes would be the same as those for the Proposed Route.

Project roads would be permanent features and have permanent impacts in the flood zones. Permanent impacts would occur where access roads cross flood zones in Morrow County (0.5 miles) and Malheur County (0.8 mile). Access roads for alternative routes would cross flood zones in Morrow County (0.1 mile) and Malheur County (0.2 mile). See Exhibit K, Figures K-19 and K-20 for Morrow County locations, Figure K-62 for Union County locations, and Figure K-75 for Malheur County locations.

Table H-4. Flood Zone Impacts for Work Areas[1] and Access Roads[2] – Proposed Route and Alternative Routes

Facility	County	100-year Flood Zone Crossed: Temporary Work Areas[1] (acres)	100-year Flood Zone Crossed: Permanent Roads[2] (miles)
Proposed Route	Morrow	4.8	0.5
	Umatilla	0	0
	Union	0	0
	Baker	30.3	0
	Malheur	10.0	0.8
Total Proposed Route		***45.1***	***1.3***
Alternative Routes			
West of Bombing Range Road Alternative 1	Morrow	0	0.1
West of Bombing Range Road Alternative 2	Morrow	0	0.1
Morgan Lake	Union	0	0
Double Mountain	Malheur	0	0.2

[1] Work Areas include multi-use areas, pulling and tensioning sites, and structure work areas. Work areas for Alternative Routes would be the same as those for the Proposed Route.
[2] Access Roads are existing roads with improvements and new roads.
Source: Oregon Spatial Data Library (DOGAMI 2015)

3.9.3 Erosion

Erosion is a continuing natural process that can be accelerated by human disturbances. Factors that influence soil erosion include soil texture, structure, length and slope steepness, vegetative cover density, and rainfall or wind intensity. Soils most susceptible to erosion by wind and water are typically non-cohesive soils with low infiltration rates, residing on moderate to steep and sparsely vegetated slopes. Non-cohesive soils include silty, sandy, or gravelly soils, with little to no clay-sized particles. Wind erosion processes are less affected by slope angles but highly influenced by wind intensity. The potential for soil erosion within the Site Boundary varies based on the erosion mechanism and soil characteristics.

The erosion potential was analyzed using three factors: soil K factor, wind erodibility, and slope. The Phase 2 geotechnical analysis will provide further evaluation of soil erosion potential, based on both additional review of soil properties and laboratory testing of soil samples collected during geotechnical drilling. Soil erodibility will be considered in design of the Project to avoid dangers to human safety.

Soil K Factor

Soil erosion hazards were mapped throughout the Site Boundary based on the soil's K factor, the soil-erodibility factor. The standard measurement condition is the unit plot. The unit plot is 72.6 feet (22.1 meters) long on a 9 percent slope, maintained in continuous fallow, tilled up and down hill periodically to control weeds and break crusts that form on the surface of the soil. The plots are plowed, disked, and cultivated the same for a row crop of corn or soybeans except that no crop is grown on the plot.

Soils high in clay have low K values, because they are resistant to detachment. Coarse-textured soils, such as sandy soils, have low K values, because of low runoff even though these soils are easily detached. Medium-textured soils, such as the silt loam soils, have a moderate K values, because they are moderately susceptible to detachment and they produce moderate runoff.

Soils having a high silt content are the most erodible of all soils. They are easily detached, tend to crust, and produce high rates of runoff.

The State Soil Geographic (STATSGO) database was used to characterize soil erosion factors. The U.S. Department of Energy, Pacific Northwest National Laboratory website (DOE 2003) guideline was used to segregate the mapped soils into low, moderate, or high K Factor soils. Low K values ranged from 0.05 to 0.15, moderate K values were from 0.25 to 0.4, and high K values were greater than 0.4. However, the closest category in the Natural Resources Conservation Service (NRCS) geographic information system data file to 0.4 was 0.37. As such, a K factor of 0.37 was used to define soils mostly likely to erode. Appendix B of Attachment H-1 presents further information concerning soil erosion potential. Areas of soils with high K factor that could be affected during construction and operations are contained in Exhibit I, Table I-5 and Table I-9.

Wind Erosion

The potential for soil erosion by wind was evaluated using NRCS wind erodibility group data, which are based on the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion. Project construction activities that could expose soils particularly erodible to wind erosion include any surface disturbance (e.g., road construction and improvements, vegetation clearing).

Slope

In general, steep slopes possess a greater potential for erosion by water or mass movements than flat areas. Areas containing greater than 25 percent slope were considered to have greater erosion potential.

3.10 Geologic Hazard Mitigation

The following section discusses anticipated Project design, engineering, and construction measures to avoid or mitigate dangers to human safety resulting from the geologic hazards described above.

3.10.1 Seismic Hazard Mitigation

> OAR 345-021-0010(1)(h)(H): An explanation of how the applicant will design, engineer and construct the facility to avoid dangers to human safety from the seismic hazards identified in paragraph (F). The applicant shall include proposed design and engineering features, applicable construction codes, and any monitoring for seismic hazards.

