

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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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

1 Exhibit H

2 Geological Hazards and Soil Stability

3 1.0 INTRODUCTION

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

10 2.0 APPLICABLE RULES AND AMENDED PROJECT ORDER

11 PROVISIONS

12 2.1 General Standards for Siting Facilities

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

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

17 *(a) The applicant, through appropriate site-specific study, has adequately*
18 *characterized the site as to the Maximum Considered Earthquake Ground Motion*
19 *as shown for the site in the 2009 International Building Code and maximum*
20 *probable ground motion, taking into account ground failure and amplification for*
21 *the site specific soil profile under the maximum credible and maximum probable*
22 *seismic events; and*

23 *(b) The applicant can design, engineer, and construct the facility to avoid*
24 *dangers to human safety presented by seismic hazards affecting the site that are*
25 *expected to result from maximum probable ground motion events. As used in this*
26 *rule "seismic hazard" includes ground shaking, ground failure, landslide,*
27 *liquefaction, lateral spreading, tsunami inundation, fault displacement, and*
28 *subsidence;*

29 *(c) The applicant, through appropriate site-specific study, has adequately*
30 *characterized the potential geological and soils hazards of the site and its vicinity*
31 *that could, in the absence of a seismic event, adversely affect, or be aggravated*
32 *by, the construction and operation of the proposed facility; and*

33 *(d) The applicant can design, engineer and construct the facility to avoid dangers*
34 *to human safety presented by the hazards identified in subsection (c).*

35¹

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.

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

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

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

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

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

23 **2.3 Amended Project Order Provisions**

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

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

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

37 *Note that OAR 345-021-0010(1)(h), paragraphs (A), (F)(i), and (F)(iv) contain references*
38 *to outdated guidelines and codes. Although the Council rules are currently applicable,*
39 *before the B2H application process is concluded, the department intends to engage in*
40 *rulemaking and will be seeking EFSC approval of updated rules that reflect currently*
41 *applicable guidelines and codes. The department anticipates the requirements of OAR*
42 *345-021-0010(1)(h) will be modified to require compliance with the rules that became*
43 *effective July 1, 2014. In anticipation of that rulemaking, the department recommends that*
44 *the applicant consult directly with DOGAMI regarding the current DOGAMI requirements.*

45 (Amended Project Order, Section III(h))

1 **3.0 ANALYSIS**

2 **3.1 Analysis Area**

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

- 8 • The Proposed Route, consisting of 270.8 miles of new 500-kilovolt (kV) electric
9 transmission line, removal of 12 miles of existing 69-kV transmission line, rebuilding of
10 0.9 mile of a 230-kV transmission line, and rebuilding of 1.1 miles of an existing 138-kV
11 transmission line;
- 12 • Four alternatives that each could replace a portion of the Proposed Route, including the
13 West of Bombing Range Road Alternative 1 (3.7 miles), West of Bombing Range Road
14 Alternative 2 (3.7 miles), Morgan Lake Alternative (18.5 miles), and Double Mountain
15 Alternative (7.4 miles);
- 16 • One proposed 20-acre station (Longhorn Station);
- 17 • Ten communication station sites of less than ¼-acre each and two alternative
18 communication station sites;
- 19 • Permanent access roads for the Proposed Route, including 206.3 miles of new roads
20 and 223.2 miles of existing roads requiring substantial modification, and for the
21 Alternative Routes including 30.2 miles of new roads and 22.7 miles of existing roads
22 requiring substantial modification; and
- 23 • Thirty-one temporary multi-use areas and 299 pulling and tensioning sites of which four
24 will have light-duty fly yards within the pulling and tensioning sites.

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

28 **3.2 Methods**

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

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

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

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

17 **3.3 Geologic Report**

18 OAR 345-021-0010(1)(h): Information from reasonably available sources regarding the
19 geological and soil stability within the analysis area, providing evidence to support findings by
20 the Council as required by OAR 345-022-0020, including: (A) A geologic report meeting the
21 guidance in Oregon Department of Geology and Mineral Industries open file report 00-04
22 "Guidelines for Engineering Geologic reports and Site-Specific Seismic Hazard Reports."

