3.2 Earth Resources

This Programmatic Environmental Impact Statement (EIS) considers the adverse environmental impacts on earth resources that would result from the types of facilities described in Chapter 2, Overview of Transmission Facilities, Development Considerations, and Regulations. This section addresses the following topics related to the new construction, operation and maintenance, upgrade, and modification of high-voltage electric transmission facilities (transmission facilities) in Washington.

- Section 3.2.1 identifies regulatory, siting, and design considerations.
- Section 3.2.2 describes the affected environment.
- Section 3.2.3 describes the adverse environmental impacts.
- Section 3.2.4 describes Mitigation Measures.
- Section 3.2.5 identifies probable significant adverse environmental impacts on earth resources.
- Section 3.2.6 provides an environmental sensitivity map and criteria weighting for the siting of transmission facilities as it relates to earth resources, based on the identified considerations, adverse environmental impacts, and Mitigation Strategies.

3.2.1 Regulatory, Siting, and Design Considerations

This Programmatic EIS establishes a broad framework for compliance, outlining general laws, regulations, best management practices (BMPs), and design considerations. It is assumed that project-specific applications would be developed within this pre-established regulatory context and comply with existing laws and regulations. Any projects not complying with applicable laws and regulations or failing to adhere to design considerations or BMPs would require additional project-specific environmental analysis and mitigation. The federal, state, and local laws and regulations that apply to earth resources are summarized in **Table 3.2-1**.

Table 3.2-1: Laws and Regulations for Earth Resources

Applicable Legislation	Agency	Summary Information
43 USC Chapter 35 – FLPMA	Bureau of Land Management	FLPMA is a comprehensive statute that governs the management of public lands administered by the BLM under the DOI. FLPMA established that public lands should generally remain in federal ownership unless disposal serves the national interest. The act mandates that public lands be managed for multiple uses (e.g., recreation, grazing, timber, and minerals) and sustained yield, ensuring that resources are available for future generations.
16 USC § 1451 et seq. – Coastal Zone Management Act	Washington State Department of Ecology[(a)]	The federal consistency provisions of the CZMA require that federal actions, including federal activities and the issuance of federal licenses and permits, be consistent with the enforceable policies of the Washington Coastal Zone Management Program. This applies to federal actions in Washington’s 15 coastal counties that could have reasonably foreseeable impacts on state coastal resources and uses. The CZMA was enacted to protect the coastal environment from growing demands associated with residential, recreational, commercial, and industrial uses. It encourages coastal states to develop and implement coastal zone management programs to manage and balance competing uses of the coastal zone. Washington’s program is discussed in the Washington Coastal Zone Management Program section of this table.
16 USC §§ 1600–1614 – NFMA	U.S. Forest Service	NFMA provides the framework for managing national forests and grasslands, emphasizing sustainable management and conservation of forest resources.
RCW 36.70A, Growth Management – Planning by Selected Counties and Cities	Local governments with assistance from the Washington State Department of Commerce[(a)]	RCW 36.70A requires all cities, towns, and counties in the state to identify critical areas and establish regulations to protect and limit development in those areas. Among the critical areas defined by the GMA are frequently flooded areas and geologically hazardous areas. As defined by WAC 365-190-120, geologically hazardous areas are areas susceptible to erosion, landslide, seismic activity, or other geological events such as mine hazards, volcanic hazards, mass wasting,[1] debris flows,[2] rock falls, and differential settlement.[3] The GMA requires that local governments

[1] The movement of soil, rock, and debris down a slope due to the force of gravity.

[2] Fast-moving landslides composed of a mixture of water, soil, rock, and organic material that travel down slopes under the influence of gravity.

[3] The uneven settling of a structure's foundation, where different parts of the foundation settle at different rates.

Applicable Legislation	Agency	Summary Information
		establish critical area protection programs that address the following: ▪ Protecting members of the public, public resources, and facilities from injury, loss of life, or property damage due to landslides and slope failures, erosion, seismic events, volcanic eruptions, or flooding ▪ Maintaining healthy, functioning ecosystems through the protection of unique, fragile, and valuable elements of the environment ▪ Directing activities not dependent on critical area resources to less ecologically sensitive sites, and mitigating unavoidable adverse environmental impacts on critical areas by regulating alterations in and adjacent to those areas Preventing cumulative adverse environmental impacts on frequently flooded areas.
RCW 80.50, Energy Facilities – Site Locations	Energy Facility Site Evaluation Council	This chapter establishes EFSEC's role in siting, new construction, and operation of major energy facilities in Washington. It provides the legal framework for EFSEC to streamline the permitting process and ensure compliance with state environmental and safety standards.
WAC 365-190, Minimum Guidelines to Classify Agriculture, Forest, Mineral Land and Critical Areas	Washington State Department of Commerce[(a)]	This chapter provides the framework for counties and cities in Washington to classify and designate various types of lands, including critical areas such as wetlands, aquifer recharge areas, frequently flooded areas, and geologically hazardous areas. Specifically, Chapter 365-190-120 provides guidelines for classifying and designating areas that are susceptible to geological hazards such as erosion, landslides, earthquakes, and other geological events.
Washington State Building Code	Washington State Building Code Council[(a)]	This code incorporates standards for construction in geologically hazardous areas to ensure safety and resilience for buildings intended for human occupancy.
Washington State Environmental Policy Act	▪ Washington State Agencies ▪ Local governments	This act is a process that identifies and analyzes adverse environmental impacts that can be related to issuing permits. SEPA helps permit applicants and decision-makers understand how a proposed project would impact the environment.

Table 3.2-1 Notes:

[a] The agency responsible for administering most permits or authorizations for the identified regulation. However, if EFSEC is determined to be the agency responsible for approving a proposal, EFSEC can administer several types of permits at the state and local levels. EFSEC provides a streamlined process for siting and licensing major energy facilities, including transmission facilities in Washington. EFSEC coordinates all evaluation and licensing steps, specifies the conditions for new construction and operation, and issues a Site Certification Agreement, which assumes the responsibility for issuing individual state or local permits. By consolidating these permits into a single Site Certification Agreement, EFSEC can simplify the regulatory process for energy facility developers. While EFSEC itself does not directly administer federal permits, it works closely with federal agencies to ensure that all necessary federal requirements are met during the evaluation and licensing of energy facilities.

BLM = Bureau of Land Management; **CZMA** = Coastal Zone Management Act; **DOI** = Department of the Interior; **EFSEC** = State of Washington Energy Site Evaluation Council; **FLPMA** = Federal Land Policy and Management Act; **GMA** = Growth Management Act; **NFMA**= National Forest Management Act; **RCW** = Revised Code of Washington; **SEPA** = Washington State Environmental Policy Act; **USC** = United States Code; **WAC** = Washington Administrative Code

The siting of transmission facilities is determined by engineering, technical, environmental, and socioeconomic factors. **Table 3.2-2** summarizes guidance documents and management plans that outline the design considerations and BMPs generally used to avoid or minimize adverse environmental impacts on earth resources.

Table 3.2-2: Siting and Design Considerations for Earth Resources

Siting and Design Consideration	Description
Recommended Siting Practices for Electric Transmission Developers (Americans for a Clean Energy Grid 2023)	This document outlines best practices for siting electric transmission facilities. Recommended practices include: ▪ Early and transparent engagement ▪ Respect and fair dealing ▪ Environmental considerations ▪ Interagency coordination ▪ Use of existing infrastructure
Best Management Practices for Regional Road Maintenance (WSDOT n.d.)	This document provides comprehensive guidelines for managing erosion and sedimentation[4] during road maintenance activities.
Guide for Transmission Line Foundations with Least Impact to the Environment (CEATI International n.d.)	This guide provides guidelines for selecting and designing transmission line foundations with minimal environmental impact.

[4] The process by which particles of soil, sand, and other materials are dislodged and transported by natural forces such as water, wind, or human activities like construction and deforestation.

Siting and Design Consideration	Description
IEEE Standards	Some IEEE standards address geotechnical aspects. For example, IEEE 81-2012 provides guidelines for measuring earth resistivity, ground impedance, and earth surface potentials of a grounding system. Additionally, IEEE standards related to geotechnical instrumentation include requirements for measuring thermal and thermomechanical responses, stress, strain, displacements, and pore pressure.
ASCE Standards	ASCE standards help ensure the safe and reliable design of transmission facilities by addressing various geotechnical factors such as soil stability, foundation design, and structural integrity.

ASCE = American Society of Civil Engineers; **CEATI** = Centre for Energy Advancement Through Technological Innovation; **IEEE** = Institute of Electrical and Electronics Engineers; **WSDOT** = Washington State Department

3.2.2 Affected Environment

This section describes earth resources within the Study Area (see Chapter 1, Introduction). The analysis of the affected environment incorporates the following:

- Geology
- Soils
- Topography
- Unique Physical Features
- Erosion/Accretion
- Geologic Hazards

3.2.2.1 Geology

Washington is divided into several geologic provinces, as shown in **Figure 3.2-1**; each with unique characteristics, described below (DNR 2024a):

- Columbia Basin
    - **Composition:** Dominated by basalt flows from the Miocene epoch,[5] forming one of the largest plateaus in the world. The result of fissure eruptions created the Columbia River Basalt Group.

[5] A specific period in time, often marked by notable events or developments.

    - **Features:** Formed by the accretion[6] of oceanic sediments and volcanic rocks, uplifted by tectonic forces.
- Puget Lowland
    - **Composition:** A mix of glacial deposits, including till, outwash, and lacustrine sediments.[7] Shaped by repeated glaciations[8] during the Pleistocene epoch.
    - **Features:** Shaped by repeated glaciations, the lowland is a flat to gently rolling area with numerous lakes and wetlands.
- Olympic Mountains
    - **Composition:** Primarily composed of sedimentary rocks, including sandstone and shale. Created by the accretion of marine sediments and volcanic rocks.
    - **Features:** Rugged terrain with high peaks and deep valleys.
- Blue Mountains
    - **Composition:** A mix of volcanic and sedimentary rocks. Formed by volcanic activity and subsequent erosion.
    - **Features:** Rolling hills and dissected plateaus.[9]
- Willapa Hills
    - **Composition:** Predominantly underlain by Crescent Formation basalts; includes sedimentary rocks and basalt flows from the Columbia River Basalt Group.
    - **Features:** Characterized by hills that are rounded due to extensive weathering.

[6] The process of growth or increase, typically by the gradual accumulation of additional layers of matter.
[7] Deposits that form at the bottom of lakes. These sediments are typically composed of fine particles like silt, clay, and sometimes organic matter, which settle out of the water due to the low-energy environment of a lake.
[8] Periods in Earth's history when large ice sheets covered portions of the continents.
[9] A type of landform that has been eroded by rivers and streams, resulting in a landscape with sharp relief and deep valleys.

- Okanogan
  - **Composition:** Composed of Precambrian, Paleozoic, and Mesozoic rocks, as well as formations from the Eocene Epoch.
  - **Features:** Metamorphic core complexes, Precambrian rocks, thrust faults[10] and terrane boundaries,[11] plutonic intrusions,[12] glacial features, and Eocene extensional[13] features highlight the complex and dynamic geological history.
- South Cascades
  - **Composition:** Characterized by volcanic activity and complex geological history shaped by the subduction[14] of the oceanic plate beneath the North American plate.
  - **Features:** Part of the Cascades Volcanic Arc,[15] formed by subduction. This process has created a series of volcanic peaks over millions of years. Geological history also involves accretion of oceanic sediments and volcanic islands.
- North Cascades
  - **Composition:** Similar to the South Cascades, a complex mix of metamorphic and igneous rocks, including schist, gneiss, and granite. Result of complex tectonic processes, including subduction and terrane accretion.
  - **Features:** Known for steep, glaciated peaks and alpine scenery.

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[10] A type of reverse fault where the fault plane has a low dip angle (which it is the angle at which the fault dips), typically less than 45 degrees. In a thrust fault, the hanging wall (the block of rock above the fault plane) moves up and over the footwall (the block below the fault plane) due to compressional forces.

[11] Typically marked by faults or complex fault zones, these boundaries form where a terrane, which is a fragment of crust with a distinct geological history, has been accreted or attached to a larger continental mass.

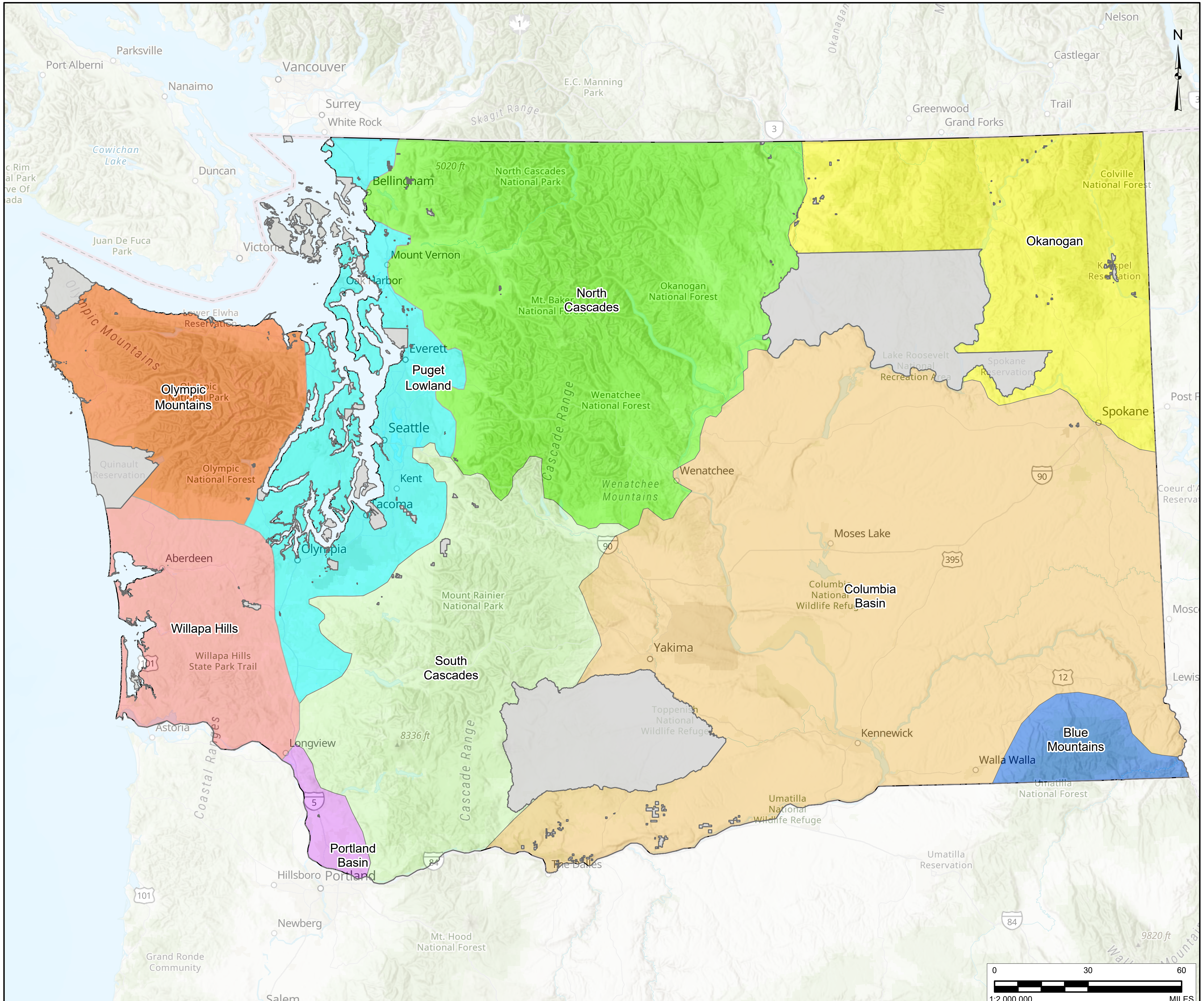
[12] Bodies of igneous rock that form when magma cools and solidifies beneath the Earth's surface.

[13] Processes and structures associated with the stretching and thinning of the Earth's crust or lithosphere. This typically occurs in regions where tectonic forces pull the crust apart, leading to the formation of features such as normal faults, rift valleys, and mid-ocean ridges.

[14] A geological process where one tectonic plate moves under another and sinks into the Earth's mantle.

[15] A major volcanic region in western North America, extending from southwestern British Columbia through Washington and Oregon to Northern California.

- Portland Basin
  - **Composition:** Contains up to 1,800 feet of late Miocene and younger sediments, as well as volcanic deposits, including the Columbia River Basalt Group and the Boring Volcanic Field.
  - **Features:** Part of the Puget-Willamette forearc trough of the Cascadia subduction system. It is characterized by a faulted, asymmetric syncline structure. The Columbia River has played an important role in shaping the basin, carving channels, and depositing sediments.