In general, transmission towers are designed for large wind and tension loads, which results in ample capacity to resist seismic loads. Towers will be designed in accordance with the NESC C2 (IEEE 2006), ASCE Standard 10-97 (ASCE 1997), ASCE Standard 7, Chapters 13 and 16 (ASCE 2013), and ASCE Manual of Practice (MOP)-74 (Wong and Miller 2010). Substation structures will be designed in accordance with applicable portions of the Oregon Structural Specialty Code (OSSC; ICC 2014).

All towers and facilities for the Project will be designed to meet or exceed the 2014 OSSC. The codebook contains the amendments to the 2015 IBC as adopted by the State of Oregon and local agencies. A qualified engineer will assess and review the seismic, geologic, and soil hazards associated with the construction of the towers and facilities. The Project will be designed to withstand wind and ice loads, which are greater than typical seismic forces. All designs and subsequent construction requirements may be modified based on the site-specific characterization of seismic, geologic and soil hazards. By following the appropriate codes; NESC C-2, OSSC Section 1604, 2015 IBC, ASCE 10-97, ASCE 7-13, ASCE 7-16, and ASCE MOP-74, the Project will be designed, engineered, and constructed to adequately avoid potential dangers to human safety presented by seismic hazards.

The Project facilities are generally unmanned and located in sparsely populated areas. Therefore, the risks to human safety due to seismic hazards are minimal due to the low probability of human presence. All Project facilities will be constructed in accordance with the 2014 OSSC and 2015 IBC, or the more recent standards applicable at the time of detailed design. To ensure compliance with the relevant building codes, IPC proposes that the Council include the following condition in the site certificate providing for the same:

> ***Structural Standard Condition 2:*** *During construction, the site certificate holder shall construct the facility in accordance with the versions of the International Building Code, Oregon Structural Specialty Code, and building codes adopted by the State of Oregon.*

Additional work will be necessary to complete the final seismic hazard assessment and identify all the areas that will require mitigation due to seismic hazards. As discussed in Attachment H-1, this will include the geotechnical field exploration program, laboratory testing, and detailed site reconnaissance. A qualified engineer will assess the seismic, geologic, and soil hazards associated with the construction of each tower and each facility. The Project will be designed to withstand wind and ice loads, which are typically greater than seismic loads from ground shaking. All designs and subsequent construction requirements will be modified based on the site-specific characterization of seismic, geologic, and soil hazards. Some specific mitigation techniques for earthquake-induced landslide and liquefaction hazards are presented below. The principal mitigation strategy for surface rupture hazards is modification of structure locations. Additional mitigation strategies will be developed and refined following completion of future geotechnical investigations. To ensure IPC conducts the additional geological and geotechnical investigations and develops any necessary mitigation, IPC proposes that the Council include the following condition in the site certificate providing for the same:

> ***Structural Standard Condition 1:*** *Prior to construction, the site certificate holder shall conduct a site-specific geological and geotechnical investigation, and shall submit to the department for its approval a Site-Specific Geological and Geotechnical Report. The investigation and/or report shall address the following:*
> *a. Subsurface soil and geologic conditions within the site boundary;*
> *b. Geotechnical design criteria and data for the facility's project features;*
> *. . .*
> *j. Define and delineate geological and geotechnical hazards to the facility, and means to mitigate the identified hazards.*

3.10.1.1 Earthquake-Induced Landslide Mitigation

Hazards and mitigation measures related to landslides in general are discussed in Section 3.10.2 under Mitigation of Slope Instability. To the extent landslides may be triggered by earthquakes in particular, IPC will investigate active faults within the Site Boundary as part of the Site-Specific Geological and Geotechnical Report and will propose mitigation measures specific to earthquake-induced landslides, if necessary. To ensure IPC conducts landslide potential investigations and develops any necessary mitigation, IPC proposes that the Council include the following condition in the site certificate providing for the same:

> ***Structural Standard Condition 1:*** *Prior to construction, the site certificate holder shall conduct a site-specific geological and geotechnical investigation, and shall submit to the department for its approval a Site-Specific Geological and Geotechnical Report. The investigation and/or report shall address the following:*
>
> *. . .*
>
> *c. Description of potentially active faults that may affect the facility and their potential risk to the facility;*
>
> *d. LiDAR or field survey investigation of the site boundary to assess the potential for slope instability and landslide hazards;*
>
> *. . .*
>
> *j. Define and delineate geological and geotechnical hazards to the facility, and means to mitigate the identified hazards.*

3.10.1.2 Liquefaction Mitigation

For structures or towers that are located in areas with a risk of liquefaction, a number of methods are available to either adequately reduce the risk of liquefaction or improve the performance of the structure (or improve resiliency), if liquefaction were to occur. Specific methods to reduce the liquefaction potential are ground densification to increase the soil's natural resistance to liquefaction, installation of drains to prevent excess ground water pore pressure build-up during a seismic event, and installation of soil-cement shear cells which reduce the seismic shearing demands on the soil. As an alternative, the structure foundations can be designed to account for a layer of soil that may liquefy—e.g., deep foundations can be designed to bypass the liquefiable layer, being founded on deeper layers. IPC proposes that the Council include the following conditions in the site certificate providing that the Site-Specific Geological and Geotechnical Report addresses liquefaction potential and any necessary mitigation measures regarding the same:

> ***Structural Standard Condition 1:*** *Prior to construction, the site certificate holder shall conduct a site-specific geological and geotechnical investigation, and shall submit to the department for its approval a Site-Specific Geological and Geotechnical Report. The investigation and/or report shall address the following:*
>
> *. . .*
>
> *e. Evaluation of potential liquefaction hazards;*
>
> *. . .*
>
> *j. Define and delineate geological and geotechnical hazards to the facility, and means to mitigate the identified hazards.*

3.10.2 Soil-Related Hazard Mitigation

OAR 345-021-0010(1)(h)(I): An explanation of how the applicant will design, engineer and construct the facility to adequately avoid dangers to human safety presented by the hazards identified in paragraph (G).

3.10.2.1 Mitigation of Slope Instability

Slope instability hazards should be thoroughly evaluated to assess the potential for failure. At locations where landslides, debris flows, or marginally stable slopes are identified, the hazard will be mapped and adequately characterized during the field exploration. All roads and transmission facilities will be designed to meet structural and zoning requirements. Structural requirements should adhere to soil lateral load requirements in the 2014 OSSC (Section 1610).

In general, structures should be located to avoid potential slope instability hazards wherever possible, and newly constructed slopes should be designed with an adequate safety factor against failure. Appropriate mitigation methods should be selected based on site characteristics and the structure to be constructed. If feasible, structures should be located with sufficient setback from slopes to mitigate the potential for slope instability during construction and operation. Where structures cannot be moved or realigned, slope instability mitigation techniques may include modification of slope geometry, hydrogeological mitigation, and slope reinforcement methods.

Slope geometry may be altered by grading or removing soil in order to provide a sufficient factor of safety. Hydrogeological mitigation may include surface drainage, shallow drainage, and deep drainage. These drainage mechanisms vary in intensity; however, all mechanisms attempt to reduce the soil's water content. This decreases both the soil's pore pressures and the overall driving force, thereby decreasing landslide risk. Types of drains may include trench drains, horizontal drain wells, siphon drains, or micro drains.

Reinforcement measures may be implemented when geometric slope modifications or drainage improvements are not sufficient or practical. Reinforcement modifications can involve the use of anchors or tieback systems, geofabric installation, buttressing, and cellular and crib face installation.

The use of vegetation may also be combined with the methods described above to help prevent shallow slides by intercepting rainfall, decreasing runoff, and providing root stabilization.

To ensure IPC conducts slope stability investigations and develops any necessary mitigation, IPC proposes that the Council include the following condition in the site certificate providing for the same:

> ***Structural Standard Condition 1:*** *Prior to construction, the site certificate holder shall conduct a site-specific geological and geotechnical investigation, and shall submit to the department for its approval a Site-Specific Geological and Geotechnical Report. The investigation and/or report shall address the following:*
> *. . .*
> *c. Description of potentially active faults that may affect the facility and their potential risk to the facility;*
> *d. LiDAR or field survey investigation of the site boundary to assess the potential for slope instability and landslide hazards;*
> *. . .*
> *j. Define and delineate geological and geotechnical hazards to the facility, and means to mitigate the identified hazards.*

3.10.2.2 Mitigation of Erosion

A desktop analysis of soil conditions was conducted prior to initial Project siting (Shaw 2012). This analysis incorporated data from many sources as previously described. The transmission line siting was based partly on engineering constraints related to known geologic hazards, soil stability, water crossings, and areas of steep topography. By considering soil and slope conditions throughout the siting and design process, IPC has avoided soil impacts to the extent possible.

The Project will use existing roads to access Project sites to the extent practicable. Where needed, existing roads will be improved to reduce sediment generation and minimize impacts to soils. Results of further engineering evaluations will be used to provide micrositing and design of Project structures that protect the public and minimize construction on unstable soil surfaces. Additional soil data will be collected during the site-specific geotechnical evaluation to further evaluate soil conditions and to assist in preparing detailed foundation designs and erosion and sediment control measures.

Localized impacts to soils at and around tower locations, access roads, light-duty fly yards, and facility footprints in the temporary disturbance area will be minimized though the use of best management practices (BMP) and restoration efforts to restore soil surfaces and vegetation following disturbances.