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

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

1 study. Recommendations for additional investigations or hazard mitigations are also a part of
2 typical engineering geology and seismic hazard reports.

3 Attachment H-1 includes an introduction, summary of topographical and geological features,
4 general description of the scope of the proposed site-specific investigation, and summaries and
5 mitigation strategies for seismic and non-seismic hazards. In turn, Exhibit H supplements the
6 data contained in Attachment H-1 in a format that closely matches the requirements of OAR
7 345-021-0010(1)(h)(A).

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

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

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

24 **3.4 Site-specific Geotechnical Work**

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

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

31 Based on the geologic reconnaissance performed to date, IPC's geotechnical engineers have
32 identified approximately 469 initial geotechnical boring locations for the Proposed Route (see
33 Attachment H-1, Section 3.0 and Appendix C of Attachment H-1). Appendix A of Attachment H-
34 1 includes maps of these proposed borehole locations. Section 3 of the Attachment H-1
35 provides an overview of the proposed site-specific geotechnical work, including right-of-way
36 considerations, access and disturbance, and exploration methods.

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

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

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

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

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

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

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

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

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

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

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

15 **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

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

17 3.5 Consultation with DOGAMI

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

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

- 27 1) *The SLIDO (Statewide Landslide Inventory Database for Oregon) was being updated*
 28 *based on new LIDAR data, and you requested that the updated SLIDO 2 data should be*
 29 *incorporated into the geotechnical hazard assessment and engineering design prior to*
 30 *construction.*
- 31 2) *Geological and soil hazard analysis is not required at each tower location. The degree of*
 32 *investigation should be contingent on the type of hazards present, facility to be*
 33 *constructed, and potential danger to human safety. The degree of analysis will vary*
 34 *across the Project corridor.*
- 35 3) *The most recent IBC and Oregon Structural Specialty Code (OSSC) requirements*
 36 *should be used although current Oregon Administrative Rules reference historical IBC*
 37 *requirements.*
- 38 4) *You were aware that in transmission line construction, design for wind and ice forces is*
 39 *more than sufficient to account for typical seismic forces.*

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

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

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

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

11 3.6 Locations of Geotechnical Work

12 OAR 345-021-0010(1)(h)(D): For all transmission lines, a description of locations along the
13 proposed route where the applicant proposes to perform site specific geotechnical work,
14 including but not limited to railroad crossings, major road crossings, river crossings, dead
15 ends, corners, and portions of the proposed route where geologic reconnaissance and other
16 site specific studies provide evidence of existing landslides or marginally stable slopes that
17 could be made unstable by the planned construction.

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

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

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

31 3.7 Pipelines

32 OAR 345-021-0010(1)(h)(E): For all pipelines that would carry explosive, flammable or
33 hazardous materials, a description of locations along the proposed route where the applicant
34 proposes to perform site specific geotechnical work, including but not limited to railroad
35 crossings, major road crossings, river crossings and portions of the proposed alignment
36 where geologic reconnaissance and other site specific studies provide evidence of existing
37 landslides or marginally stable slopes that could be made unstable by the planned
38 construction.

39 OAR 345-021-0010(1)(h)(E) applies to pipelines. This subpart of the regulations does not apply
40 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.

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

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

10 **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

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

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

17 ³ Class B Faults are faults of uncertain origin that may be older than Quaternary.
 18

19 **3.8.3 Recorded Earthquakes**

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

25 Due to the large areas of impact from earthquakes, the analysis area for recorded earthquakes
 26 was larger than the Site Boundary, and chosen by a variable buffer distance around epicenters,
 27 or groups of epicenters, of historical earthquakes. The seismology department at University of
 28 Nevada at Reno states that earthquakes of Richter magnitude 6.1 to 6.9 may affect areas up to
 29 100 km from the epicenter (UNR 1996). Given that estimate, an analysis area radius of 25 miles
 30 was selected for earthquakes less than magnitude 6. A radius of 50 miles was assumed for