LEGEND

- Study Area
- Exclusion Areas

Geologic Provinces of Washington (DNR, 2024)

- Blue Mountains
- Columbia Basin
- North Cascades
- Okanogan
- Olympic Mountains
- Portland Basin
- Puget Lowland
- South Cascades
- Willapa Hills

REFERENCES AND NOTES

1. SERVICE LAYER CREDITS: SOURCES: ESRI, TOMTOM, GARMIN, FAO, NOAA, USGS, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY, ESRI, USGS
2. DNR (WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES). 2024A. GEOLOGIC PROVINCES OF WASHINGTON. ACCESSED NOVEMBER 20, 2024. HTTPS://WWW.DNR.WA.GOV/PROGRAMS-AND-SERVICES/GEOLOGY/EXPLORE-POPULAR-GEOLOGY/GEOLOGIC-PROVINCES-WASHINGTON

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FIGURE
3.2-1

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The Puget Lowland was heavily influenced by glaciation during the last Ice Age. Glaciers advanced and retreated multiple times over the past 2 million years, depositing thick layers of glacial till and outwash. These sediments created the region's characteristic rolling hills, valleys, and numerous lakes, such as Lakes Union, Washington, and Sammamish. Glacial activity also formed the many islands in the Strait of Juan de Fuca and Puget Sound.

The Olympic Mountains, located on the Olympic Peninsula, are primarily composed of marine sedimentary rocks and basalt that were accreted onto the continent over millions of years. These mountains support dense coniferous forests and temperate rainforests, such as the Hoh Rainforest, which are among the few temperate rainforests in the continental United States.

The geological history of the Pacific Northwest reflects the evolution of plate tectonic forces. Between about 17 and 12 million years ago, large volumes of lava erupted from deep crustal fissures[16] above a "mantle hotspot."[17] These basalt flows make up the Columbia River Basalt Group, the most common type of exposed rock in the region. The convergence of the North American, Juan de Fuca, and Pacific plates has had a profound impact on the geology of the Pacific Northwest, as described below (Swanson et al. 1989):

- North American
    - **Description:** The North American plate is one of the largest tectonic plates, covering most of North America, parts of the Atlantic Ocean, Greenland, and parts of Siberia.
    - **Movement:** This plate moves roughly westward at a rate of about 0.9 inches per year. In Washington, the western boundary is defined by the Cascadia Subduction Zone (CSZ), where it interacts with the Juan de Fuca plate.
- Juan de Fuca
    - **Description:** The Juan de Fuca plate is a small oceanic plate off the coast of the Pacific Northwest. It is a remnant of the larger Farallon plate.

[16] Fractures or cracks in the Earth's crust that can vary in size from a few meters to several kilometers. These fissures can form due to various geological processes, including tectonic activity, volcanic activity, and the cooling and contraction of lava.
[17] A location in the Earth's mantle where hot, buoyant material rises towards the surface, creating volcanic activity.

  - **Movement:** This plate is subducting beneath the North American plate at the CSZ. The subduction process leads to geological activity, including the formation of the Cascade Range and frequent seismic events. The rate of the Juan de Fuca plate's eastward movement is about 2 inches per year.
- Pacific
  - **Description:** The Pacific plate is the largest tectonic plate, covering much of the Pacific Ocean basin.
  - **Movement:** This plate moves northwestward at a rate of 2.0 to 3.9 inches per year. It interacts with the North American plate along the San Andreas Fault to the south and the Aleutian Trench to the north. Its interaction with the Juan de Fuca plate occurs at the Juan de Fuca Ridge.

The geological processes in western Washington are shaped by the region's dynamic tectonic activity and glacial history. Western Washington is affected by the ongoing tectonic activity associated with the CSZ. The CSZ is where the Juan de Fuca and North American plates interact. The Juan de Fuca plate, entirely oceanic, is slowly sinking and moving eastward beneath the western edge of the North American plate, a process known as subduction. The Pacific plate lies beneath the Pacific Ocean and adjoins the Juan de Fuca plate. The separation of the Pacific and Juan de Fuca plates causes the Juan de Fuca plate to move eastward beneath the North American plate. As the Juan de Fuca plate moves away from the Pacific plate, molten rock fills the gap between the plates, forming "spreading centers" with many hot springs and undersea eruptions. This slow movement drives most of the active geological processes in the Pacific Northwest, including the generation of earthquakes, formation and eruption of volcanoes, and uplift and folding of the earth's surface.

The relative motions of tectonic plates alter the structure of rocks in the overlying North American plate. Continuous plate movements along the plate's western edge have fragmented it into smaller crustal blocks, such as the Oregon Coastal Range, Canadian Coastal Mountains, and Sierra Nevada blocks. The northward movement of the Oregon Coastal Range block has pushed western Washington against the stationary Canadian Coast Mountains. This interaction has caused most of Oregon and southwest Washington to rotate clockwise relative to North America at a rate of 0.4 to 1.0 degrees per million years (Wells and Heller 1988; Wells and Simpson 2001; Brocher et al. 2017). These rotations and block movements result in north–south-directed compression and the folding of the Earth's crust in Washington.

The north–south-directed compression and folding in the shallow crust of eastern Washington have created the Yakima fold and thrust belt (YFTB). This region features a series of alternating ridges and valleys, known as anticlines (ridges) and synclines (valleys). An anticline is the elevated part of a geological unit folded by geological forces, while a syncline is a geological trough, representing the lower part of a folded unit. The young ridge-and-valley topography of the YFTB includes narrow anticlinal ridges up to 2,000 feet high, separated by broad synclinal valleys that are 1 to 10 miles wide, covering approximately 5,500 square miles in eastern Washington (Reidel et al. 2003).

Geological Processes – "Ice Ages"

Another major geological impact on the state was the advance and retreat of continent-wide glaciers over the last million years. During the most recent glaciation, from about 15,000 to 10,000 years ago, glaciers formed an ice dam on the Clark Fork River in northern Idaho, creating Lake Missoula. The lake rose until the ice in the dam floated and broke up, releasing the water, causing massive recurring flood events across eastern Washington and the Columbia River. These floods carved deep channels into the basalt bedrock, forming the "channeled scabland" landscape.

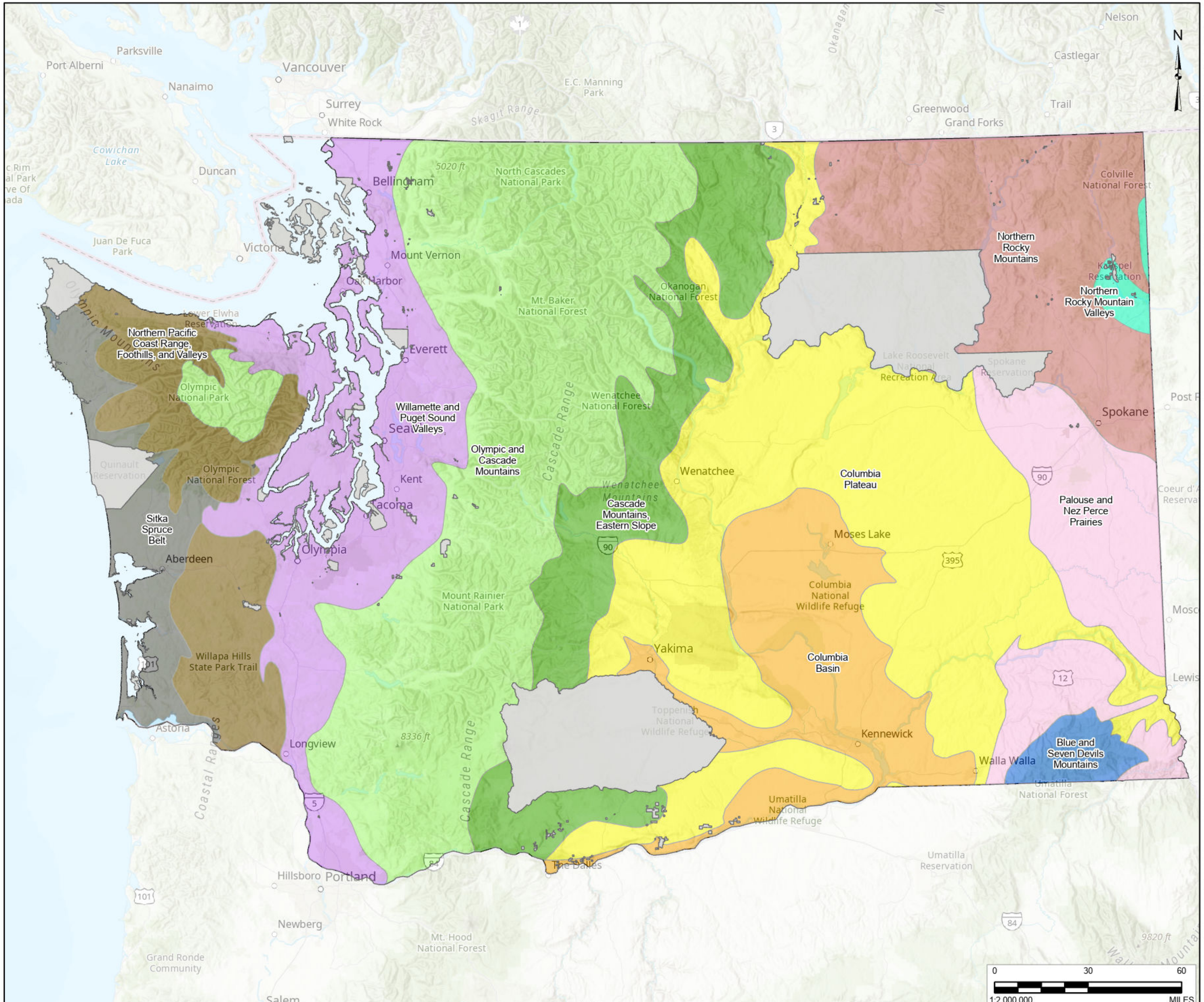
Evidence of these floods is visible at Wallula Gap and Grand Coulee, which form a two-stage canyon 50 miles long and up to 900 feet deep. Each flood discharged an estimated 350,000,000 cubic feet per second, stripping topsoil and glacial deposits in eastern Washington and northern Oregon. Older glacial sediments were deposited in western Washington and the Pacific Ocean, later blown back into the Columbia Basin by southwesterly winds as eolian loess (Sweeny et al. 2017).

Geologists agree that the Puget Sound area experienced six or more major glacial events. Ice from the Coast Range and Rocky Mountains of British Columbia advanced southward into the Puget Lowland, depositing new sediments and partially eroding previous ones. During ice-free periods, streams, waves, weathering, bioturbation,[18] and landslides reworked these sediments. The most recent glaciation, the Fraser Glaciation (18,000 to 13,000 years ago), covered the central Puget Lowland with ice about 3,000 feet thick, compacting the soils beneath (Thorson 1989; Porter and Swanson 1998). As the ice retreated, meltwater streams deposited sand, gravel, cobbles, and boulders, while post-glacial lacustrine and organic deposits formed in depressions and low-flowing water areas. These glacial recessional soils are not glacially consolidated.

[18] Reworking of soils and sediments by living organisms, such as animals and plants.

3.2.2.2 Soils

Major Land Resource Areas (MLRAs) are used for understanding and managing soils in Washington. MLRAs help in statewide agricultural planning, provide a framework for managing natural resources, guide research and education efforts, assess and mitigate environmental impacts, and inform policymakers and land managers about land use and conservation. Washington's MLRAs are shown in **Figure 3.2-2**.



LEGEND

- Study Area
- Exclusion Areas

Major Land Resource Areas (USDA, 2022)

- Blue and Seven Devils Mountains
- Cascade Mountains, Eastern Slope
- Columbia Basin
- Columbia Plateau
- Northern Pacific Coast Range, Foothills, and Valleys
- Northern Rocky Mountain Valleys
- Northern Rocky Mountains
- Olympic and Cascade Mountains
- Palouse and Nez Perce Prairies
- Sitka Spruce Belt
- Willamette and Puget Sound Valleys

REFERENCES AND NOTES

1. SERVICE LAYER CREDITS: ESRI, CGIAR, USGS, SOURCES: ESRI, TOMTOM, GARMIN, FAO, NOAA, USGS, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
2. USDA . 2022. MAJOR LAND RESOURCE AREAS. ACCESSED OCTOBER 3, 2024. HTTPS://WWW.NRCS.USDA.GOV/RESOURCES/DATA-AND-REPORTS/MAJOR-LAND-RESOURCE-AREA-MLRA

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MAJOR LAND RESOURCE AREAS OF WASHINGTON

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Washington’s soils are diverse and influenced by various factors, including parent material,[19] climate, topography, biological activity, and time, as described below (Hipple n.d.):

- **Parent Material:** Soils in Washington are derived from a variety of parent materials, including volcanic ash, glacial till, alluvium, and loess. These materials contribute to the soils’ physical and chemical properties.
- **Climate:** The state’s climate varies from west to east, affecting soil moisture and temperature regimes. Western Washington’s soils are influenced by high precipitation and mild temperatures, while eastern Washington’s soils experience lower precipitation and more extreme temperatures.
- **Topography:** The diverse topography, from coastal plains to mountainous regions, influences soil drainage, erosion, and deposition patterns.
- **Biological Activity:** Vegetation, microorganisms, and fauna contribute to soil formation through organic matter decomposition and nutrient cycling.
- **Time:** Soil development varies with age, with older soils typically exhibiting more developed horizons[20] and greater nutrient leaching.

Washington has soils from 10 of the 12 different soil orders[21] recognized by the U.S. Department of Agriculture's (USDA) soil classification system. This diversity is due to the state’s varied climate, vegetation, and geological history. The 10 soil orders found in Washington are described below:

- **Andisols:** Found primarily in areas with volcanic activity, such as the Cascade Range, these soils are rich in volcanic ash and have high water-holding capacity. They are highly valued for their fertility and water-holding capacity.
- **Mollisols:** Predominantly found in the Palouse region, these soils are fertile and rich in organic matter, making them ideal for agriculture. They are highly prized for agricultural use.

[19] The unconsolidated material, mineral or organic from which the soil develops (AGI Dictionary of Geologic Terms 1984).
[20] A distinct layer of soil or sediment that has unique characteristics compared to the layers above and below it.
[21] In soil science, a soil order is the highest level of classification in the U.S. Department of Agriculture Soil Taxonomy system. There are 12 soil orders, each defined by specific characteristics and processes that influence soil formation.

- **Alfisols:** Common in forested areas, particularly in the foothills of the Cascades and the Olympic Mountains, these soils have a clay-enriched subsoil and are moderately fertile.
- **Entisols:** These soils are young, with little horizon development, and are found in areas with recent geological activity like river valleys and coastal regions.
- **Inceptisols:** These soils are widespread across the state and are characterized by minimal horizon development.
- **Ultisols:** Found in the wetter, forested regions of the state, these soils tend to be weathered and acidic but can still support forestry and some types of agriculture.
- **Histosols:** Present in wetland areas, these organic-rich soils are formed from decomposed plant material. They are often protected due to their ecological significance and role in water filtration.
- **Aridisols:** These soils are found in the drier, eastern parts of the state.
- **Spodosols:** Typically found in cooler, forested areas with high rainfall, these soils are often protected to maintain the diversity of ecosystems.
- **Vertisols:** These soils are characterized by high clay content and the expansion and contraction with moisture changes.

Soil orders are important for several reasons, particularly in the fields of agriculture, environmental science, and land management. Soil orders provide a systematic way to classify and organize soils based on their properties and formation processes. This helps scientists and land managers understand and communicate about different soil types more effectively. Knowing the soil order of a given area can inform best practices for soil management, including irrigation, fertilization, and crop selection. Different soil orders have distinct characteristics that affect their suitability for various uses. Some orders are more prone to erosion or nutrient leaching, which can also influence management decisions. Recognizing soil orders can aid in conservation efforts by identifying areas that need protection and restoration. In Washington, several soil types are protected due to their unique characteristics and ecological importance. These soils are described below:

- **Prime Farmland Soils:** These highly productive soils are essential for agriculture. Prime farmland is typically associated with several soil orders that have the best combination of physical and chemical characteristics for agricultural productivity. This soil type can include Mollisols, Alfisols, and Inceptisols (USDA NRCS n.d.).