Impacts to soils at and around tower locations, access roads, and facility footprints will be avoided or minimized through the use of BMPs and restoration measures to restore soil surfaces and vegetation following disturbances. IPC will meet design standards for new roads as required by the Bureau of Land Management, United States Forest Service (USFS), and Oregon Department of Transportation and will implement BMPs described below and in the Erosion and Sediment Control Plan (ESCP) and National Pollutant Discharge Elimination System (NPDES) permits to reduce potential soil erosion during the construction process. Construction of roads, facilities, and towers will be regulated by the NPDES 1200-C Stormwater Construction Permit and the associated ESCP. To minimize soil erosion, where practical IPC will implement revegetation procedures, such as recontouring, scarification, soil replacement, seedbed preparation, fertilization, seed mixtures, seeding timing, seeding methods, supplemental wetland and riparian plantings, and supplemental forest plantings.

Once the roads, towers, and other facilities have been constructed to the designed specifications, operations will have minimal potential for soil erosion. Slopes and cut banks will be stabilized with riprap and/or planted or seeded with vegetation as practical, and Project facilities will be maintained as required to prevent erosion. Temporary access road sites and other compacted soils will be mechanically loosened where necessary, and where required previously salvaged topsoil will be replaced and non-cropped areas will be revegetated.

Vegetation management methods employed during maintenance operations will not result in soil erosion.

Mitigation for Soil Erosion by Water

Erosion control measures will be designed with attention to the mapped soil erosion hazards described above, with particular attention to areas with medium and high hazard ratings. Work on access roads will include grading and re-graveling of existing roads and construction of new roads. Soil erosion will be minimized by constraining traffic, heavy equipment and construction to existing roads where possible. Where new road construction is required, road widths will be limited to the width necessary to accommodate construction equipment. New roads will be located to avoid steep areas as much as possible.

Areas affected by construction will be reseeded with vegetation to minimize future erosion and to restore the systems to their natural state. Erosion and sediment control measures will be designed to remain intact until natural vegetation is sufficient to protect against erosion. The station operational footprint areas will be graveled to prevent erosion. The area outside the station fence may also be graveled where practical to prevent soil erosion during operations.

The Project has applied for and will obtain a 1200-C permit (see Exhibit I, Attachment I-3). Specific erosion and sediment control measures and BMPs to be implemented during the project construction and operations include the following BMPs:

- Avoid Highly Erodible Areas: Initial mitigation measures should include avoiding highly erodible areas, such as steep slopes, where possible, and rerouting impacted drainages to natural drainages to minimize erosion and sedimentation from runoff. Areas impacted by construction should be reseeded and sediment fences, check dams, and other BMPs will remain in place until impacted areas are well vegetated and the risk of erosion has subsided.

- Stabilize Road Entrance/Exit: A stabilized construction entrance/exit should be installed at locations where dirt (exposed, disturbed land) or newly constructed roads intersect existing paved roads. Stabilized entrances should also be installed at the construction laydown areas. The stabilized construction entrance/exits should be inspected and maintained for the duration of the Project life.
- Preserve/Restore Vegetation: To the extent practicable, existing vegetation should be preserved. In the event that vegetation is destroyed in temporary road locations or laydown areas, stockpiled topsoils should be replaced and recontoured. Vegetation should be reseeded to prevent erosion using an approved seed mixture specified by the NRCS or the USFS as being capable of surviving in local conditions (see the Vegetation Management Plan attached to Exhibit P1, Attachment P1-4).
- Control Dust: Dust should be controlled during construction through water application to the disturbed grounds and access roads where necessary. Application of excess water that could lead to erosion or sedimentation should be avoided. Other methods of dust control may include the use of poly sheeting, vegetation, or mulching. Speed limits should be kept to a minimum to prevent pulverization of road substrate.
- Install Silt Fencing: Silt fencing or an equivalent control measure should be installed at various locations along the transmission line. The fencing should be installed on contours downgradient of excavations, fill areas, or graded areas where necessary. Silt fencing or an equivalent control measure should be installed around the perimeters of material stockpiles and construction laydown areas.
- Install Straw Wattles: Straw wattles should be installed to decrease the velocity of sheet flow from stormwater. The wattles should be used along the downgradient edge of access roads adjacent to slopes or sensitive areas.
- Apply Gravel and Mulching: Gravel should be used where soil becomes wet or muddy to prevent erosion and working of the soil. Mulch should be provided to immediately stabilize soil exposed as a result of land disturbing activities. The mulch reduces the potential for wind and raindrop erosion.
- Install Stabilization Matting: Jute mesh, straw matting, or turf reinforcement matting should be used to stabilize slopes that could become exposed during installation of access roads, during rainfall events, or to stabilize intermittent streams disturbed during construction of road crossings. Erosion control matting should be combined with revegetation techniques.
- Control Concrete Washout Area: Concrete washout should be appropriately managed to prevent concrete washout water from impacting soils, water bodies, or wetlands.
- Manage Stockpiles: Soils excavated may be temporarily stockpiled. While the material is stockpiled, perimeter controls should be established and the stockpiled material should be covered as necessary with mulch, plastic sheeting, and/or other appropriate means to prevent erosion and sedimentation.
- Install Check Dams, Sediment Traps, and Sediment Basins: Check dams and sediment traps should be used during construction near tributaries and existing drainages. The check dams and sediment traps will minimize downstream disturbances and sedimentation of creeks. A sediment basin is a constructed temporary pond, built to

capture eroded soils that wash off from larger construction sites during rain storms. The sediment-laden soil settles in the pond before the runoff is discharged.