1 earthquakes of magnitude 6 to less than 7, and the analysis area was extended out to 100 miles
2 for earthquakes of magnitude 7 or greater. The distance of 100 miles was chosen because,
3 above that distance, the effect on the proposed transmission line from even the strongest
4 recorded past earthquakes would be minimal. The locations of historical earthquake epicenters
5 were also reviewed relative to the Proposed Route and Alternative Routes. Earthquake data for
6 Idaho and Oregon were obtained from the applicable state geologic survey departments. None
7 of the recorded earthquakes within the Site Boundary exceeded Richter magnitude 6.0. The
8 recommended design earthquake magnitudes of 6.0 to 6.2 appear realistic, given the maximum
9 magnitude of historic earthquakes.

10 Historical earthquakes recorded by the USGS Earthquake Search Database (USGS 2016), the
11 National Geophysical Data Center (NGDC 1985), and the Pacific Northwest Seismic Network
12 (2008) are presented in Appendix D of Attachment H-1. A map of recorded earthquakes with
13 magnitudes of 2 or greater within 50 miles of the Project is shown as Attachment H-1, Appendix
14 D, Figure D10.

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

21 *III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many*
22 *people do not recognize it as an earthquake. Standing motor cars may rock slightly.*
23 *Vibrations similar to the passing of a truck. Duration estimated.*

24 *IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes,*
25 *windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking*
26 *building. Standing motor cars rocked noticeably.*

27 *V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable*
28 *objects overturned. Pendulum clocks may stop.*

29 *VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen*
30 *plaster. Damage slight.*

31 *VII. Damage negligible in buildings of good design and construction; slight to moderate in*
32 *well-built ordinary structures; considerable damage in poorly built or badly designed*
33 *structures; some chimneys broken.*

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

39 **3.8.4 Median Ground Response, MCE and MPE**

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

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

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

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

21 **3.8.5 Seismic Hazards Resulting from Seismic Events**

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

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

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

38 **Ground Motion or Seismic Shaking**

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

1 **Ground Failure**

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

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

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

34 **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 ¹ Column may not sum exactly due to rounding.

2 **Landslides**

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

13 **Liquefaction**

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

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

27 **Subsidence**

28 Subsidence is the sinking or the gradual downward settlement of the land surface, and is often
29 related to groundwater drawdown, compaction, tectonic movements, mining, or explosive
30 activity. Seismic activity in the area could lead to the settling of sediment and could also
31 exacerbate potential subsidence associated with groundwater withdrawal in more populous
32 regions. No historical cases of subsidence in the Site Boundary have been identified, and the

1 majority of the site has a low susceptibility to subsidence. At this time, there are no specific
2 locations where subsidence studies will be performed. However, if subsidence-prone areas are
3 identified during the Phase 2 geotechnical investigation, the transmission line will be designed
4 and located to avoid subsidence hazards.

5 ***Lateral Spreading***

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

11 **3.9 Soil-Related and Geologic Hazards**

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

15 **3.9.1 Mass Wasting and Landslides**

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

26 **3.9.2 Flooding**

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

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

1 **Table H-4. Flood Zone Impacts for Work Areas¹ and Access Roads² – Proposed**
 2 **Route and Alternative Routes**

Facility	County	100-year Flood Zone Crossed	
		Temporary Work Areas ¹ (acres)	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 **3.9.3 Erosion**

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

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

17 **Soil K Factor**

18 Soil erosion hazards were mapped throughout the Site Boundary based on the soil's K factor,
 19 the soil-erodibility factor. The standard measurement condition is the unit plot. The unit plot is
 20 72.6 feet (22.1 meters) long on a 9 percent slope, maintained in continuous fallow, tilled up and
 21 down hill periodically to control weeds and break crusts that form on the surface of the soil. The
 22 plots are plowed, disked, and cultivated the same for a row crop of corn or soybeans except that
 23 no crop is grown on the plot.