- **Wetland Soils:** These soils support wetland ecosystems and are protected under various environmental regulations. Wetland soils can be found across all 12 soil orders in the USDA Soil Taxonomy system; however, certain soil orders are more commonly associated with wetlands due to their specific characteristics. These orders include Histosols, Inceptisols, Entisols, Mollisols, and Spodosols (National Academies Press 2024).
- **Forest Soils:** Found in forested areas, these soils are crucial for maintaining forest health and biodiversity. Forest soils can be found in several soil orders, each with unique characteristics that support forest ecosystems. Soil orders include Alfisols, Andisols, Entisols, Inceptisols, Mollisols, Spodosols, and Ultisols (USDA NRCS n.d.).
- **Erosion-prone Soils:** Soils susceptible to erosion are protected to prevent land degradation and maintain water quality. Some of the most erosion-prone soil orders include Entisols, Inceptisols, Alfisols, Ultisols, and Aridisols (USDA NRCS n.d.).

Due to their ecological importance and unique characteristics, Histosols, Andisols, Alfisols, and Mollisols are protected through various conservation practices and regulations, including the following:

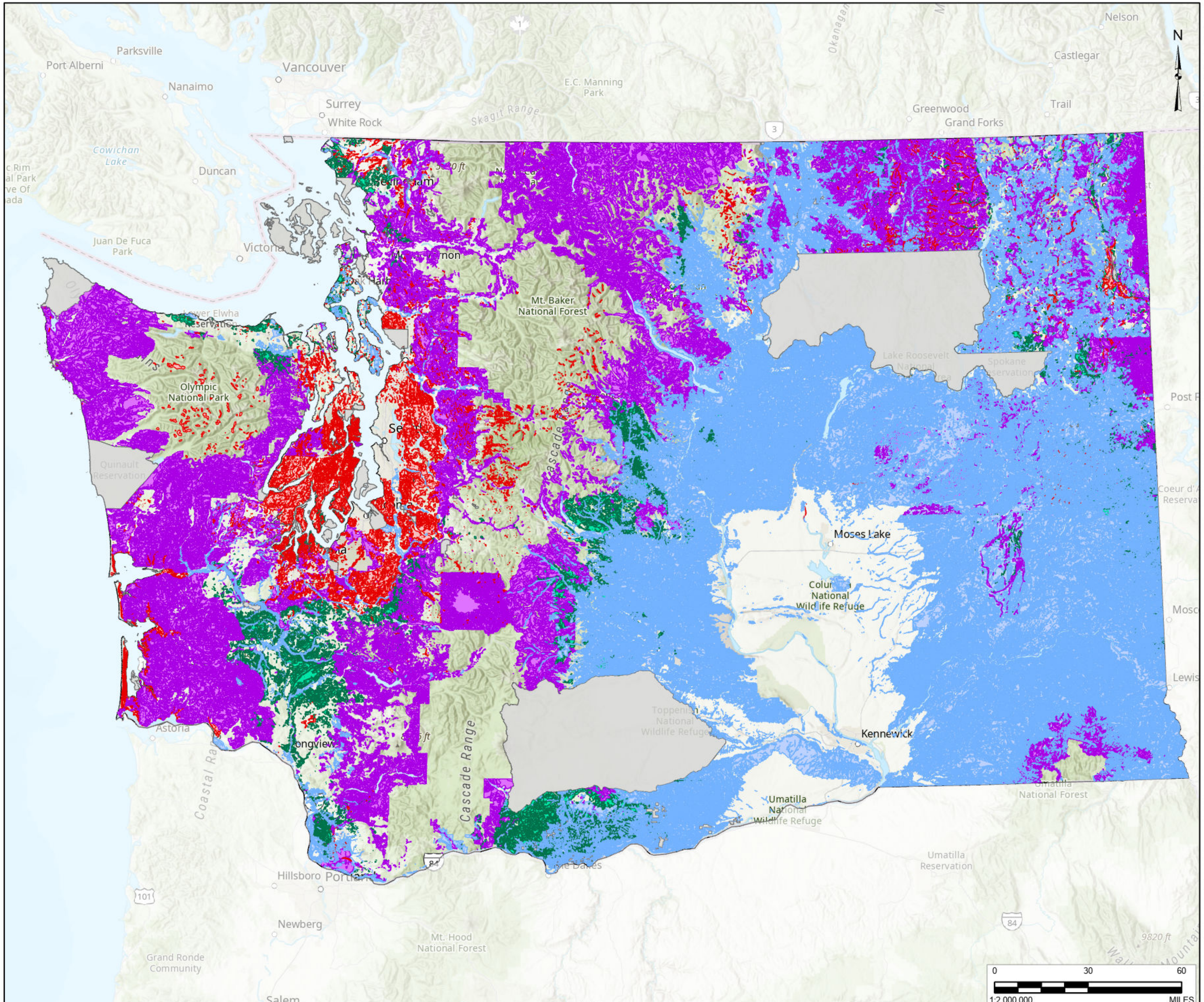
- **Conservation Programs:** Programs like the Natural Resources Conservation Service (NRCS) promote soil health through practices such as no-till farming,[22] cover crops,[23] and conservation buffers.
- **Soil Surveys:** The NRCS conducts soil surveys to map and assess soil resources, providing data for sustainable management. At a higher level, the U.S. Geological Survey (USGS) provides a soil survey map available online.
- **Regulatory Frameworks:** Wetland soils (Histosols) and other critical soils are protected under environmental regulations to preserve their ecological functions.

[22] Also known as zero tillage or direct drilling, no-till farming is an agricultural technique where crops are grown without disturbing the soil through tillage. Instead of plowing, farmers used specialized equipment to plant seeds directly into the soil, leaving crop residues on the surface.

[23] Plants grown primarily to cover and protect the soil rather than for harvest.

- **Erosion Control:** Measures are implemented to prevent soil erosion, protecting soils like Alfisols and Mollisols.

Washington's soils of ecological importance can be found in **Figure 3.2-3**.



LEGEND

- Study Area
- Exclusion Areas

Sensitive Soil Survey (USDA, 2019)

Taxonomic Order of Sensitive Soils

- Alfisols
- Andisols
- Histosols
- Mollisols

REFERENCES AND NOTES

1. SERVICE LAYER CREDITS: SOURCES: ESRI, TOMTOM, GARMIN, FAO, NOAA, USGS, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY, ESRI, USGS
2. USDA. 2019. WEB SOIL SURVEY. ACCESSED AUGUST 8TH, 2025. HTTPS://WEBSOILSURVEY.NRCS.USDA.GOV/APP/

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SOILS OF ECOLOGICAL IMPORTANCE

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Soil Properties

Washington's soils exhibit a wide range of physical and chemical properties. Physically, they vary from sandy to clayey textures, influencing water retention, drainage, and root penetration. Soil structures in the state range from granular to blocky or prismatic, affecting aeration and water movement. The depth of soil horizons varies, with some areas having shallow soils over bedrock and others having deeper profiles. Bulk density impacts root growth and water movement, with higher-density soils being more compact.

Chemically, soil pH[24] ranges from acidic in wetter, forested areas to neutral or slightly alkaline in drier regions, affecting nutrient availability and microbial activity. Organic matter content, particularly high in Mollisols and Histosols, influences fertility, structure, and water-holding capacity. Nutrient levels vary widely, with fertile soils like Mollisols having high levels of essential nutrients. Biological properties, such as organic matter content and microbial activity, are higher in regions with dense vegetation and organic inputs.

Soil compaction can become an issue in construction projects, ultimately changing the properties of the soil. Compacted soil has fewer air spaces, which reduces its ability to absorb water. This can lead to increased surface runoff and standing water, potentially causing erosion and waterlogging. Poor drainage can also affect the stability of structures and lead to foundation problems. Without adequate pore spaces, compacted soil is more susceptible to erosion by wind and water. Erosion can undermine the foundations of structures and lead to sedimentation in nearby waterbodies, affecting water quality (see Section 3.4, Water Resources).

Compacted soil is difficult for plant roots to penetrate, which can inhibit vegetation growth (see Section 3.5, Vegetation). This can lead to poor landscaping outcomes and reduced soil stability, as plants play a crucial role in preventing erosion.

3.2.2.3 Topography

Washington's topography is highly diverse, ranging from sea level at the Pacific Ocean to the towering peak of Mount Rainier at 14,411 feet above mean sea level. The state's landscape includes the rugged Cascade Range and Olympic Mountains, which feature steep slopes exceeding 30 degrees, and the more moderate slopes of the Blue Mountains. In contrast, the Columbia Plateau and Puget Lowlands have gentler slopes,

[24] A measurement of the acidity and alkalinity of water; stands for "potential of hydrogen."

generally less than 10 degrees, making these areas more suitable for agriculture and urban development.

This variation in elevation and slope gradients influences land use, climate, and ecological diversity across Washington. The steep, forested mountains support dense vegetation and unique ecosystems, while the fertile, gently sloping plains of the Columbia Plateau are ideal for farming.

3.2.2.4 Unique Physical Features

In geography, unique physical features can include landforms like mountains, valleys, and rivers, as well as other natural elements such as climate, soil, vegetation, and wildlife. These areas are often safeguarded through national and state park designations, natural area preserves, and other conservation efforts to maintain their natural beauty and ecological integrity. Unique physical features contribute to Washington's rich natural heritage and play a crucial role in its ecology, economy, and cultural identity. The following are some examples of unique physical features in the state:

- **Mount Rainier:** Protected within Mount Rainier National Park
- **Hoh Rainforest:** Located in Olympic National Park
- **Palouse Falls:** Located in Palouse Falls State Park
- **Mima Mounds**: Protected within the Mima Mounds Natural Area Preserve
- **Mount St. Helens:** Part of the Mount St. Helens National Volcanic Monument
- **Beacon Rock:** Located in the Columbia River Gorge
- **North Cascades National Park:** Known for its rugged mountain landscapes and glaciers

3.2.2.5 Erosion/Accretion

Erosion and accretion are natural processes that shape landscapes, especially along coastlines. Erosion is the process by which natural forces like wind, water, and ice wear away rocks and soil, transporting them from one location to another. It can lead to the loss of land and changes in landscape features. Accretion is the deposition of materials like sand, silt, and gravel, which build up landforms. Accretion can create new land or add to existing land masses. These processes are essential for maintaining the dynamic balance of coastal and riverine environments.

Coastal erosion is a major concern in Washington, especially along the Pacific Northwest coastline. It can lead to the loss of valuable land, damage to infrastructure, and changes in coastal ecosystems. Factors like wave action, sea-level rise, and human activities (e.g., construction of jetties) can intensify erosion.

Accretion can counteract erosion to some extent, creating new habitats and stabilizing shorelines. This process helps build beaches and landforms by depositing sediments. Coastal structures like jetties and seawalls can disrupt natural sediment transport, leading to increased erosion in some areas and accretion in others.

3.2.2.6 Geologic Hazards

Washington Administrative Code (WAC) 365-190-120 specifically mentions that geologically hazardous areas include areas prone to erosion, sliding, earthquakes, or other geological events. These areas pose a threat to transmission facilities that occur in these areas.

Landslide Hazards

The USGS defines a landslide as the movement of a mass of rock, debris, or earth down a slope under the direct influence of gravity (USGS n.d.[a]). While landslide-caused disasters are rare in Washington, when they do occur, they can impact transportation systems, communities, and natural resources, leading to severe property damage and loss of life. Landslides can occur on nearly any ground if the right conditions of soil, moisture content, and slope angle are present. Triggers for landslides include heavy rain, rapid snowmelt, flooding, earthquakes, vibrations, wildland fires, and other natural or human-induced events.

Vegetation plays a crucial role in maintaining slope stability, and its removal can exacerbate landslide hazards. Plant roots help bind soil particles together, providing mechanical stability to slopes. When vegetation is removed, this root reinforcement is lost, making the soil more prone to erosion and landslides. Vegetation also intercepts rainfall and facilitates evapotranspiration,[25] reducing the amount of water that reaches the soil. Without vegetation, more water infiltrates the soil, increasing pore water pressure and reducing soil strength, which can trigger landslides (see Section 3.5, Vegetation).

[25] Combined process of water movement from the Earth's surface to the atmosphere through evaporation and transpiration.

There are two main types of landslides, as described below:

- **Shallow Rapid Landslides:** These are fast-moving landslides that typically involve the upper layers of soil and rock. They are often triggered by heavy rainfall or rapid snowmelt.
- **Deep-Seated Landslides:** These involve deeper layers of soil and rock and can move more slowly. They are often triggered by prolonged periods of wet weather or seismic activity.

Washington is divided into several landslide provinces, each characterized by specific geological and environmental conditions that influence landslide activity, as described below:

- **Olympic Mountains:** This region experiences frequent landslides due to its rugged topography and high rainfall.
- **Southwest Washington:** This region is characterized by its high susceptibility to landslides due to its geological and climatic conditions.
- **Puget Lowland:** This area is prone to both shallow and deep-seated landslides due to its glacially derived soils and steep slopes. Urban development and heavy rainfall contribute to landslide risk in this area.
- **Cascades Range:** The steep, mountainous terrain of the Cascades is susceptible to landslides, particularly in areas with volcanic activity and heavy precipitation.
- **Columbia Plateau:** Although generally less prone to landslides, this area can experience landslides along river valleys and steep slopes, especially during periods of heavy rain or rapid snowmelt.
- **Okanogan Highlands:** This province is susceptible to various types of landslides due to its steep slopes, geological composition, and climatic conditions. Landslides in this region can be triggered by heavy rainfall, rapid snowmelt, and seismic activity.

Landslides encompass rockfalls, slides, slumps, and debris flows. While gravity is the primary force driving landslides, they can also be triggered by water, wind, or large-scale disturbances such as earthquakes or volcanic activity. Steep and unstable slopes are most at risk for landslides. Other factors influencing the likelihood of a slide include soil type and thickness, geological structure, vegetative cover, soil conditions and saturation, and the amount, rate, and duration of precipitation. Landslide hazard areas are typically defined as regions where a combination of slope inclination, soil type, geological structure, and water presence makes them susceptible to failure and subsequent downhill movement.

Earthquake Hazards

Earthquakes pose numerous hazards to both built and natural environments. Earthquakes in Washington can cause strong ground shaking that can be felt locally, throughout the state, and even across the broader Pacific Northwest. The severity and reach of this shaking are primarily determined by the earthquake's magnitude, which measures the energy released at the source.

Earthquake magnitude is measured by analyzing records from regionally deployed seismometers[26] and accelerometers.[27] The most common magnitude scale now used by seismologists is the moment magnitude, expressed as M_W or **M**. The M_W scale measures the energy released at the earthquake source. The M_W and most other earthquake magnitude scales are logarithmic, meaning that an earthquake of M_W 6 releases about 30 times more energy at its source than an M_W 5 earthquake. Most people do not feel earthquakes smaller than about M_W 3 unless they are within approximately 5 miles of the epicenter and the earthquake is less than about 10 miles deep.

The main hazards associated with earthquakes in the Pacific Northwest and Washington are:

- Strong ground shaking
- Soil liquefaction
- Earthquake-triggered landslides
- Surface fault rupture
- Tsunami and seiche

Earthquake hazards in the Pacific Northwest are primarily related to the ongoing activity of the CSZ as the North American and Juan de Fuca tectonic plates converge

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[26] An instrument that measures the motion of the ground, especially those caused by earthquakes, volcanic eruptions, and explosions.

[27] A device that measures the acceleration of ground motion caused by seismic waves during events like earthquakes

toward each other. The major types of earthquakes that occur in the Pacific Northwest region are described below:

- **Megathrust CSZ Earthquakes:** Also referred to as a subduction interface earthquake, this earthquake type results from rupture at the shallow section (less than 30 miles from the surface) of the interface or boundary between the Juan de Fuca plate and the overriding North American plate.
- **Deep CSZ Earthquakes:** Also referred to as a subduction in-slab earthquake, this earthquake type results from the release of stresses within the subducting Juan de Fuca plate beneath the plate interface during its slow eastward descent beneath the Pacific Northwest area.
- **Shallow Crustal Earthquakes:** Shallow crustal earthquakes are those that occur in the upper 18 miles of the Earth's crust. Some shallow crustal earthquakes originate along known and mapped crustal fault zones; these are referred to as background earthquakes or crustal fault earthquakes. There are also shallow crustal earthquakes that are not associated with mapped faults and occur within the region between the mapped faults (DNR 2024b).