To ensure the protective measures set forth in the draft ESCP are incorporated into the final ESCP and to ensure compliance with the final ESCP, IPC proposes that the Council include the following conditions in the site certificate providing for the same:

> ***Soil Protection Condition 3:*** *Prior to construction, the site certificate holder shall submit to the department a copy of an ODEQ-approved construction-related final Erosion and Sediment Control Plan (ESCP). The protective measures described in the draft ESCP Plan in ASC Exhibit I, Attachment I-3, shall be included as part of the construction-related final ESCP, unless otherwise approved by the department.*

> ***Soil Protection Condition 6:*** *During construction, the site certificate holder shall conduct all work in compliance with the final ESCP referenced in Soil Protection Condition 3.*

Mitigation for Soil Erosion by Wind

To mitigate the risk of accelerating soil erosion by wind in areas rated with wind erodibility groups 1 through 4, IPC will implement reseeding efforts, apply mulch, and use water for dust control. Areas that are susceptible to aeolian processes that will be disturbed by construction activities and not permanently covered by aboveground facilities will be vegetated using a seed mixture specified by the applicable agencies as being capable of surviving in local conditions, and withstanding burial and deflation from aeolian processes. Disturbed areas susceptible to wind erosion may be hydroseeded when temperatures and moisture levels are conducive to seed germination. Vegetation protection actions and activities will be presented as part of the Project's Vegetation Management Plan (see Exhibit P1, Attachment P1-4). To ensure the protective measures set forth in the draft Vegetation Management Plan are incorporated into the final Vegetation Management Plan and to ensure compliance with the final Vegetation Management Plan, IPC proposes that the Council include the following conditions in the site certificate providing for the same:

> ***Fish and Wildlife Condition 5:*** *Prior to construction, the site certificate holder shall finalize, and submit to the department for its approval, a final Vegetation Management Plan. The protective measures described in the draft Vegetation Management Plan in ASC Exhibit P1, Attachment P1-4, shall be included as part of the final Vegetation Management Plan, unless otherwise approved by the department.*

> ***Fish and Wildlife Condition 18:*** *During construction, the site certificate holder shall conduct all work in compliance with the final Vegetation Management Plan referenced in Fish and Wildlife Condition 5.*

> ***Fish and Wildlife Condition 28:*** *During operation, the site certificate holder shall conduct all work in compliance with the final Vegetation Management Plan referenced in Fish and Wildlife Condition 5.*

3.10.2.3 Mitigation of Expansive Soils

Expansive soils swell when exposed to moisture and shrink when dried. This change in volume can be detrimental to structure foundations. The selection of appropriate mitigation techniques will depend on the specific properties of site soils and foundation requirements of proposed structures. In general, mitigation techniques for expansive soils include removal, bypass, isolation, and treatment. If only a thin layer of expansive soil is present at a site, it may be feasible to strip and remove it. For thicker layers of expansive soil, it is common practice to extend foundations deep enough to effectively bypass the zone where moisture content is likely to change. Another mitigation alternative is to isolate the soil from changes in moisture content, through the use of enhanced drainage and/or coverings. Where only shallow foundations are practical, another mitigation alternative is to treat the expansive soils with lime or some other material that reduces their expansive properties. IPC proposes that the Council include the following condition in the site certificate providing that the Site-Specific Geological and Geotechnical Report addresses the potential of expansive soil impacts and any necessary mitigation measures regarding the same:

> ***Structural Standard Condition 1:*** *Prior to construction, the site certificate holder shall conduct a site-specific geological and geotechnical investigation, and shall submit to the department for its approval a Site-Specific Geological and Geotechnical Report. The investigation and/or report shall address the following:*
>
> *. . .*
>
> *f. Evaluation of potential soil expansion hazards;*
>
> *. . .*
>
> *j. Define and delineate geological and geotechnical hazards to the facility, and means to mitigate the identified hazards.*

3.10.2.4 Mitigation of Groundwater

The first step in mitigation of hazards posed by groundwater is to understand where and when it is present. Groundwater levels can vary significantly from one location to another and from one season to another. The geotechnical investigation will help to determine where groundwater will be relevant along the proposed alignments. Where groundwater plays a role in slope instability, the hydrogeological mitigation measures discussed in above should be considered. As discussed in Attachment H-1, groundwater can also complicate construction, particularly where excavations extend below the water table. This will most likely be applicable to the proposed alignment where drilled shafts are required for tower foundations. If a shaft is excavated in good quality rock or firm fine-grained soils below the water table, groundwater may not be a significant concern. However, if shaft foundations extend below the water table in granular soils, casing and/or slurry may be necessary to prevent soil heave and maintain shaft integrity. IPC proposes that the Council include the following condition in the site certificate providing that the Site-Specific Geological and Geotechnical Report addresses affected groundwater and any necessary mitigation measures regarding the same:

> ***Structural Standard Condition 1:*** *Prior to construction, the site certificate holder shall conduct a site-specific geological and geotechnical investigation, and shall submit to the department for its approval a Site-Specific Geological and Geotechnical Report. The investigation and/or report shall address the following:*
>
> *. . .*
>
> *g. Description of groundwater detections and any related potential risk to the facility;*
>
> *. . .*
>
> *j. Define and delineate geological and geotechnical hazards to the facility, and means to mitigate the identified hazards.*

3.10.2.5 Mitigation of Corrosive Subsurface Conditions

Where soil conditions are identified that may be corrosive to metals, potential mitigation alternatives may include application of protective coatings, such as coal tar enamel. Another mitigation alternative is to increase the metal thickness to provide a "sacrificial" layer that is thick enough to manage the amount of corrosion anticipated to occur over the structure's design life. Where sulfates are present and corrosion of concrete is a concern, mitigation alternatives may include use of sulfate-resistant cement, such as type II low-alkali cement, coating the concrete with an asphalt emulsion, or reducing the water-cement ratio to reduce the hydraulic conductivity of the concrete and slow the reaction processes. IPC proposes that the Council include the following condition in the site certificate providing that the Site-Specific Geological and Geotechnical Report addresses corrosive soils and any necessary mitigation measures regarding the same:

> ***Structural Standard Condition 1:*** *Prior to construction, the site certificate holder shall conduct a site-specific geological and geotechnical investigation, and shall submit to the department for its approval a Site-Specific Geological and Geotechnical Report. The investigation and/or report shall address the following:*
>
> *. . .*
>
> *h. Description of corrosive soils detections and any related potential risk to the facility; …*
>
> *. . .*
>
> *j. Define and delineate geological and geotechnical hazards to the facility, and means to mitigate the identified hazards.*

3.10.2.6 Flood Mitigation

Flood hazard mitigation goals are to avoid and reduce damage to constructed tower and facility locations, prevent construction that could exacerbate flooding, minimize economic losses associated with repair of structures influenced by flooding hazards and avoid dangers to human safety. Federal and state policies related to development in flood-prone areas were developed according to FEMA requirements and guidelines. These policies include zoning ordinances found in local regulations and building code ordinances in the OSSC Section 1612. This code establishes flood protection standards for all construction, including criteria to ensure that the foundation will withstand flood forces.

There are very few miles of access roads (permanent Project features) within the 100-year flood zone within the Site Boundary. Results of further engineering evaluations will be used to provide micrositing and design of Project structures that protect the public and minimize construction in flood zone areas. To reduce flood hazards, Project structures and towers will be set back from areas of high flood risks during final design. Where structures cannot be set back, a site-specific structural and erosion hazard assessment will be conducted to determine mitigation requirements.

Standards for protecting foundations against flood damage include requirements for soil testing and prepared fill. Building code provisions impose conditions to ensure that structures built in flood zones meet minimum standards. The primary structural code in Oregon is the OSSC, Section 1612 (ICC 2014). This code establishes flood protection standards for all construction, including criteria to ensure that the foundation will withstand flood forces and that all portions of the structures subject to damage are above, or otherwise protected from, flooding. IPC proposes that the Council include the following condition in the site certificate providing that the Site-Specific Geological and Geotechnical Report addresses flood hazards and any necessary mitigation measures regarding the same:

Structural Standard Condition 1: *Prior to construction, the site certificate holder shall conduct a site-specific geological and geotechnical investigation, and shall submit to the department for its approval a Site-Specific Geological and Geotechnical Report. The investigation and/or report shall address the following:*
. . .
i. Description of Project features within the 100-year flood zone and any related potential risk to the facility; and
j. Define and delineate geological and geotechnical hazards to the facility, and means to mitigate the identified hazards.

4.0 IDAHO POWER'S PROPOSED SITE CERTIFICATE CONDITIONS

IPC proposes the following site certificate conditions to ensure compliance with the relevant EFSC standards:

Prior to Construction

Structural Standard Condition 1: *Prior to construction, the site certificate holder shall conduct a site-specific geological and geotechnical investigation, and shall submit to the department for its approval a Site-Specific Geological and Geotechnical Report. The investigation and/or report shall address the following:*
a. Subsurface soil and geologic conditions within the site boundary;
b. Geotechnical design criteria and data for the facility's project features;
c. Description of potentially active faults that may affect the facility and their potential risk to the facility;
d. LiDAR or field survey investigation of the site boundary to assess the potential for slope instability and landslide hazards;
e. Evaluation of potential liquefaction hazards;
f. Evaluation of potential soil expansion hazards;
g. Description of groundwater detections and any related potential risk to the facility;
h. Description of corrosive soils detections and any related potential risk to the facility;
i. Description of Project features within the 100-year flood zone and any related potential risk to the facility; and
j. Define and delineate geological and geotechnical hazards to the facility, and means to mitigate the identified hazards.