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

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

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

13 **Wind Erosion**

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

20 **Slope**

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

24 **3.10 Geologic Hazard Mitigation**

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

28 **3.10.1 Seismic Hazard Mitigation**

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

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

39 All towers and facilities for the Project will be designed to meet or exceed the 2014 OSSC. The
40 codebook contains the amendments to the 2015 IBC as adopted by the State of Oregon and
41 local agencies. A qualified engineer will assess and review the seismic, geologic, and soil
42 hazards associated with the construction of the towers and facilities. The Project will be
43 designed to withstand wind and ice loads, which are greater than typical seismic forces. All

1 designs and subsequent construction requirements may be modified based on the site-specific
2 characterization of seismic, geologic and soil hazards. By following the appropriate codes;
3 NESC C-2, OSSC Section 1604, 2015 IBC, ASCE 10-97, ASCE 7-13, ASCE 7-16, and ASCE
4 MOP-74, the Project will be designed, engineered, and constructed to adequately avoid
5 potential dangers to human safety presented by seismic hazards.

6 The Project facilities are generally unmanned and located in sparsely populated areas.
7 Therefore, the risks to human safety due to seismic hazards are minimal due to the low
8 probability of human presence. All Project facilities will be constructed in accordance with the
9 2014 OSSC and 2015 IBC, or the more recent standards applicable at the time of detailed
10 design. To ensure compliance with the relevant building codes, IPC proposes that the Council
11 include the following condition in the site certificate providing for the same:

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

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

30 ***Structural Standard Condition 1: Prior to construction, the site certificate***
31 ***holder shall conduct a site-specific geological and geotechnical investigation, and***
32 ***shall submit to the department for its approval a Site-Specific Geological and***
33 ***Geotechnical Report. The investigation and/or report shall address the following:***
34 ***a. Subsurface soil and geologic conditions within the site boundary;***
35 ***b. Geotechnical design criteria and data for the facility's project features;***
36 ***...***
37 ***j. Define and delineate geological and geotechnical hazards to the facility, and***
38 ***means to mitigate the identified hazards.***

39 3.10.1.1 Earthquake-Induced Landslide Mitigation

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

1 **Structural Standard Condition 1:** Prior to construction, the site certificate
 2 holder shall conduct a site-specific geological and geotechnical investigation, and
 3 shall submit to the department for its approval a Site-Specific Geological and
 4 Geotechnical Report. The investigation and/or report shall address the following:

5 ...

6 c. Description of potentially active faults that may affect the facility and their
 7 potential risk to the facility;

8 d. LiDAR or field survey investigation of the site boundary to assess the potential
 9 for slope instability and landslide hazards;

10 ...

11 j. Define and delineate geological and geotechnical hazards to the facility, and
 12 means to mitigate the identified hazards.

13 3.10.1.2 Liquefaction Mitigation

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

26 **Structural Standard Condition 1:** Prior to construction, the site certificate
 27 holder shall conduct a site-specific geological and geotechnical investigation, and
 28 shall submit to the department for its approval a Site-Specific Geological and
 29 Geotechnical Report. The investigation and/or report shall address the following:

30 ...

31 e. Evaluation of potential liquefaction hazards;

32 ...

33 j. Define and delineate geological and geotechnical hazards to the facility, and
 34 means to mitigate the identified hazards.

35 3.10.2 Soil-Related Hazard Mitigation

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

39 3.10.2.1 Mitigation of Slope Instability

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

45 In general, structures should be located to avoid potential slope instability hazards wherever
 46 possible, and newly constructed slopes should be designed with an adequate safety factor

1 against failure. Appropriate mitigation methods should be selected based on site characteristics
2 and the structure to be constructed. If feasible, structures should be located with sufficient
3 setback from slopes to mitigate the potential for slope instability during construction and
4 operation. Where structures cannot be moved or realigned, slope instability mitigation
5 techniques may include modification of slope geometry, hydrogeological mitigation, and slope
6 reinforcement methods.

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

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

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

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

22 ***Structural Standard Condition 1: Prior to construction, the site certificate***
23 ***holder shall conduct a site-specific geological and geotechnical investigation, and***
24 ***shall submit to the department for its approval a Site-Specific Geological and***
25 ***Geotechnical Report. The investigation and/or report shall address the following:***

26 . . .