Megathrust CSZ earthquakes occur when there are sudden ruptures along the brittle upper part of the Juan de Fuca-North American plate boundary. Although subduction interface earthquakes are rare, they can reach magnitudes greater than M_W 9 when they do happen. No such earthquakes have been recorded in the Pacific Northwest's written history, but geological evidence from Northern California to British Columbia shows that multiple CSZ subduction interface earthquakes of M_W 8+ to M_W 9 have occurred over the last 10,000 years (e.g., Atwater et al. 1995, 2005; Clague et al. 2000; Kelsey et al. 2005; Nelson et al. 2006). The most recent subduction interface earthquake in the Pacific Northwest happened in January 1700, with an estimated magnitude of M_W 8.7 to 9.2 (Cascadia Department of Bioregion n.d.). Geological evidence suggests that earthquakes of M_W 9.0 or greater have occurred at least seven times in the Pacific Northwest over the past 3,500 years, indicating an average recurrence interval of 400 to 600 years (PNSN n.d.).

As the Juan de Fuca plate subducts beneath the North American plate, the resulting increase in rock and bending stresses can cause subduction in-slab earthquakes. These earthquakes tend to have lower maximum magnitudes and occur at greater depths than megathrust subduction interface earthquakes. Most CSZ in-slab earthquakes have been recorded beneath the Puget Sound region. Notable historical in-slab earthquakes include the 1949 M_W 6.9 Olympia, the 1965 M_W 6.7 Seattle-Tacoma, and the 2001 M_W 6.8

Nisqually earthquakes. The recurrence interval for in-slab earthquakes is approximately every 30 to 50 years (EERI and WMDEMD 2005). The subduction of the Juan de Fuca plate compresses and deforms the western edge of the North American plate, creating crustal faults and folds. Crustal fault earthquakes occur when shallow faults, which can extend up to 15 miles deep, rupture. Additionally, background earthquakes are generated by unmapped and deeper faults within the shallow crust, away from known and mapped faults.

In addition to the major types of earthquakes that occur in the Pacific Northwest as a result of plate tectonics, the region's active volcanoes can also trigger earthquakes. Unlike tectonic earthquakes, volcanic earthquakes are caused by the upward movement of molten rock (magma) beneath and within the Cascade Range volcanoes. These earthquakes are typically localized to the volcanic centers and are usually not felt beyond the immediate vicinity. However, during large volcanic eruptions, such as the 1980 eruption of Mount St. Helens, volcanic earthquakes can cause strong shaking several miles from the volcano.

Surface Fault Rupture

The initial displacement along a fault, known as a fault rupture, releases energy that propagates as seismic waves.[28] In larger earthquakes, with a moment magnitude of 6 or higher, the fault can rupture all the way to the ground surface. This surface fault rupture can cause ground displacements, sometimes up to 30 feet. Such ruptures can lead to severe structural damage to buildings, bridges, and other infrastructure situated across the fault line.

Strong Ground Shaking

Strong ground shaking from earthquakes is the most widespread hazard in the Pacific Northwest. This shaking can cause damage to engineered structures. The extent of earthquake damage at a specific location depends on the following factors:

- The structure of the earth between the earthquake source and the site (i.e., travel path)
- The properties of the near-surface soil and rock beneath the site
- The type, design, and construction of the structures subjected to the shaking

[28] Energy waves generated by earthquakes, volcanic eruptions, or explosions.

The intensity of earthquake ground motion is measured by several parameters, with horizontal peak ground acceleration being the greatest acceleration experienced by the ground at a given location during an earthquake. The USGS has developed the Unified Hazard Tool, which can estimate peak ground acceleration and provide other crucial information for engineers designing facilities to withstand earthquake shaking.

Soil Liquefaction

Soil liquefaction is a temporary transformation of sandy soil from a solid state to a more liquid-like state. This phenomenon typically occurs during strong ground shaking, especially in loose sandy or silty sand soils that are saturated and have poor drainage. Soils that are most prone to liquefaction are those that lie less than 80 feet below ground surface, non-cohesive, and frequently saturated near the ground surface. Loose to medium-dense sands and soft to medium-stiff, low plasticity silts[29] are particularly susceptible because earthquake shaking can increase pore pressures in these saturated soils.

The potential for liquefaction increases with prolonged ground shaking. For instance, megathrust subduction interface earthquakes, which can cause strong shaking lasting longer than one minute, are more likely to induce liquefaction in susceptible soils. Liquefaction can lead to ground settlement and lateral spreading,[30] especially along riverbanks or stream channels. This settlement can reduce the bearing capacity of both shallow and deep foundations, adversely affecting structures. It can be helpful to categorize the risk of liquefaction to aid in planning for mitigation in earthquake-prone regions. Commonly used categories of liquefaction susceptibility are described below (USGS n.d.[b]):

- **Very High:** Areas where the soil is highly prone to liquefaction during an earthquake. These zones typically have loose, saturated sands and silts, often found in regions with man-made fill or young, unconsolidated sediments.
- **High:** Zones with a significant risk of liquefaction, though not as extreme as the "Very High" category. These areas still contain loose, water-saturated soils that can liquefy under seismic shaking.

[29] Fine-grained soils that exhibit low plasticity, meaning they have limited ability to deform without cracking or breaking when wet.

[30] A type of ground deformation that occurs when saturated soil layers lose their strength and move laterally due to seismic activity, such as an earthquake.

- **Medium:** Areas with a moderate risk of liquefaction. The soils in these zones may liquefy under strong earthquake shaking, but the conditions are less favorable for liquefaction than the "High" and "Very High" categories.
- **Low:** Zones where the risk of liquefaction is relatively low. The soils here are less likely to liquefy during an earthquake, often due to being denser or less saturated.
- **Very Low:** Areas with minimal risk of liquefaction. The soils in these zones are typically dense, well-drained, and not prone to liquefaction even during strong seismic events.

Tsunamis and Seiches

Tsunamis are long-duration ocean waves, typically lasting more than 20 minutes, generated by offshore earthquakes, landslides, and volcanic eruptions that displace the seafloor. These waves can range from a few feet to tens of feet in height, inundating coastal and low-lying inland areas. The risk of tsunamis is highest near ocean shorelines and river mouths. Landslides that enter waterbodies with sufficient force can also create localized tsunami waves, affecting rivers, lakes, or ocean shorelines.

Seiches are oscillating water waves that occur in enclosed or partially enclosed waterbodies like lakes and rivers. They can be triggered by earthquakes, volcanic activity, landslides, or extreme wind and weather events. Seiches become hazardous when their vertical waves approach shallow water or shorelines.

Volcanic Hazards

Cascade Range volcanoes have produced more than 100 eruptions in the past few thousand years. Cascade volcanoes have the potential to cause widespread disasters. The Pacific Northwest is extensively monitored by the USGS and the Cascades Volcano Observatory with an advanced seismic network. As Cascade volcanoes erupt, they can produce the following adverse conditions:

- **Ashfall:** This effect results when ash is forcibly ejected by a volcanic explosion and becomes airborne. Volcanic ash can become suspended in the air and travel great distances from the volcanic vent, entrained by the wind, before falling to the ground.
- **Lahars:** This component of a volcanic eruption occurs when volcanic ash and other debris mix with a water source to form volcanic mudflows. Lahars are

typically generated during and after eruptions, when large volumes of loose volcanic ash are present along the flanks of a volcano. Lahars may continue to mobilize loose debris for years after the event that caused them. Lahars are very fast-moving and can destroy bridges, roads, and other infrastructure along drainage paths.

- **Debris flows:** Like lahars, debris flows contain a higher concentration of volcanic debris, but with lower water content. Debris flows are not easily mobilized and are extremely dense, capable of causing damage.
- **Lava flows:** Lava flows are streams of molten rock that pour or ooze from an erupting vent. Lava erupts during either non-explosive activity or explosive lava fountains.
- **Pyroclastic flows:** These flows are chaotic blasts of volcanic ash, hot gases, and rock debris, usually generated from the collapse of an eruption column. Pyroclastic flows can spread out in any direction from a volcanic vent at very high speeds and are not restricted to drainage channels, unlike lahars, debris flows, and lava flows.
- **Other Effects:** Massive landslides can occur if portions of a volcano collapse during an eruption, as seen in the Mount St. Helens eruption in May 1980. Another hazard is the seismicity associated with volcanic activity, which may trigger earthquake events. Significant volcanic activity is generally preceded by weeks to months of increased seismicity.

Underground Mines

Washington contains more than 3,800 inactive and/or abandoned metal mines located on private, state, federal, and tribal lands (Huntting 1956; U.S. Bureau of Mines 1995) and approximately 230 inactive and abandoned coal mines (Schasse et al. 1994). Most of these mines became inactive prior to the enactment of environmental laws requiring reclamation (Norman 2000). Conditions at these sites are largely undocumented. Depending on the depth of the mine and the material above the mine, subsidence can occur over a large area (regional subsidence) that extends beyond the limits of the mine workings. This can cause foundation settlement, damage to utility lines (water, sewer, gas), or other problems. Where mine workings are relatively shallow, subsidence can be very localized and can result in localized depressions. Mine openings, waste dumps, and mine gases can pose other risks if they are present.

3.2.3 Impacts

For this Programmatic EIS, adverse environmental impacts were assessed for the new construction, operation and maintenance, upgrade, and modification of transmission facilities within the Study Area.

3.2.3.1 Method of Analysis

The study area for a project-specific application would typically encompass several key regions and features, such as the following:

- **Project Site and Immediate Vicinity:** This includes the specific location of the project and the surrounding area that might be directly affected by new construction, operation and maintenance, and upgrade or modification activities.
- **Soil and Geology:** This includes the types of soils and geological formations present in the area. This helps in understanding the potential for erosion, landslides, and other geotechnical issues. Unique geologic formations that are within the viewshed of the project should be included.
- **Natural Hazard Zones:** This includes floodplains, wildfire risk areas, landslide-prone zones, and seismic hazard zones.
- **Previous Earthworks:** Previous earthworks, such as landfills or underground mines, aid in understanding whether uneven settlement or subsidence is a concern. Additionally, disturbing these sites could release contaminants, posing environmental and health risks.
- **Hazardous Materials and Contaminated Sites:** This includes known Superfund or brownfield sites, areas with historical industrial activity, and locations with underground storage tanks or waste disposal areas.

This Programmatic EIS analyzes the affected environment and adverse environmental impacts on earth resources within the Study Area defined in Chapter 1, Introduction. Four project stages for each transmission facility type (overhead or underground) were considered: new construction, operation and maintenance, upgrade, and modification.

This evaluation considers both overhead and underground transmission facilities for each stage. Overhead transmission facilities consist of transmission lines, substations, and ancillary infrastructure. Overhead and underground transmission facilities may involve similar aboveground infrastructure. Underground transmission facilities consist of underground transmission lines, underground access vaults, and other infrastructure located below the ground surface. The new construction of underground transmission facilities could include both open-trench and trenchless construction methods.

Impact Determination

The discussion of adverse environmental impacts is qualitative given the high-level nature of a Programmatic EIS; quantification would require project-specific details to analyze. **Table 3.2-3** describes the criteria used to evaluate adverse environmental impacts from the Action Alternative and No Action Alternative. Information reviewed to identify adverse environmental impacts on earth resources in the Study Area was obtained from federal agencies, state agencies, local planning documents, and public scoping.

Table 3.2-3: Criteria for Assessing the Impact Determination on Earth Resources

Impact Determination	Description
Nil	No foreseeable adverse environmental impacts are expected. A project would not adversely affect the soil, geology, or other related earth resources during any stage (e.g., new construction, operation and maintenance, upgrade, and modification). A project would not cause soil erosion, compaction, or instability.
Negligible	A project would result in minimal adverse environmental impacts on earth resources. Changes would either be non-detectable or, if detected, would have only slight effects. There would be no noticeable changes to geological formations or the stability of the area. A project would not be adversely affected by existing seismic conditions. Negligible impacts would be short-term in duration. BMPs and design considerations are expected to be effective.
Low	A project would result in noticeable adverse environmental impacts on earth resources, even with the implementation of BMPs and design considerations. A project would cause some soil disturbance, but it would be limited in extent and duration. There could be minor changes to geological formations, but these would not affect the stability of the area. Minor adjustments could be needed to account for existing geohazards. These adverse environmental impacts may be short or long-term in duration.
Medium	A project would result in adverse environmental impacts on earth resources even with the implementation of BMPs and design considerations. A project would cause noticeable soil disturbance, including erosion and compaction. There could be changes to geological formations, which could affect the stability of the area. A project could be affected by existing geohazards, necessitating specific design considerations. Medium impacts may be short or long-term in duration.
High	A project would result in adverse and potentially severe environmental impacts on earth resources even after implementation of BMPs and design considerations. A project would cause extensive soil disturbance, including

Impact Determination	Description
	substantial erosion, compaction, and loss of soil fertility. There would be substantial changes to geological formations, which could affect the stability of the area. This might include an increased risk of landslides or other geotechnical issues. A project is highly vulnerable to existing geohazards, requiring extensive design and construction measures to address these risks. High adverse environmental impacts may be short or long-term.

BMP = best management practice

To clearly understand the potential severity of adverse environmental impacts without any interventions, the following impact determinations exclude the use of Avoidance Criteria and Mitigation Measures. The ratings assume compliance with all federal, state, and local laws and regulations, as well as standardized BMPs and design considerations. Assessing adverse environmental impacts without Avoidance Criteria or Mitigation Measures offers a baseline understanding of potential environmental effects, helping to identify the true extent of these impacts. Environmental laws often require that initial impact assessments be conducted without considering mitigation to maintain the integrity of the environmental review process.

When impact determinations are identified as medium or high, then either the applicant would adopt applicable Mitigation Measures from this Programmatic EIS, or the State Environmental Policy Act (SEPA) Lead Agency may require other applicable mitigation measures to be implemented to reduce project-specific adverse environmental impacts. When impact determinations are low, applicable Mitigation Measures should still be considered by the applicant and the SEPA Lead Agency, as these measures would help to further reduce adverse environmental impacts, including the project's contribution to cumulative impacts. These measures would be implemented in addition to compliance with laws, regulations, environmental permits, plans, and design considerations required for transmission facilities.

3.2.3.2 Action Alternative

New Construction

Overhead Transmission Facilities

Activities for new construction of overhead transmission facilities would vary and depend on the scale of the facility and site characteristics. New construction could include a relatively short site preparation period (e.g., a few months), followed by a longer construction and start-up period. It is assumed that the new construction of overhead transmission facilities, per mile, would have a shorter duration than underground construction. Overhead transmission facilities infrastructure could have the following adverse environmental impacts related to earth resources during new construction:

- Alteration of Topography and Drainage Patterns
- Soil Erosion and/or Accretion
- Compaction of Soil
- Damage from a Geologic Hazard

Alteration of Topography and Drainage Patterns

The new construction of transmission facilities often involves alterations to the landscape. Changes to topography or drainage patterns can occur during clearing and grading, the new construction of access roads, and foundation excavation.

The first step in constructing transmission facilities is often clearing vegetation and grading the land to create a stable foundation for structures. This process can alter the natural topography and disrupt surface runoff by leveling small foundation areas on hills, creating steps and terraces, and removing trees and other vegetation. The new construction of access roads for construction vehicles and maintenance crews can also change the natural drainage patterns and topography. Roads often require cutting into slopes and installing culverts to make certain areas of new construction more accessible. Excavating for the foundations of transmission towers and substations can disturb the soil and rock layers, leading to changes in the natural drainage patterns.

Impact Determination: Adverse environmental impacts on earth resources resulting from the alteration of topography and drainage patterns during the new construction of overhead transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from negligible to medium.

Soil Erosion and/or Accretion

New construction activities associated with overhead transmission facilities can lead to increased soil erosion and accretion. Soil erosion occurs when soil particles are detached and transported by wind, water, or other natural forces. Eroded soil can be carried into nearby waterbodies, leading to added sedimentation that affects aquatic habitats and water quality. The following factors can contribute to soil erosion during new construction:

- **Vegetation Removal:** Clearing land for transmission facilities removes the protective cover of vegetation, exposing soil to erosion by wind and water (see Section 3.5, Vegetation).
- **Excavation and Grading:** These activities disturb the soil structure, increasing the risk of erosion by water runoff.
- **Stormwater Runoff:** Heavy rainfall can lead to increased runoff, which can carry away loose soil particles (see Section 3.4, Water Resources).

During the new construction of overhead transmission facilities, soil accretion can occur in areas where eroded soil is transported and settles. This can lead to the formation of new landforms or the alteration of existing ones. The following factors can influence soil accretion:

- **Sediment Transport:** Eroded soil particles are carried by water or wind and deposited in lower-lying areas.
- **New construction Activities:** Movement of soil during new construction can lead to the unintentional buildup of soil in certain areas.

Soil erosion can lead to the loss of fertile topsoil, which is essential for crop growth. This can result in reduced agricultural yields and increased costs for farmers who need to replace lost nutrients. Eroded soil can be carried into rivers and streams, leading to sedimentation (see Section 3.4, Water Resources). Sedimentation can affect water quality, harm aquatic habitats, and increase the risk of flooding by clogging waterways. Coastal erosion can lead to the loss of land and damage to infrastructure. Coastal erosion is particularly concerning in areas with a lot of human development, such as residential and commercial properties.