Soil Protection Condition 3: *Prior to construction, the site certificate holder shall submit to the department a copy of an ODEQ-approved construction-related final Erosion and Sediment Control Plan (ESCP). The protective measures described in the draft ESCP in ASC Exhibit I, Attachment I-3, shall be included as part of the construction-related final ESCP Plan, unless otherwise approved by the department.*

Fish and Wildlife Condition 5: *Prior to construction, the site certificate holder shall finalize, and submit to the department for its approval, a final Vegetation Management Plan. The protective measures described in the draft Vegetation Management Plan in ASC Exhibit P1, Attachment P1-4, shall be included as part of the final Vegetation Management Plan, unless otherwise approved by the department.*

During Construction

Structural Standard Condition 2: *During construction, the site certificate holder shall construct the facility in accordance with the versions of the International Building Code, Oregon Structural Specialty Code, and building codes adopted by the State of Oregon.*

Soil Protection Condition 6: *During construction, the site certificate holder shall conduct all work in compliance with the final ESCP referenced in Soil Protection Condition 3.*

Fish and Wildlife Condition 18: *During construction, the site certificate holder shall conduct all work in compliance with the final Vegetation Management Plan referenced in Fish and Wildlife Condition 5.*

During Operation

Fish and Wildlife Condition 28: *During operation, the site certificate holder shall conduct all work in compliance with the final Vegetation Management Plan referenced in Fish and Wildlife Condition 5.*

5.0 CONCLUSIONS

Exhibit H includes the application information provided for in OAR 345-021-0010(1)(h). Further, the evidence set forth in Exhibit H shows the Project will meet the Structural Standard at OAR 345-022-0020.

6.0 COMPLIANCE CROSS-REFERENCES

Table H-5 identifies the location within the application for site certificate of the information responsive to the application submittal requirements in OAR 345-021-0010(1)(h), the Structural Standard at OAR 345-022-0020, and the relevant Amended Project Order provisions.

Table H-5. Compliance Requirements and Relevant Cross-References

Requirement	Location
OAR 345-021-0010(1)(h)	
(h) Exhibit H. Information from reasonably available sources regarding the geological and soil stability within the analysis area, providing evidence to support findings by the Council as required by OAR 345-022-0020, including:	
(A) A geologic report meeting the guidance in Oregon Department of Geology and Mineral Industries open file report 00-04 "Guidelines for Engineering Geologic reports and Site-Specific Seismic Hazard Reports."	Exhibit H, Section 3.3 and Attachment H-1
(B) A description and schedule of site-specific geotechnical work that will be performed before construction for inclusion in the site certificate as conditions.	Exhibit H, Section 3.4 and Attachment H-1
(C) Evidence of consultation with the Oregon Department of Geology and Mineral Industries regarding the appropriate site specific geotechnical work that must be performed before submitting the application for the Department to determine that the application is complete.	Exhibit H, Section 3.5 and Attachment H-2

Requirement	Location
(D) For all transmission lines, 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, corners, and portions of the proposed route where geologic reconnaissance and other site specific studies provide evidence of existing landslides or marginally stable slopes that could be made unstable by the planned construction.	Exhibit H, Section 3.6 and Attachment H-1
(E) 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 and portions of the proposed alignment where geologic reconnaissance and other site specific studies provide evidence of existing landslides or marginally stable slopes that could be made unstable by the planned construction.	Exhibit H, Section 3.7. Not Applicable because the Project does not contain pipelines.
(F) An assessment of seismic hazards. For the purposes of this assessment, the maximum probable earthquake (MPE) is the maximum earthquake that could occur under the known tectonic framework with a 10 percent chance of being exceeded in a 50 year period. If seismic sources are not mapped sufficiently to identify the ground motions above, the applicant shall provide a probabilistic seismic hazard analysis to identify the peak ground accelerations expected at the site for a 500 year recurrence interval and a 5000 year recurrence interval. In the assessment, the applicant shall include:	Exhibit H, Section 3.8
(i) Identification of the Maximum Considered Earthquake Ground Motion under the 2009 International Building Code.	Exhibit H, Section 3.8.1 and Attachment H-1
(ii) Identification and characterization of all earthquake sources capable of generating median peak ground accelerations greater than 0.05g on rock at the site. For each earthquake source, the applicant shall assess the magnitude and minimum epicentral distance of the maximum credible earthquake (MCE).	Exhibit H, Section 3.8.2 and Attachment H-1
(iii) A description of any recorded earthquakes within 50 miles of the site and of recorded earthquakes greater than 50 miles from the site that caused ground shaking at the site more intense than the Modified Mercalli III intensity. The applicant shall include the date of occurrence and a description of the earthquake that includes its magnitude and highest intensity and its epicenter location or region of highest intensity.	Exhibit H, Section 3.8.3 and Attachment H-1
(iv) Assessment of the median ground response spectrum from the MCE and the MPE and identification of the spectral accelerations greater than the design spectrum provided in the 2010 Oregon Structural Specialty Code. The applicant shall include a description of the probable behavior of the subsurface materials and amplification by subsurface materials and any topographic or subsurface conditions that could result in expected ground motions greater than those characteristic of the Maximum Considered Earthquake Ground Motion identified above.	Exhibit H, Section 3.8.4
(v) An assessment of seismic hazards expected to result from reasonably probable seismic events. As used in this rule “seismic hazard” includes ground shaking, ground failure, landslide, lateral spreading, liquefaction, tsunami inundation, fault displacement and subsidence.	Exhibit H, Section 3.8.5