27 *c. Description of potentially active faults that may affect the facility and their*
28 *potential risk to the facility;*

29 *d. LiDAR or field survey investigation of the site boundary to assess the potential*
30 *for slope instability and landslide hazards;*

31 . . .

32 *j. Define and delineate geological and geotechnical hazards to the facility, and*
33 *means to mitigate the identified hazards.*

34 3.10.2.2 Mitigation of Erosion

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

41 The Project will use existing roads to access Project sites to the extent practicable. Where
42 needed, existing roads will be improved to reduce sediment generation and minimize impacts to
43 soils. Results of further engineering evaluations will be used to provide micrositing and design of
44 Project structures that protect the public and minimize construction on unstable soil surfaces.
45 Additional soil data will be collected during the site-specific geotechnical evaluation to further

1 evaluate soil conditions and to assist in preparing detailed foundation designs and erosion and
2 sediment control measures.

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

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

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

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

27 ***Mitigation for Soil Erosion by Water***

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

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

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

- 43 • Avoid Highly Erodible Areas: Initial mitigation measures should include avoiding highly
44 erodible areas, such as steep slopes, where possible, and rerouting impacted drainages
45 to natural drainages to minimize erosion and sedimentation from runoff. Areas impacted

1 by construction should be reseeded and sediment fences, check dams, and other BMPs
2 will remain in place until impacted areas are well vegetated and the risk of erosion has
3 subsided.

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

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

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

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

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

15 **Mitigation for Soil Erosion by Wind**

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

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

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

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

41 **3.10.2.3 Mitigation of Expansive Soils**

42 Expansive soils swell when exposed to moisture and shrink when dried. This change in volume
43 can be detrimental to structure foundations. The selection of appropriate mitigation techniques
44 will depend on the specific properties of site soils and foundation requirements of proposed

1 structures. In general, mitigation techniques for expansive soils include removal, bypass,
2 isolation, and treatment. If only a thin layer of expansive soil is present at a site, it may be
3 feasible to strip and remove it. For thicker layers of expansive soil, it is common practice to
4 extend foundations deep enough to effectively bypass the zone where moisture content is likely
5 to change. Another mitigation alternative is to isolate the soil from changes in moisture content,
6 through the use of enhanced drainage and/or coverings. Where only shallow foundations are
7 practical, another mitigation alternative is to treat the expansive soils with lime or some other
8 material that reduces their expansive properties. IPC proposes that the Council include the
9 following condition in the site certificate providing that the Site-Specific Geological and
10 Geotechnical Report addresses the potential of expansive soil impacts and any necessary
11 mitigation measures regarding the same:

12 **Structural Standard Condition 1:** *Prior to construction, the site certificate*
13 *holder shall conduct a site-specific geological and geotechnical investigation, and*
14 *shall submit to the department for its approval a Site-Specific Geological and*
15 *Geotechnical Report. The investigation and/or report shall address the following:*

16 . . .
17 *f. Evaluation of potential soil expansion hazards;*

18 . . .
19 *j. Define and delineate geological and geotechnical hazards to the facility, and*
20 *means to mitigate the identified hazards.*

21 3.10.2.4 Mitigation of Groundwater

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

36 **Structural Standard Condition 1:** *Prior to construction, the site certificate*
37 *holder shall conduct a site-specific geological and geotechnical investigation, and*
38 *shall submit to the department for its approval a Site-Specific Geological and*
39 *Geotechnical Report. The investigation and/or report shall address the following:*

40 . . .
41 *g. Description of groundwater detections and any related potential risk to the*
42 *facility;*

43 . . .
44 *j. Define and delineate geological and geotechnical hazards to the facility, and*
45 *means to mitigate the identified hazards.*

1 3.10.2.5 Mitigation of Corrosive Subsurface Conditions

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

13 **Structural Standard Condition 1:** *Prior to construction, the site certificate*
14 *holder shall conduct a site-specific geological and geotechnical investigation, and*
15 *shall submit to the department for its approval a Site-Specific Geological and*
16 *Geotechnical Report. The investigation and/or report shall address the following:*

17 . . .