Impact Determination: Adverse environmental impacts on earth resources resulting from soil erosion and/or accretion during the new construction of overhead transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from negligible to low.

Compaction of Soil

Heavy construction equipment compresses the soil, reducing the size and number of air-filled pores. This limits the oxygen available to plant roots and soil microorganisms, which can negatively affect plant growth and soil health (see Section 3.5, Vegetation). Compacted soil has fewer and smaller pores, which reduces its ability to absorb water and can lead to increased surface runoff, erosion, and reduced groundwater recharge. Persistent soil compaction can lead to long-term degradation of soil structure and fertility, making it difficult to restore the land to its original condition.

Impact Determination: Adverse environmental impacts on earth resources resulting from compaction of soil during the new construction of overhead transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from nil to low.

Damage from a Geologic Hazard

Geological hazards represent the susceptibility of an area to landslides, earthquakes, soil liquefaction, and other ground movements. The following factors can contribute to geologic instability of areas where transmission facilities could be constructed:

- **Soil Composition:** Certain soil types, such as clay or loose, unconsolidated materials, are more prone to instability. These soils can shift or collapse under the weight of construction. Heavy machinery used during construction can compact the soil, reducing its permeability and affecting plant growth and water infiltration.
- **Water Infiltration:** Excessive water from rainfall or construction activities can weaken soil and rock structures, leading to increased risk of landslides and erosion. Water infiltration can also cause frost-thaw in rock fractures, causing rock instability and falls.
- **Subsidence:** Heavy construction equipment and the weight of the structures can compact the soil, leading to subsidence. This is especially common in areas with loose or unconsolidated soils. Excavating for foundations and then backfilling can disturb the natural soil structure. If the backfill is not properly compacted, it can settle over time, causing subsidence. If the construction site is above old mine workings, natural caverns, or other underground voids, the additional load from the construction can cause the ground to collapse into these voids, leading to subsidence.

Impact Determination: Adverse environmental impacts on earth resources resulting from geological hazards during the new construction of overhead transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from low to high.

Underground Transmission

Activities for the new construction of underground transmission facilities would vary and depend on the scale of the facility and site characteristics. New construction could include a site preparation period of relatively short duration (e.g., a few months), followed by a longer construction and start-up period. It is assumed that the new construction of overhead transmission, per mile, would have a shorter duration than underground construction. Underground transmission facilities could have the following adverse environmental impacts related to earth resources during new construction:

- Alteration of Topography and Drainage Patterns
- Soil Erosion and/or Accretion
- Compaction of Soil
- Damage from a Geologic Hazard

Alteration of Topography and Drainage Patterns

The new construction of underground transmission facilities often involves alterations to the landscape. Changes to topography or drainage patterns can occur during clearing and grading, the new construction of access roads, and excavation.

Installing underground cables typically requires extensive excavation unless trenchless construction methods are used. Excavation disturbs the natural soil structure, leading to changes in the landscape such as the creation of trenches and pits. The process of digging and backfilling trenches can alter the natural topography. For example, the removal of soil and rock can create depressions, while the addition of backfill can create raised areas, which then can alter topography and runoff flows.

Impact Determination: Adverse environmental impacts on earth resources resulting from alteration of topography and drainage patterns during the new construction of underground transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from low to medium.

Soil Erosion and/or Accretion

Adverse environmental impacts related to soil erosion or accretion are generally greater for the new construction of underground transmission facilities than for overhead facilities due to extensive excavation, trenching, and vegetation disruption. Underground transmission facilities require more excavation to bury transducer cables. This process disturbs a large amount of soil, increasing the risk of erosion, especially during heavy rainfall. The removal of vegetation and topsoil exposes the soil to erosion. The amount of ground disturbance varies with the method of new underground transmission construction.

In contrast, overhead transmission facilities involve minimal ground disturbance, primarily limited to areas around tower foundations. The new construction of underground transmission facilities often involves digging long trenches, which can disrupt the natural soil structure and drainage patterns. This can lead to increased erosion, especially if the trenches are not properly stabilized.

Impact Determination: Adverse environmental impacts on earth resources resulting from soil erosion and/or accretion during the new construction of underground transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from low to medium.

Compaction of Soil

Soil compaction during the new construction of underground transmission facilities would be similar to that of overhead transmission facilities. Persistent soil compaction can lead to long-term degradation of soil structure and fertility, making it difficult to restore the land to its original condition.

Impact Determination: Adverse environmental impacts on earth resources resulting from compaction of soil during the new construction of underground transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from low to medium.

Damage from a Geologic Hazard

Geological instability can cause ground movement (e.g., landslides) and settling (e.g., subsidence). This can lead to misalignment or damage to underground transmission facilities. Unstable geological conditions can lead to increased water ingress into the construction site, which can complicate excavation and installation processes, increase the risk of flooding, and necessitate extensive dewatering[31] efforts. In areas with unstable rock or soil, there is a higher risk of collapses or cave-ins during excavation. This can pose safety hazards to construction workers and infrastructure.

Impact Determination: Adverse environmental impacts on earth resources resulting from geological hazards during the new construction of underground transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from low to high.

Operation and Maintenance

Overhead Transmission Facilities

Activities for the operation and maintenance stage of overhead transmission facilities would vary based on the type of facility, scale, and site characteristics. Facilities are not expected to have staff on site daily, but maintenance crews are anticipated to be regularly deployed. Transmission facilities require ongoing maintenance for equipment and rights-of-way (ROW). Overhead transmission facilities could have the following adverse environmental impacts during the operation and maintenance stage:

- Soil Erosion and/or Accretion
- Compaction of Soil

Soil Erosion and/or Accretion

Maintenance activities, such as vegetation management and access road upkeep, can disturb soil, leading to erosion and possibly accretion. This is particularly a concern in areas with steep slopes or loose soil. Erosion can undermine the foundations of transmission towers and other structures, leading to instability and potential failure.

Impact Determination: Adverse environmental impacts on earth resources resulting from soil erosion and/or accretion during the operation and maintenance of overhead transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from nil to low.

[31] The process of removing groundwater or surface water from a construction site. Dewatering is typically done to create a dry and stable environment for excavation, foundation work, or other construction activities.

Compaction of Soil

Maintenance activities, such as the movement of heavy machinery, can compact soil, reducing its permeability and affecting plant growth.

Impact Determination: Adverse environmental impacts on earth resources resulting from compaction of soil during the operation and maintenance of overhead transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from nil to low.

Underground Transmission Facilities

Similar to overhead transmission facilities, activities for the operation and maintenance of underground transmission facilities would vary based on the type of facility, scale, and site characteristics. Facilities are not expected to have staff on site daily, but maintenance crews are anticipated to be regularly deployed. Transmission facilities require ongoing maintenance for equipment and ROW, similar to any other linear industrial facility. Underground transmission facilities could have the following adverse environmental impacts during the operation and maintenance stage:

- Soil Erosion and/or Accretion
- Compaction of Soil

Soil Erosion and/or Accretion

Maintenance activities, such as vegetation management and access road upkeep, can disturb soil, leading to erosion and, possibly, accretion. This is particularly a concern in areas with steep slopes or loose soil.

Impact Determination: Adverse environmental impacts on earth resources resulting from soil erosion and/or accretion during the operation and maintenance of underground transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from nil to low.

Compaction of Soil

Maintenance activities, such as the movement of heavy machinery, can compact soil, reducing its permeability and affecting plant growth. Maintenance activities for underground transmission facilities often require more equipment than overhead transmission facilities, especially for excavation, leading to ongoing compaction issues.

Impact Determination: Adverse environmental impacts on earth resources resulting from compaction of soil during the operation and maintenance of underground transmission facilities are expected to vary depending on the scale of the project and site-specific conditions. In the absence of mitigation, these adverse environmental impacts could range from low to medium.

Upgrade

Overhead Transmission Facilities

Upgrades to overhead transmission facilities would occur within existing ROWs without expanding the existing facility footprint or causing new ground disturbance. However, these upgrades may result in adverse environmental impacts on earth resources, including:

- Soil Erosion and/or Accretion
- Compaction of Soil

The adverse environmental impacts of upgrading overhead transmission facilities are often comparable to those of maintaining overhead transmission facilities. These adverse environmental impacts are generally anticipated to be lower than those for modifying or constructing a new transmission facility due to several factors. Table 2.3-1 highlights how upgrading existing transmission facilities would generally result in fewer or less impactful adverse environmental impacts.

Underground Transmission Facilities

Upgrades to underground transmission facilities would occur within existing ROWs without expanding the facility footprint or causing new ground disturbance. However, these upgrades may result in adverse environmental impacts on earth resources, including:

- Soil Erosion and/or Accretion
- Compaction of Soil

The adverse environmental impacts from upgrading underground transmission facilities are often comparable to those of maintaining underground transmission facilities. These adverse environmental impacts are generally anticipated to be lower than those for modifying or constructing a new transmission facility due to several factors. Table 2.3-1 highlights how upgrading existing transmission facilities would generally result in fewer or less impactful adverse environmental impacts.

Modification

Overhead Transmission Facilities

Modifying existing overhead transmission facilities typically involves several key steps, each with specific requirements, timelines, and settings, as outlined in Chapter 2, Overview of Transmission Facilities, Development Considerations, and Regulations. The adverse environmental impacts of modifying existing transmission facilities would vary depending on the scale of the project-specific application. Overhead transmission facilities could have the following adverse environmental impacts on earth resources during the modification stage:

- Alteration of Topography and Drainage Patterns
- Soil Erosion and/or Accretion
- Compaction of Soil
- Damage from a Geologic Hazard

Adverse environmental impacts of modifying overhead transmission facilities could be similar to those of new construction, but are anticipated to be lower. Table 2.3-2 highlights how modifying existing transmission facilities would generally result in fewer or less impactful adverse environmental impacts.

Underground Transmission Facilities

Modifying existing underground transmission facilities typically involves several key steps, each with specific requirements, timelines, and settings, as outlined in Chapter 2, Overview of Transmission Facilities, Development Considerations, and Regulations. The adverse environmental impacts of modifying existing transmission facilities would vary depending on the scale of the project-specific application. Underground transmission facilities could have the following adverse environmental impacts on earth resources during the modification stage:

- Alteration of Topography and Drainage Patterns
- Soil Erosion and/or Accretion
- Compaction of Soil
- Damage from a Geologic Hazard

Adverse environmental impacts of modifying underground transmission facilities could be similar to those of new construction, but are anticipated to be lower.

Table 2.3-2 highlights how modifying existing transmission facilities would generally result in fewer or less impactful adverse environmental impacts.

3.2.3.3 No Action Alternative

Under the No Action Alternative, the Programmatic EIS would not be adopted as a planning or analytical framework. Instead, transmission facility siting and development would continue under existing state and local regulatory processes, with each project evaluated for environmental compliance without the benefit of the environmental review provided in this document. This approach would lack the advanced notice of potential serious environmental concerns for those planning transmission facilities, as well as the Mitigation Strategies developed under the Programmatic EIS. As a result, environmental outcomes could be less predictable and consistent, and adverse environmental impacts could be greater.

3.2.4 Mitigation Measures

Under SEPA, there are six recognized forms of mitigation that agencies can apply to reduce or address adverse environmental impacts:

- **Avoiding the adverse environmental impact** altogether by not taking a certain action or parts of an action.
- **Minimizing adverse environmental impacts** by limiting the degree or magnitude of the action and its implementation.
- **Rectifying the adverse environmental impact** by repairing, rehabilitating, or restoring the affected environment.
- **Reducing or eliminating the adverse environmental impact** over time by preservation and maintenance operations during the life of the action.
- **Compensating for the adverse environmental impact** by replacing or providing substitute resources or environments.
- **Monitoring the adverse environmental impact** and taking appropriate corrective measures.

This section describes the Avoidance Criteria and Mitigation Measures that could apply to adverse environmental impacts from new construction, operation and maintenance, upgrade, and modification of transmission facilities.

All General Measures adopted for this Programmatic EIS, identified in Section 3.1, are relevant to this resource section. Applicants would be responsible for providing information within their application materials documenting their implementation of the General Measures.

Avoidance Criteria[32] that are relevant to this resource section are described below:

AVOID-1 – Hazardous Areas: Avoid having equipment or infrastructure within known hazardous areas, including, but not limited to, contaminated soils, geologically hazardous areas, landfills, and cutbanks.

Rationale: Avoiding having equipment or infrastructure within hazardous areas provides safety for workers, the public, and infrastructure, as well as environmental protection. Disturbing sites of known contamination or other hazards may require the development of remediation plans.

AVOID-2 – Wetland Disturbance: Avoid having equipment or infrastructure within 300 feet of all wetlands.

Rationale: Protecting wetlands would decrease the chances of wetland degradation during new construction activities, as these areas are important for sustained wetland function. Wetlands within the project footprint would be delineated following the U.S. Army Corps of Engineers wetland delineation methodology and rated using the ECY's Western Washington, Version 2, and Eastern Washington, Version 1.

The Programmatic EIS is intended to support more efficient and effective siting and permitting of transmission facilities, consistent with the legislative direction in Revised Code of Washington (RCW) 43.21C.408, by streamlining environmental review where projects incorporate the recommended planning and Mitigation Strategies. Applicants would be responsible for providing information within their application materials documenting the project's compliance with the above Avoidance Criteria. While total avoidance of all adverse environmental impacts is not required in order to use the Programmatic EIS, applicants are expected to demonstrate how their project aligns with the intent of the Avoidance Criteria to the extent practicable. If specific Avoidance Criteria are not met, the applicant would provide an explanation and supporting information. Additional environmental analyses would be required as part of the documentation for SEPA for the project. Additional mitigation could be required,

[32] The complete list of Avoidance Criteria and their rationales can be found in Section 3.1 and Appendix 3.1-1.

depending on the nature of the deviation and its potential to result in probable significant adverse environmental impacts.

Mitigation Measures have been identified to minimize adverse environmental impacts from transmission facility projects. These measures are intended to be broad so that they can be applied to most projects that would be covered under this Programmatic EIS. However, project-specific plans would be needed to adapt the measures for project-specific applications. The inclusion of a Mitigation Measure in this Programmatic EIS does not imply that a given adverse environmental impact is presumed to occur. Rather, the measures are provided to support early planning and the avoidance of adverse environmental impacts, streamlining project-specific environmental reviews when impacts are identified. Mitigation Measures are intended to serve as a set of potential strategies that the SEPA Lead Agency and applicants can draw from, depending on the specific environmental context and project footprint. Applicants and the SEPA Lead Agency retain discretion to:

- Propose alternative mitigation strategies that achieve equivalent or better outcomes.
- Demonstrate that certain Mitigation Measures are not applicable due to the absence of relevant impacts.

When impact determinations are identified as medium or high, then either the applicant would adopt applicable Mitigation Measures from this Programmatic EIS, or the SEPA Lead Agency may require applicable mitigation to be implemented to reduce project-specific adverse environmental impacts. When impact determinations are low, applicable Mitigation Measures should still be considered by the applicant and the SEPA Lead Agency, as these Mitigation Measures would help to further reduce adverse environmental impacts, including the project's contribution to cumulative impacts. These Mitigation Measures would be implemented in addition to compliance with laws, regulations, environmental permits, plans, and design considerations required for transmission facilities.

The following Mitigation Measures could be adopted to mitigate adverse environmental impacts:

Geo-1 – Minimize Soil Disturbance: Minimize soil disturbance, including footprints related to access roads and permanent structures, to the greatest extent practicable. Minimize the use of construction techniques that would be harmful to topsoil composition, where feasible.

Rationale: Minimizing the footprint of access roads and permanent transmission facilities would reduce direct and indirect adverse environmental impacts on vegetation, including vegetation clearing, spread of invasive plant species or dust, and required ongoing vegetation maintenance.

Minimizing soil disturbance helps maintain the natural structure of the soil, which is essential for water infiltration, root growth, restoration activities, and the habitat of soil organisms.

Geo-2 – Slope Stabilization: Use retaining walls, terracing, and vegetation to stabilize slopes and prevent landslides when appropriate to do so.

Rationale: Slope stabilization ensures safety and protects infrastructure, property, and natural resources. Unstable slopes can lead to landslides, which pose risks to human life, property, and infrastructure.

Geo-3 – Drainage Control: Implement effective drainage systems and manage water runoff to reduce soil saturation.

Rationale: This Mitigation Measure aims to manage water effectively to prevent a range of environmental and structural issues.