Requirement	Location
(G) An assessment of soil-related hazards such as landslides, flooding and erosion which could, in the absence of a seismic event, adversely affect or be aggravated by the construction or operation of the facility.	Exhibit H, Section 3.9 and Attachment H-1
(H) An explanation of how the applicant will design, engineer and construct the facility to avoid dangers to human safety from the seismic hazards identified in paragraph (F). The applicant shall include proposed design and engineering features, applicable construction codes, and any monitoring for seismic hazards.	Exhibit H, Section 3.10.1 and Attachment H-1
(I) An explanation of how the applicant will design, engineer and construct the facility to adequately avoid dangers to human safety presented by the hazards identified in paragraph (G).	Exhibit H, Section 3.10.2
OAR 345-022-0020	
To issue the requested Site Certificate, the Council must find that: (a) The applicant, through appropriate site-specific study, has adequately characterized the site as to the Maximum Considered Earthquake Ground Motion as shown for the site in the 2009 International Building Code and maximum probable ground motion, taking into account ground failure and amplification for the site specific soil profile under the maximum credible and maximum probable seismic events; and	Exhibit H, Section 3.8.1 through Section 3.8.4, and Attachment H-1
(b) The applicant can design, engineer, and construct the facility to avoid dangers to human safety presented by seismic hazards affecting the site that are expected to result from maximum probable ground motion events. As used in this rule "seismic hazard" includes ground shaking, ground failure, landslide, liquefaction, lateral spreading, tsunami inundation, fault displacement, and subsidence;	Exhibit H, Section 3.8 and Section 3.10.1
(c) The applicant, through appropriate site-specific study, has adequately characterized the potential geological and soils hazards of the site and its vicinity that could, in the absence of a seismic event, adversely affect, or be aggravated by, the construction and operation of the proposed facility; and	Exhibit H, Section 3.9 and Section 3.10.2
(d) The applicant can design, engineer and construct the facility to avoid dangers to human safety presented by the hazards identified in subsection (c).	Exhibit H, Section 3.8, Section 3.10.1, and Section 3.10.2
Amended Project Order Provisions	
The Department understands that detailed site-specific geotechnical investigation for the entire site boundary is not practical in advance of completing the final facility design and obtaining full site access. However, the rule requires evidence of consultation with the Oregon Department of Geology and Mineral Industries (DOGAMI) prior to submitting the application if the applicant proposes to base Exhibit H on limited pre-application geotechnical work. Exhibit H should include written evidence of consultation with DOGAMI regarding the level of geologic and geotechnical investigation determined to be practical for the application submittal.	Exhibit H, Section 3.5 and Attachment H-2
Any geotechnical reports included in Exhibit H as supporting evidence that the proposed facility will meet the Council's structural standard should follow the guidelines of DOGAMI's "Open File Report 00-04 "Guidelines for Engineering Geologic Reports and Site Specific Seismic Hazard Reports."	Exhibit H, Section 3.3 and Attachment H-1

Requirement	Location
Note that OAR 345-021-0010(1)(h), paragraphs (A), (F)(i), and (F)(iv) contain references to outdated guidelines and codes. Until such time that the Council rules can be revised to reflect current standards, the Department requests that applicants consult directly with DOGAMI, determine the most current structural standards that apply to its facility, then use those codes to prepare Exhibit H. The application should clearly note which codes and guidelines were used to prepare the information in Exhibit H. Exhibit H should also provide evidence that the current codes are equivalent to or more stringent than those cited in the Council's rules, and that the applicant agrees to construct the facility in accordance with the current codes and guidelines.	Exhibit H, Section 3.2 and Attachment H-1

7.0 RESPONSE TO PUBLIC COMMENTS

Table H-6 identifies the location within the application for site certificate of the information responsive to the public comments cited in the Amended Project Order.

Table H-6. Public Comments

Requirements	Location
Geological hazards, including seismic hazards, steep terrain, and landslides, should be addressed in Exhibit H.	See Exhibit H, Section 3.3
A commenter expressed concern about "thermal vents" on Lindsey Mountain—if the proposed route is in the area and might be impacted by such vents, it should be addressed in Exhibit H.	The Project is not in the vicinity of Lindsey Mountain.
A commenter expressed concern about "27 recognized fault lines" present in the John Day Valley. The applicant should address identified fault lines in Exhibit H.	The Project is not in the vicinity of the John Day Valley.

8.0 REFERENCES

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