18 *h. Description of corrosive soils detections and any related potential risk to the*
19 *facility; . . .*

20 . . .

21 *j. Define and delineate geological and geotechnical hazards to the facility, and*
22 *means to mitigate the identified hazards.*

23 3.10.2.6 Flood Mitigation

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

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

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

1 **Structural Standard Condition 1:** Prior to construction, the site certificate
2 holder shall conduct a site-specific geological and geotechnical investigation, and
3 shall submit to the department for its approval a Site-Specific Geological and
4 Geotechnical Report. The investigation and/or report shall address the following:

- 5
- 6 i. Description of Project features within the 100-year flood zone and any related
 - 7 potential risk to the facility; and
 - 8 j. Define and delineate geological and geotechnical hazards to the facility, and
 - 9 means to mitigate the identified hazards.

10 **4.0 IDAHO POWER'S PROPOSED SITE CERTIFICATE CONDITIONS**

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

13 **Prior to Construction**

14 **Structural Standard Condition 1:** Prior to construction, the site certificate
15 holder shall conduct a site-specific geological and geotechnical investigation, and
16 shall submit to the department for its approval a Site-Specific Geological and
17 Geotechnical Report. The investigation and/or report shall address the following:

- 18 a. Subsurface soil and geologic conditions within the site boundary;
- 19 b. Geotechnical design criteria and data for the facility's project features;
- 20 c. Description of potentially active faults that may affect the facility and their
- 21 potential risk to the facility;
- 22 d. LiDAR or field survey investigation of the site boundary to assess the potential
- 23 for slope instability and landslide hazards;
- 24 e. Evaluation of potential liquefaction hazards;
- 25 f. Evaluation of potential soil expansion hazards;
- 26 g. Description of groundwater detections and any related potential risk to the
- 27 facility;
- 28 h. Description of corrosive soils detections and any related potential risk to the
- 29 facility;
- 30 i. Description of Project features within the 100-year flood zone and any related
- 31 potential risk to the facility; and
- 32 j. Define and delineate geological and geotechnical hazards to the facility, and
- 33 means to mitigate the identified hazards.

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

40 **Fish and Wildlife Condition 5:** Prior to construction, the site certificate holder
41 shall finalize, and submit to the department for its approval, a final Vegetation
42 Management Plan. The protective measures described in the draft Vegetation
43 Management Plan in ASC Exhibit P1, Attachment P1-4, shall be included as part
44 of the final Vegetation Management Plan, unless otherwise approved by the
45 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

1 7.0 RESPONSE TO PUBLIC COMMENTS

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

4 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.

5 8.0 REFERENCES

- 6 ASCE (American Society of Civil Engineers). 1997. Design of Latticed Steel Transmission
7 Structures (ASCE Standard 10-97). Reston, VA, 71pp.
- 8 ASCE. 2013. Minimum Design Loads and Associated Criteria for Buildings and Other Structures
9 (ASCE Standard 7). Reston, VA, 593pp.
- 10 Burns, Bill. 2011. DOGAMI staff member discussions during meeting of April 4, 2011.
- 11 DOGAMI (Oregon Department of Geology and Mineral Industries). 2010. Oregon's Earthquake
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14 inundation zones. Available online at:
15 [http://spatialdata.oregonexplorer.info/geoportal/catalog/search/resource/details.page?uii](http://spatialdata.oregonexplorer.info/geoportal/catalog/search/resource/details.page?uuid=%7BF2CC36DE-1F0A-42D2-9B8D-FDD71721A7D3%7D)
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- 15 OSBGE (Oregon State Board of Geologist Examiners). 2014. Guideline for Preparing
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- 20 Shaw (Shaw Environmental & Infrastructure, Inc.). 2012. Desktop Geotechnical Report,
21 Proposed 500kV Transmission Line, Boardman, Oregon to Hemingway, Idaho. January.
- 22 UNR (University of Nevada, Reno, Nevada Seismological Laboratory). 1996. What is Richter
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