Geo-4 – Minimize Impacts on Sensitive Soils: Design projects to minimize adverse environmental impacts on high erodibility zones and areas sensitive to degradation.

Rationale: Minimizing adverse environmental impacts on high-erodibility zones and sensitive soils offers environmental protection, stability, and safety. Sensitive soils, such as those with high organic content or unique properties, are more susceptible to degradation from new construction activities. Minimizing impacts on these areas helps preserve their structure and function.

In addition to the above Mitigation Measures, the following Mitigation Measures[33] developed for other resources may be applicable:

W-2 – Clear Spanning or Trenchless Methods for Water Crossings: When feasible, use clear spanning for new overhead transmission or trenchless construction for underground transmission to minimize disturbance to riparian areas, wetlands and wetland buffers, and surface waters.

[33] The rationales for the identified Mitigation Measures are provided in their respective resource sections.

W-3 – Phased Construction: Sequence and schedule new construction, maintenance, and upgrade/replacement activities when near surface waterbodies to minimize erosion and sediment transport.

W-5 – Implement Erosion and Sediment Control Measures: Implement effective and appropriate erosion control measures in new construction and operation to mitigate runoff into streams.

W-6 – Minimize Hydrology Changes: Minimize water diversions and changes to natural hydrology or hydroelectric dam flow regimes to the greatest extent possible.

Veg-1 – Site Transmission Facilities in Existing ROW or Disturbed Areas: Site transmission facilities in existing right-of-way (ROW) or disturbed areas, to the greatest extent practicable.

Hab-3 – Decommission Nonpermanent Roads: Decommission and restore any access roads not required for operation and maintenance.

Hab-7 – Retain Wildlife Trees where Practicable: Wildlife trees are trees with features that are especially beneficial to wildlife. These typically include living and dead trees that are decaying and those that have cavities or good conditions for cavity creation, sloughing bark that can provide roost sites for bats, branches for perching, basal cavities for denning, and foraging opportunities for woodpeckers and other wildlife. Wildlife trees would be retained where safe to do so.

Fish-12 – Reduce Number of Stream Crossings: Design transmission facilities to reduce the number of stream crossings. Access roads and utilities would share common rights-of-way.

Fish-13 – Use Bioengineering: Design stabilization structures to incorporate bioengineering[34] principles; for example, use of living and nonliving plant materials in combination with natural and synthetic support material for slope stabilization, erosion reduction, and vegetation establishment.

Fish-14 – Removal of Riparian Vegetation: Minimize disturbance to low-growing shrubs and grass species in riparian areas, or tree removal in steep gulches.

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[34] The incorporation of biological materials and structures in engineering design.

3.2.5 Probable Significant Adverse Environmental Impacts

Determining the significance of an adverse environmental impact involves consideration of context and intensity, which, in turn, depend on the magnitude and duration of the impact. "Significant" in SEPA means a reasonable likelihood of more than a moderate adverse environmental impact on environmental quality. An adverse environmental impact may also be significant if its chance of occurrence is not great, but the resulting impact would be severe if it occurred (WAC 197-11-794).

Identification of adverse environmental impacts and assignment of discipline-specific ratings are based on a structured evaluation consistent with the criteria outlined in WAC 197-11-330. Significance determinations consider the context and intensity of potential adverse environmental impacts, using both quantitative and qualitative information where appropriate. Professional expertise does not substitute for regulatory compliance. Regulatory requirements establish the baseline for environmental analysis and mitigation. Professional experience is used to supplement this baseline, providing additional insight to identify whether mitigation beyond what is required by regulation may be warranted. In cases where data are incomplete or unavailable, a conservative approach has been applied to ensure that potential adverse environmental impacts are not underestimated.

This Programmatic EIS weighs the potential adverse environmental impacts on earth resources that would result from transmission facilities after considering the application of laws and regulations; siting and design considerations, including agency guidance and BMPs, and Mitigation Strategies, and makes a resulting determination of significance for each impact. **Table 3.2-4** summarizes the adverse environmental impacts anticipated for the new construction, operation and maintenance, upgrade, and modification of transmission facilities.

Table 3.2-4: Summary of Adverse Environmental Impacts, Mitigation Strategies, and Significance Rating for Earth Resources

Adverse Environmental Impact	Project Stage	Description of Impact	Impact Determination Before Applying Mitigation	Mitigation Strategy Applied[(a)]	Significance After Applying Mitigation Strategy	Rationale for Significance Rating
Earth – Alteration of Topography and Drainage Patterns	New Construction	Alteration of topography and drainage patterns may occur during the construction of new overhead and underground transmission facilities during grading, excavation, vegetation removal, trenching/boring, and soil management. Many of the changes to topography and drainage are considered temporary and can generally be restored after construction is completed.	**Overhead:** negligible to medium **Underground:** low to medium	▪ **AVOID-1:** Hazardous Areas ▪ **Geo-1:** Minimize Soil Disturbance ▪ **Geo-2:** Slope Stabilization ▪ **Geo-3:** Drainage Control ▪ **Geo-4:** Minimize Impacts on Sensitive Soils ▪ **W-2:** Clear Spanning or Trenchless Methods for Water Crossings ▪ **W-3:** Phased Construction ▪ **W-5:** Implement Erosion and Sediment Control Measures ▪ **W-6:** Minimize Hydrology Changes ▪ **Veg-1:** Site Transmission Facilities in Existing ROW or Disturbed Areas	Less than Significant	Required regulatory plans and permits generally prevent and/ or minimize adverse environmental impacts from alteration of topography and drainage patterns. Several BMPs can also be implemented to minimize impacts. By carefully planning and implementing BMPs and Mitigation Strategies, the environmental impacts of altering topography and drainage patterns can be reduced.
	Operation and Maintenance	This impact is not anticipated to occur during the operation and maintenance of overhead or underground transmission facilities.	**Overhead:** N/A **Underground:** N/A			
	Upgrade	Upgrading the current infrastructure would not require an expansion of the footprint or the alteration of topography.	**Overhead:** N/A **Underground:** N/A			
	Modification	Modifying existing overhead and underground transmission facilities can involve grading or leveling of land, which can alter the natural topography. These changes might not be as extensive as those from new construction, but they can still affect topography and local drainage patterns. Modifications may also include the addition of impervious surfaces, such as access roads or equipment pads. These surfaces can increase surface runoff, reducing the amount of water that infiltrates into the soil.	**Overhead:** negligible to medium **Underground:** low to medium			
Earth – Soil Erosion and/or Accretion	New Construction	Construction activities associated with the new construction of overhead and underground transmission facilities often involve clearing vegetation and disturbing the soil, which can increase the vulnerability of the land to erosion. In some cases, new construction can lead to increased sediment deposition downstream or in other areas. This can happen when construction activities increase the amount of sediment carried by water, which then settles in new locations.	**Overhead:** negligible to low **Underground:** low to medium	▪ **Geo-1:** Minimize Soil Disturbance ▪ **Geo-2:** Slope Stabilization ▪ **Geo-3:** Drainage Control	Less than Significant	Required regulatory plans and permits generally prevent and/or minimize erosion and accretion from project-related activities. With the implementation of Mitigation Measures, impacts related to soil

Adverse Environmental Impact	Project Stage	Description of Impact	Impact Determination Before Applying Mitigation	Mitigation Strategy Applied[(a)]	Significance After Applying Mitigation Strategy	Rationale for Significance Rating
	Operation and Maintenance	Regular maintenance often involves clearing vegetation to keep both overhead and underground transmission facilities clear. Vegetation maintenance activities can disturb soil and increase erosion. The movement of heavy machinery during maintenance can disturb soil and exacerbate erosion.	**Overhead:** nil to low **Underground:** nil to low	▪ **Geo-4:** Minimize Impacts on Sensitive Soils ▪ **W-5:** Implement Erosion and Sediment Control Measures ▪ **Veg-1:** Site Transmission Facilities in Existing ROW or Disturbed Areas ▪ **Hab-3:** Decommission Nonpermanent Roads ▪ **Hab-7:** Retain Wildlife Trees where Practicable ▪ **Fish-12:** Reduce Number of Stream Crossings ▪ **Fish-13:** Use Bioengineering ▪ **Fish-14:** Removal of Riparian Vegetation		erosion and/or accretion would be reduced to a less-than-significant level.
	Upgrade	Upgrading overhead and underground transmission facilities could have various impacts related to soil erosion and/or accretion. Clearing vegetation in the surrounding areas that were previously disturbed by the original project, to access the area needing to be upgraded, can cause increased erosion. Effects related to accretion would be minimal, unless increased erosion moves the sediments into the upgrade area.	**Overhead:** nil to low **Underground:** nil to low			
	Modification	The modification of both overhead and underground transmission facilities could have various impacts related to soil erosion and/or accretion. Clearing vegetation to access and modify transducer cables can lead to increased erosion. Excavation for underground transducer cables can also disturb soil structure and local ecosystems.	**Overhead:** negligible to low **Underground:** low to medium			
Earth – Compaction of Soil	New Construction	The use of heavy machinery to install both overhead and underground transmission facilities can increase bulk density and reduce porosity[35] of soils. New construction also often requires temporary access roads, which can compact the soil. Excavation for underground transducer cables often involves digging trenches, which can compact the soil along the trench lines and adjacent areas.	**Overhead:** nil to low **Underground:** low to medium	▪ **Geo-1:** Minimize Soil Disturbance ▪ **Geo-2:** Slope Stabilization ▪ **Geo-3:** Drainage Control ▪ **Geo-4:** Minimize Impacts on Sensitive Soils ▪ **Veg-1:** Site Transmission Facilities in Existing	Less than Significant	The compaction process is usually temporary and primarily occurs during the construction stage. During new construction, soil compaction would be carefully controlled and monitored to ensure it meets specific engineering standards. Additionally, construction projects often utilize BMPs to address potential adverse impacts of soil compaction, including soil aeration, the use of geotextiles, and proper drainage
	Operation and Maintenance	Soil compaction is less of a concern during the operation and maintenance of overhead transmission facilities than during new construction. During operation and maintenance, the use of heavy machinery is reduced. Most maintenance tasks can be performed with lighter equipment or by personnel on foot. Soil compaction remains a concern during the operation and maintenance of underground transmission facilities because maintenance of underground transmission facilities often requires the	**Overhead:** nil to low **Underground:** low to medium			

[35] Volume of pore spaces or voids within the soil.

Adverse Environmental Impact	Project Stage	Description of Impact	Impact Determination Before Applying Mitigation	Mitigation Strategy Applied[(a)]	Significance After Applying Mitigation Strategy	Rationale for Significance Rating
		use of heavy machinery to access and repair the transducer cables. This equipment can compact the soil, especially if maintenance is frequent or extensive. Accessing underground transducer cables typically involves re-excavating trenches, which can lead to repeated soil compaction.		ROW or Disturbed Areas		systems to maintain soil health and prevent erosion. Once the infrastructure is in place, the need for further compaction is minimal, reducing long-term impacts. With the implementation of Mitigation Measures, impacts related to soil compaction would be reduced to a less-than-significant level.
	Upgrade	Upgrades may cause additional compaction to soils through additional heavy equipment on site or material storage at locations previously disturbed by the original project, within the ROW.	**Overhead:** nil to low **Underground**: low to medium			
	Modification	Soil compaction during the modification of transmission facilities can occur due to heavy machinery, construction activities, or material storage.	**Overhead:** nil to low **Underground:** low to medium			
Earth – Damage from a Geologic Hazard	New Construction	Geological instability during site selection and new construction activities for both overhead and underground transmission facilities can impact foundation and slope stability, cause construction challenges, and require long-term maintenance.	**Overhead:** low to high **Underground**: low to high	▪ **AVOID-1:** Hazardous Areas ▪ **Geo-1:** Minimize Soil Disturbance ▪ **Geo-2:** Slope Stabilization ▪ **Geo-3:** Drainage Control ▪ **Geo-4**: Minimize Impacts on Sensitive Soils ▪ **W-6:** Minimize Hydrology Changes ▪ **Veg-1:** Site Transmission Facilities in Existing ROW or Disturbed Areas	Less than Significant	The application of BMPs, engineering design considerations, and Mitigation Strategies reduces these risks. BMPs often include techniques like slope reinforcement, retaining walls, and soil nailing, which enhance the stability of slopes and prevent landslides. Each transmission facility site is unique, and BMPs are tailored to address the specific geological and hydrological conditions of the area. This customized approach ensures that the most effective measures are implemented to maintain stability.
	Operation and Maintenance	Ongoing geological instability, such as soil erosion or landslides, can compromise the integrity of existing transmission tower foundations, leading to structural failures. However, this impact is not anticipated to occur during the operation and maintenance of overhead or underground transmission facilities with proper siting and engineering.	**Overhead**: N/A **Underground**: N/A			
	Upgrade	This impact is not anticipated to occur during the upgrade of overhead or underground transmission facilities with proper siting and engineering.	**Overhead**: N/A **Underground**: N/A			
	Modification	Geological instability during the modification of either existing overhead or underground transmission facilities can impact foundation and slope stability, cause construction challenges, and require long-term maintenance.	**Overhead**: low to high **Underground**: low to high			

Notes:

(a) Appendix 3.1-1 provides a detailed listing of each Mitigation Strategy. This appendix serves as a reference section that can be consulted independently of the main text. This is particularly useful for detailed guidance and technical specifications that may be referred to multiple times. Additionally, including this information in an appendix allows for easier updates and revisions. If Mitigation Strategies or guidance changes, the appendix can be updated without altering the main content.

BMP = best management practice; **N/A** = not applicable; **ROW** = right-of-way

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3.2.6 Environmental Sensitivity Map

Project-specific applications require a comprehensive analysis to identify the site-specific adverse environmental impacts on resources and determine the suitability of this Programmatic EIS. Environmental review may be phased by incorporating relevant information from this Programmatic EIS by reference while evaluating site-specific adverse environmental impacts of individual project applications. For more information on phased reviews, please refer to Chapter 1, Introduction.

Each project-specific application would include details about the proposal's location and site-specific conditions. This Programmatic EIS provides environmental sensitivity maps that, when used alongside project-specific data, could support more informative and efficient environmental planning. An online mapping tool has also been developed to provide public access to the most current data used in creating these environmental sensitivity maps.

Figure 3.2-4 presents the environmental sensitivity map for earth resources, identifying areas of varying sensitivity based on the siting criteria described in the following sections.

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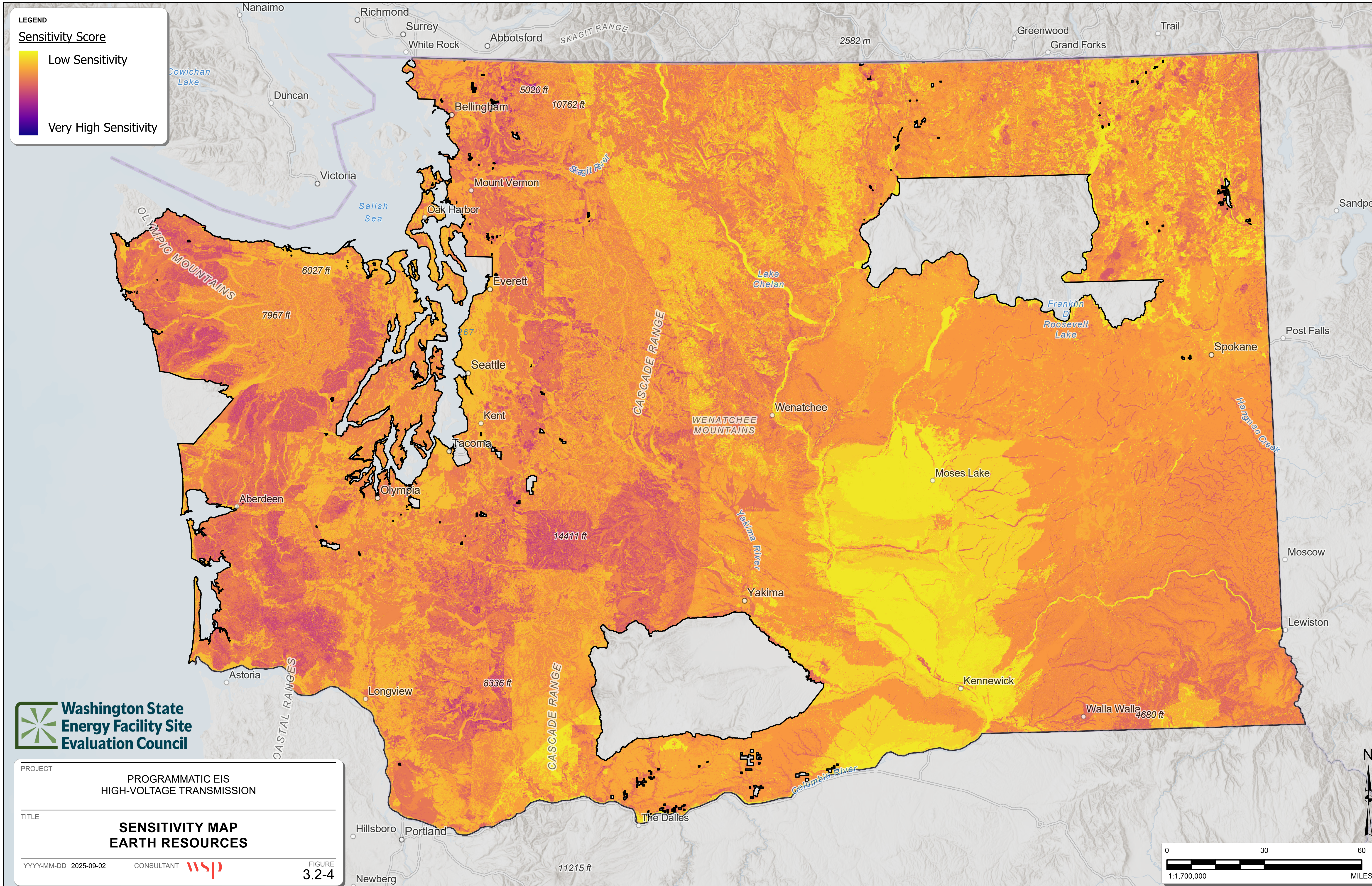

LEGEND

Sensitivity Score

Low Sensitivity

Very High Sensitivity

Washington State Energy Facility Site Evaluation Council

PROJECT

PROGRAMMATIC EIS
HIGH-VOLTAGE TRANSMISSION

TITLE

SENSITIVITY MAP
EARTH RESOURCES

YYYY-MM-DD 2025-09-02

CONSULTANT wsp

FIGURE 3.2-4

DESIGNED MK PREPARED MK REVIEWED SHJP APPROVED AH/SG/ZA

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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3.2.6.1 Environmental Sensitivity Map Criteria Cards

The environmental sensitivity map evaluates various siting criteria and assigns sensitivity levels to geographic areas based on their potential for adverse environmental impacts, as analyzed in this Programmatic EIS. Each criterion was assigned a sensitivity level (1, 2, or 3) with Level 3 representing the highest sensitivity. Criteria cards illustrate the spatial extent of the siting criteria chosen. A summary of the criteria cards is provided below. Appendix 3.1-2 details the data preparation process for the criteria cards.

Volcanic Hazards – Sensitivity Level 1

Figure 3.2-5 illustrates the spatial extent of volcanic hazards and lahar deposition zones from "Simplified Volcanic Hazards" (DNR 2016). While volcanic events are rare, any volcanic activity would be impactful to transmission facility construction, operation, and maintenance.

Earthquake Hazards – Sensitivity Level 1

Figure 3.2-6 illustrates the spatial extent of inactive faults with slip rates less than 0.2 millimeters per year (mm/yr) from "Earthquake and Faults," areas with peak ground accelerations less than 0.4 g from the "Global Earthquake Model (GEM) Seismic Hazard Map," and low- to moderate-liquefaction hazard zones from "Liquefaction Potential Hazard Zones" (DNR 2010, 2025a; Peterson et al. 2023). A 250-foot buffer was applied to the inactive faults package with slip rates less than 0.2 mm/year.

Geologic Hazards – Sensitivity Level 1

Figure 3.2-7 illustrates the spatial extent of mapped landslides in the "Washington State Landslide Inventory Database" that are classified by the DNR as "moderate" (DNR 2025b). Also included are slopes of 15 to 40 percent rise and greater than 1,000 square meters from "3D Elevation Program 1/3-Arc Second Resolution Digital Elevation Model" (USGS 2022–2024).

Sensitive Soils – Sensitivity Level 1

Figure 3.2-8 illustrates the spatial extent of where the K-Factor Rock Free value exceeds 0.4, indicating a higher susceptibility to erosion. These conditions can increase the risk of sedimentation, slope instability, and long-term maintenance issues for transmission infrastructure (USDA NRCS 2025).

Earthquake Hazards – Sensitivity Level 2

Figure 3.2-9 illustrates the spatial extent of active faults (Holocene faults with slip rates greater than 0.2 mm/yr) in "Earthquakes and Faults," peak ground accelerations greater than 0.4 g in "Global Earthquake Model (GEM) Seismic Hazard Map," high-liquefaction hazard zones from the "Ground Response" dataset, and coastal tsunami zones from "Tsunami Zones" (DNR 2010, 2025a, 2025c; Peterson et al. 2023). A 250-foot buffer was applied to active faults.

Geologic Hazards – Sensitivity Level 2

Figure 3.2-10 illustrates the spatial extent of existing mapped landslides classified as high threat in the "Washington State Landslide Inventory Database," slopes above 40 percent rise and greater than 1,000 square meters from the "3D Elevation Program 1/3-Arc Second Resolution Digital Elevation Model," and areas of underground mining from the "Mines and Minerals Database" (DNR 2023, 2025c; USGS 2022–2024). A 1-mile buffer around inactive and abandoned metal and non-metal mines, both surface and underground, as well as a 0.5-mile buffer around coal mines, were applied to the datasets.

Sensitive Soils – Sensitivity Level 2

Figure 3.2-11 illustrates the spatial extent of Histosols, Andisols, Alfisols, and Mollisols from the Gridded Soil Survey Geographic (gSSURGO) Database. These soils are ecologically valuable due to their roles in carbon sequestration, water regulation, and biodiversity support. Areas dominated by these soils are assigned elevated sensitivity levels to reflect their conservation status and potential for adverse impacts from ground disturbance (USDA NRCS 2025).

Volcanic Hazards – Sensitivity Level 1

Washington State Energy Facility Site Evaluation Council

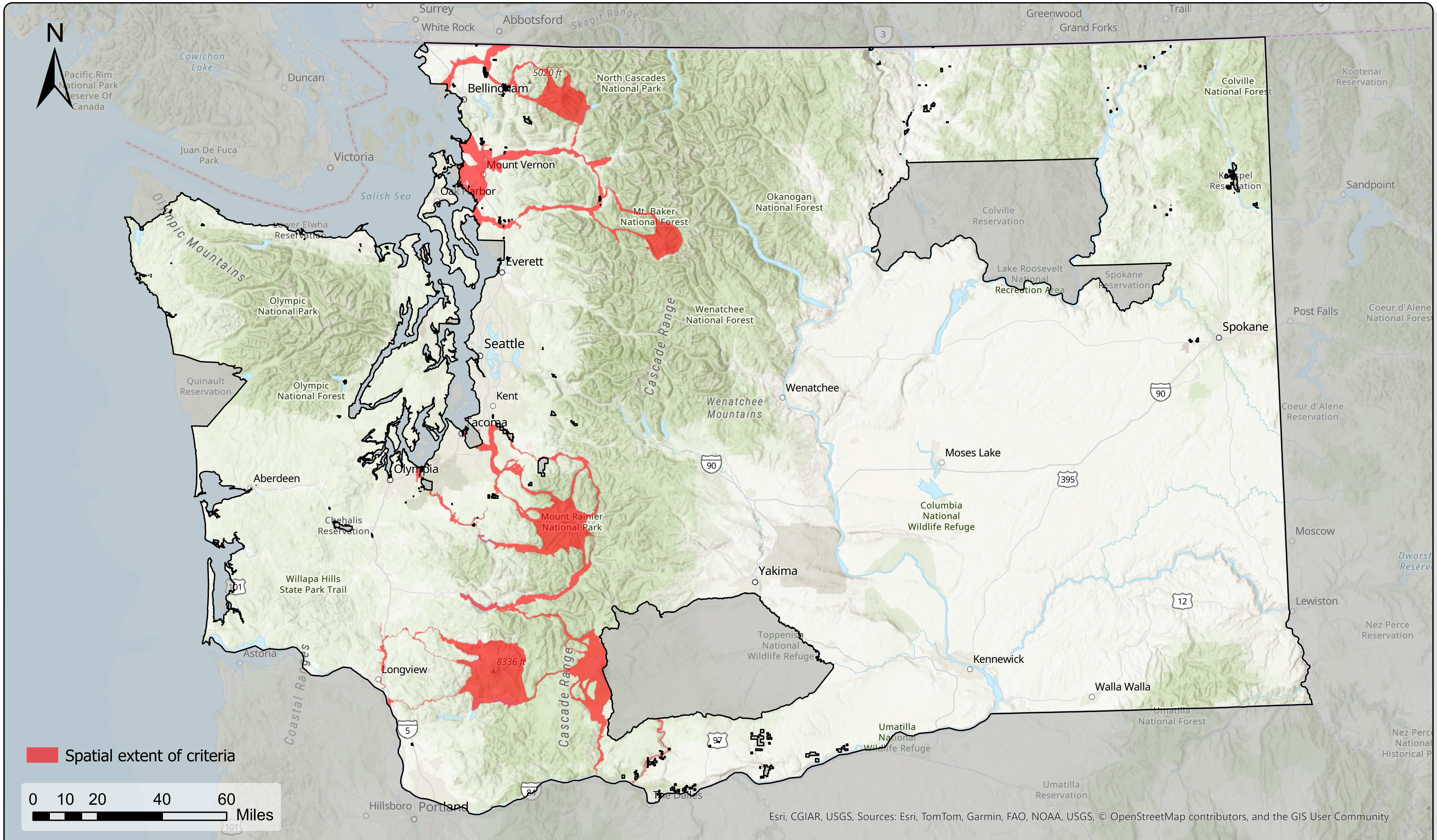

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Figure 3.2-5

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Earthquake Hazards – Sensitivity Level 1

Washington State Energy Facility Site Evaluation Council

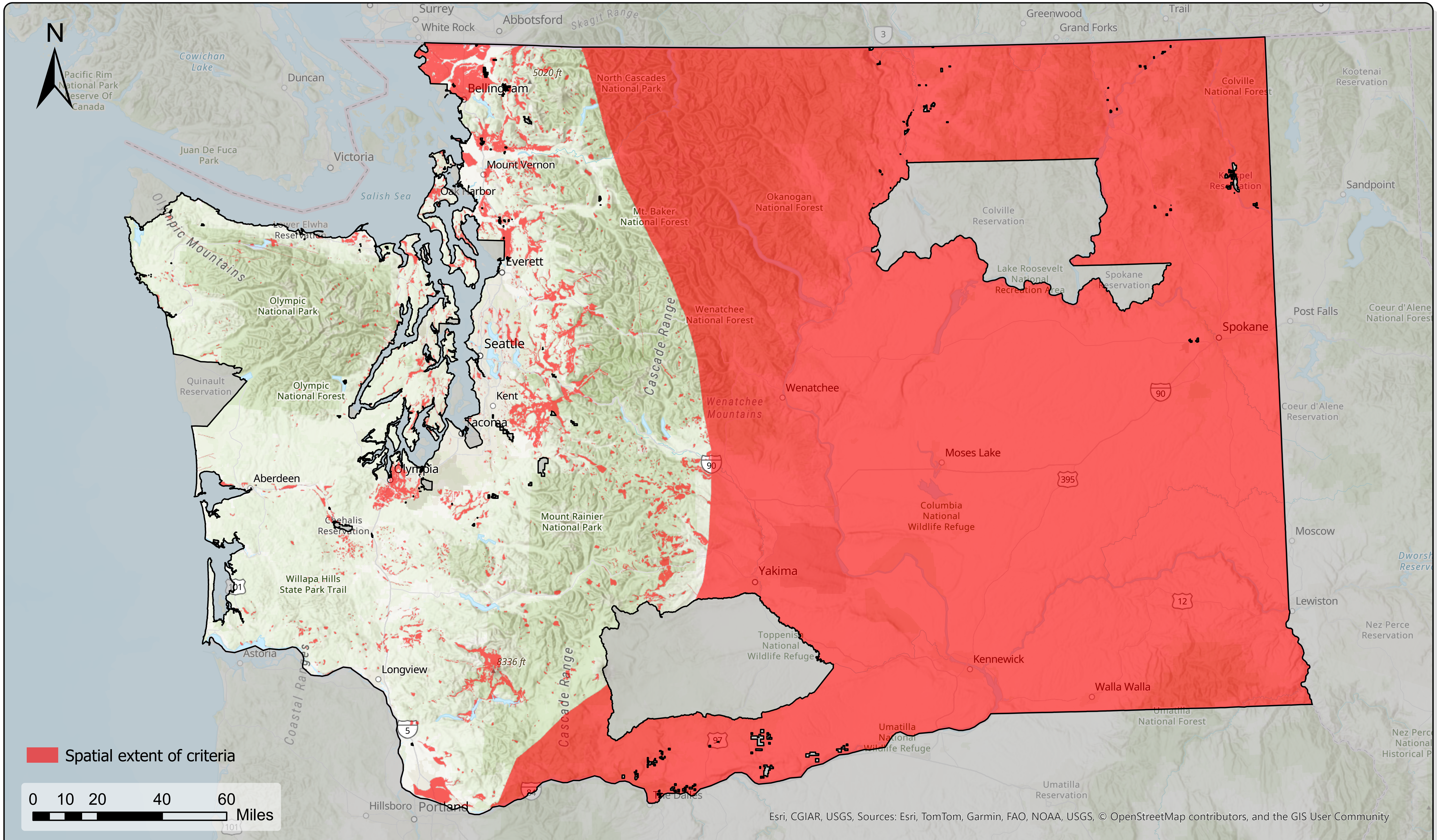

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Figure 3.2-6

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Geologic Hazards – Sensitivity Level 1

Washington State Energy Facility Site Evaluation Council

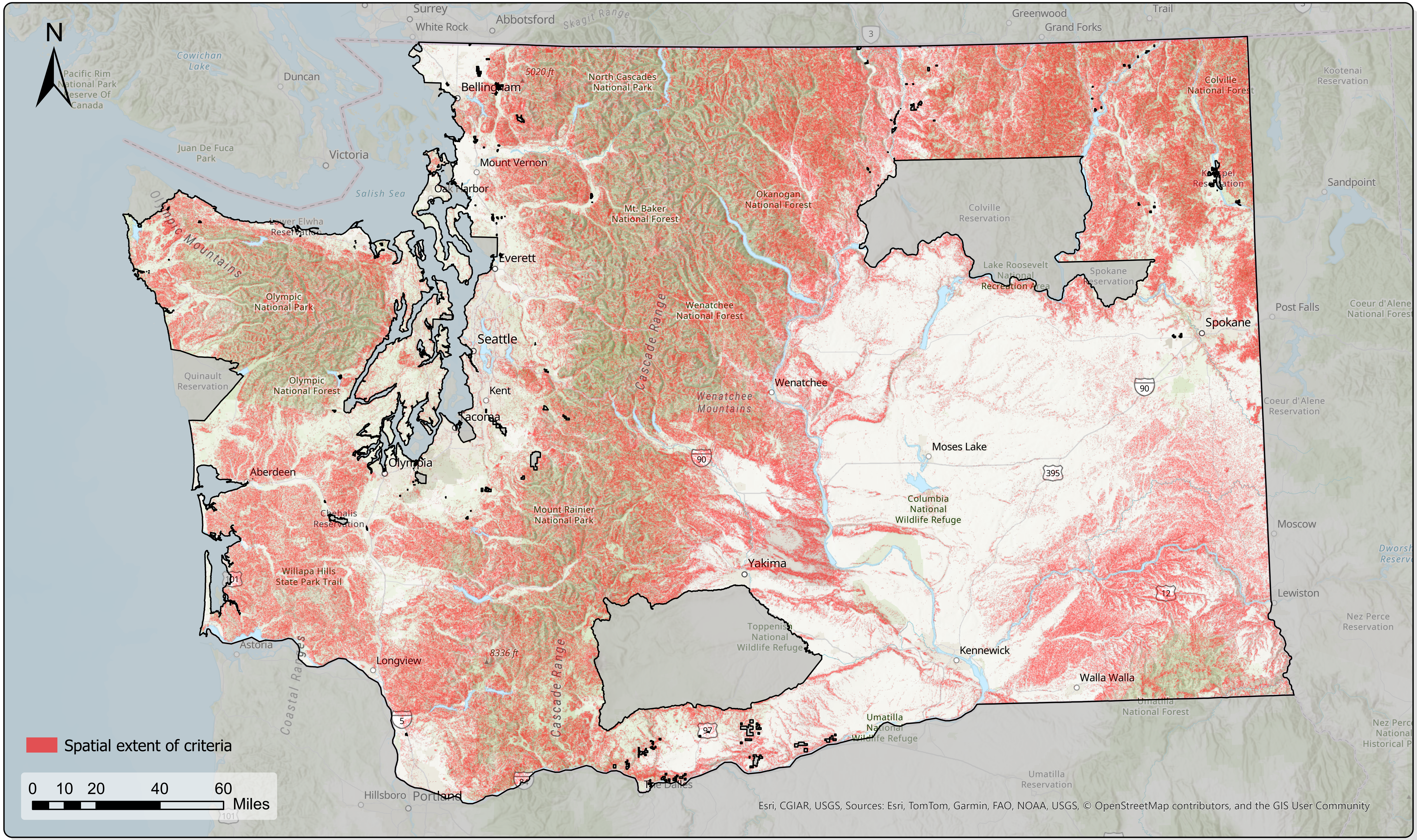

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Figure 3.2-7

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Sensitive Soils – Sensitivity Level 1

Washington State Energy Facility Site Evaluation Council

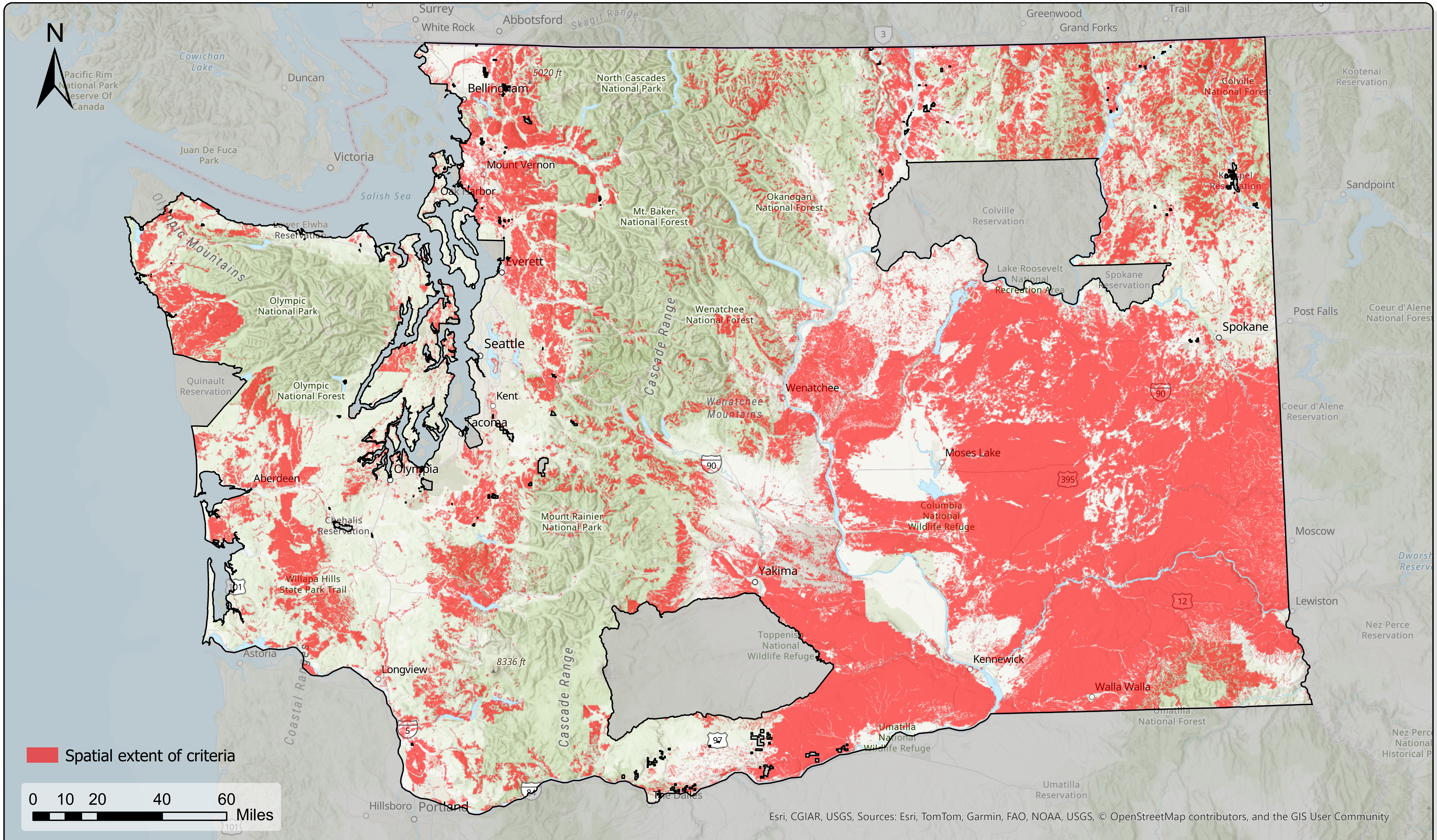

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Figure 3.2-8

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Earthquake Hazards – Sensitivity Level 2

Washington State Energy Facility Site Evaluation Council

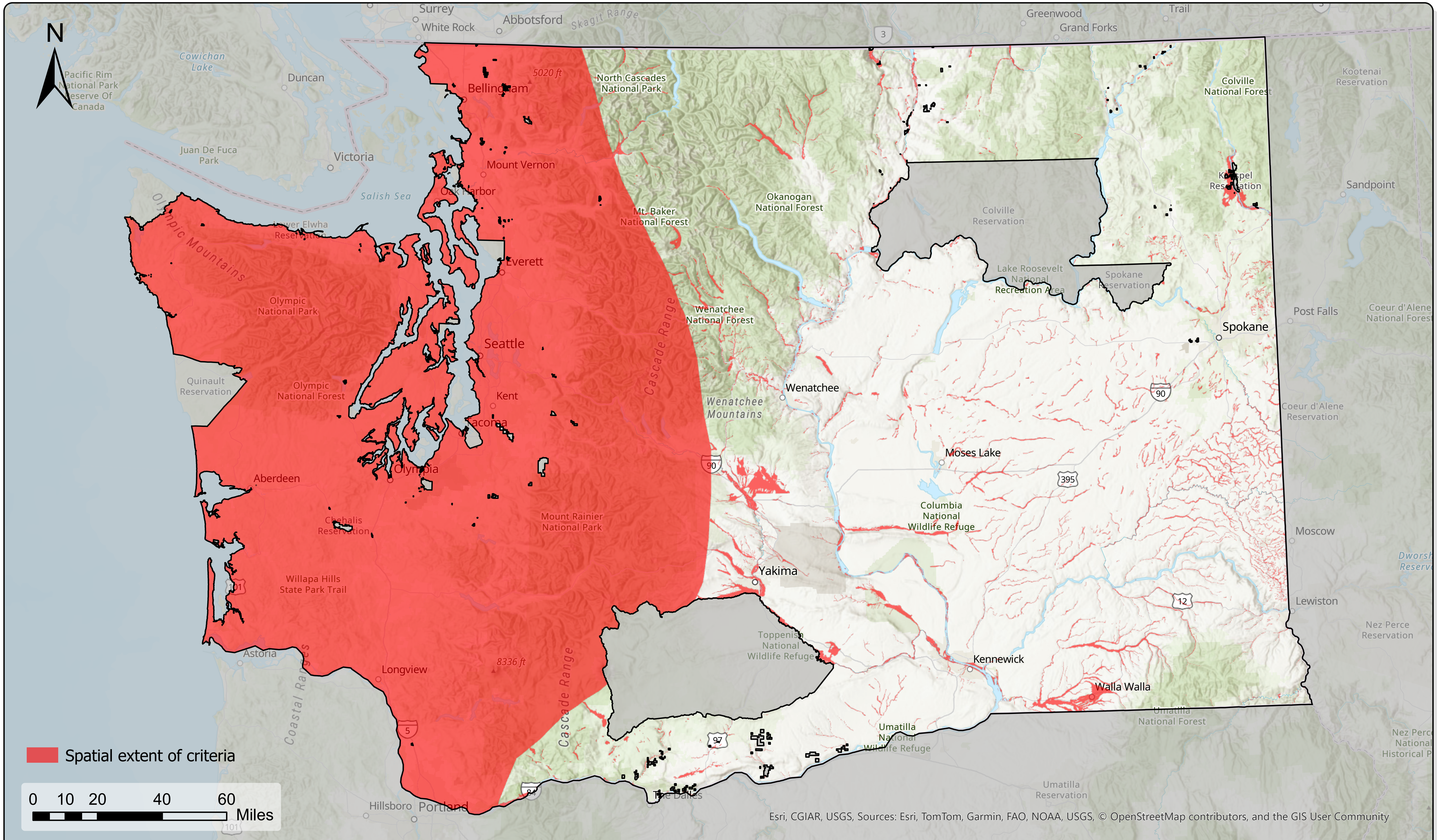

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Figure 3.2-9

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Geologic Hazards – Sensitivity Level 2

Washington State Energy Facility Site Evaluation Council

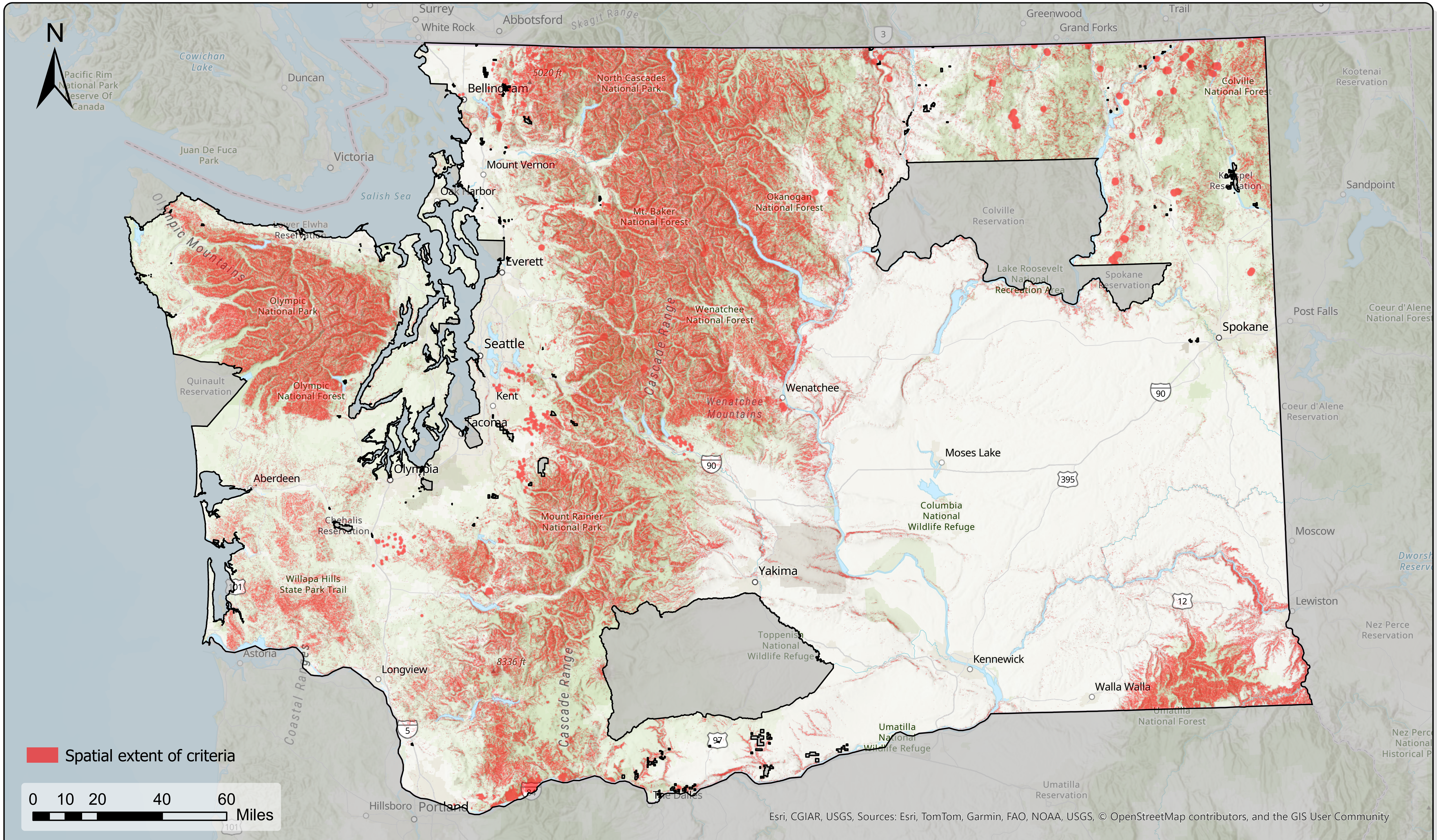

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Figure 3.2-10

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Sensitive Soils – Sensitivity Level 2

Washington State Energy Facility Site Evaluation Council

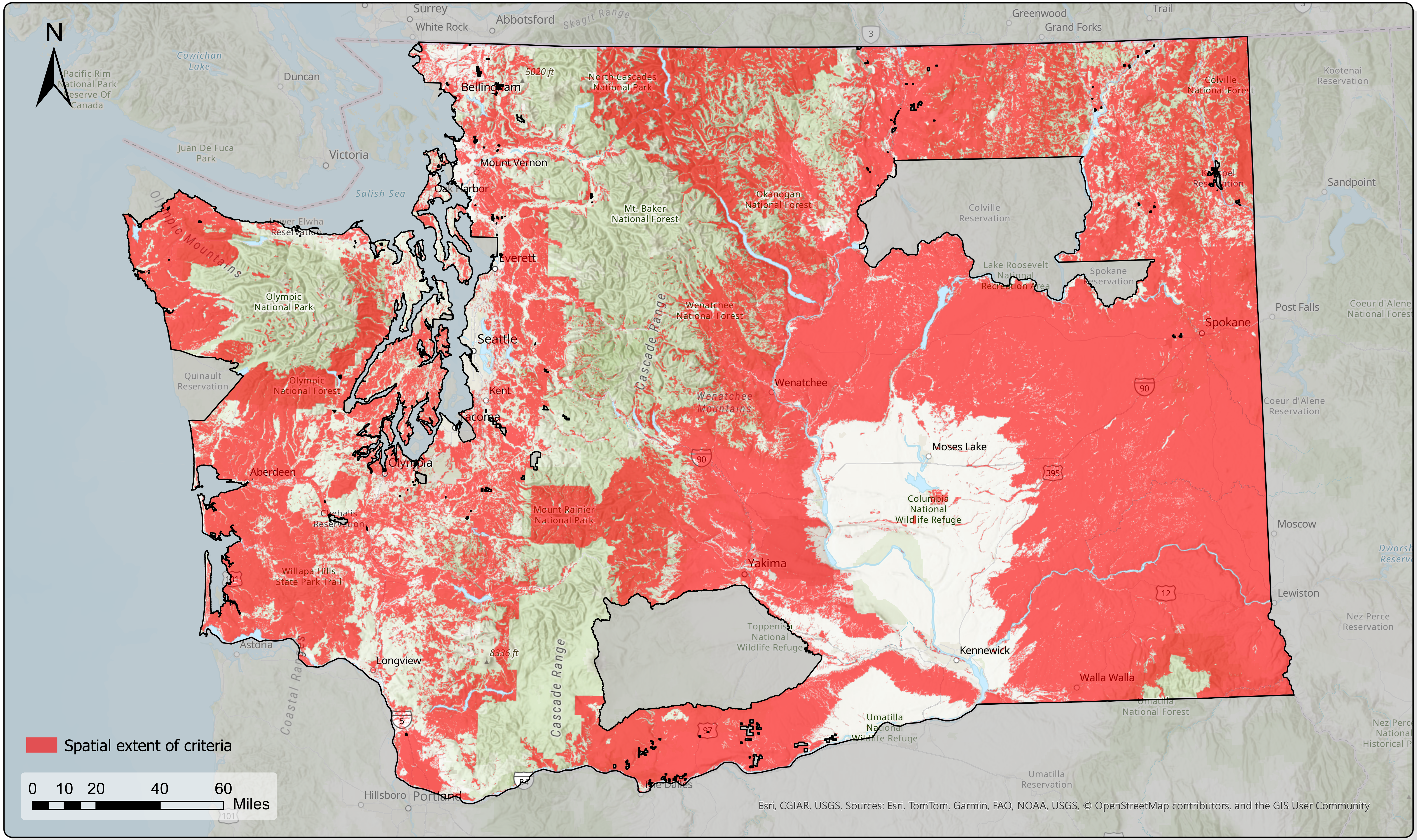

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Figure 3.2-11

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